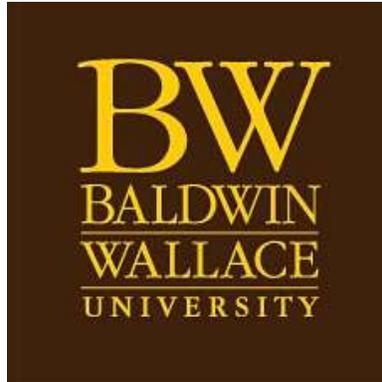


DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

Volume 1

CODE OF CONDUCT
DIVISIONS 00-14
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DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

Volume 2

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PLEASE BE ADVISED THAT SHOULD YOU HAVE
ANY QUESTIONS OR CONCERNS REGARDING THIS
BALDWIN WALLACE UNIVERSITY “DESIGN GUIDELINES
AND CONSTRUCTION STANDARDS” BOOK
IN RELATIONSHIP TO A PROJECT YOU ARE WORKING ON
OR A PROJECT YOU MAY WORK ON IN THE FUTURE,
YOU MUST CONTACT:

BUILDINGS AND GROUNDS DEPARTMENT

400 N. ROCKY RIVER DRIVE

BEREA, OH 44017

(440) 826-2233 (PHONE)

(440) 826-8551 (FAX)

NOT DOING SO MAY RESULT IN YOU OR
YOUR COMPANY BEING HELD LIABLE.



CODE OF CONDUCT

Purpose

These Special Conditions are required because work involves being in or adjacent to student residences and classroom buildings. As such, the Contractor, all workers, subcontractors, deliverymen, Labor Support Companies (LSC), and anyone else coming on to the work site must be informed of the requirements to respect the students' privacy and right to the quiet enjoyment of their residence halls or apartments. The work must be done in a manner that maintains the security of the residence halls or apartments, limits contact with the students, provides advance notice of any work that may adversely affect the residents, and limits communications about the project to those persons designated by the University.

General Rules

1. These Rules apply to all Contractors, their workers, subcontractors, Labor Support companies, deliverymen, and anyone else coming on site to work (further known as Contractor Personnel for purposes of this Code of Conduct).
2. The Baldwin Wallace University's Sexual Harassment Policy, which can be reviewed at the Baldwin Wallace University website (https://www.bw.edu/Assets/Offices/HR/Sexual_Misconduct_Policy.pdf), must be complied with. All Contractors and Contractor Personnel must adhere to the Baldwin Wallace University policy and conduct themselves in a manner that does not constitute sexual harassment (as defined in the policy) as a result of interacting with and around Baldwin Wallace University faculty, staff and students.

The Contractor is also required to inform Contractor Personnel of the Baldwin Wallace University policy prohibiting sexual harassment.

3. To support the health and well-being of our students, staff and visitors, the Baldwin Wallace University campus is 100 percent tobacco free. Please refrain from smoking or using tobacco products anywhere on campus. Thank you for your cooperation.

Smoking and use of tobacco are prohibited on the Baldwin Wallace University campus.

4. The Contractor and Contractor Personnel are required to ensure that noise prior to the official start of work does not disrupt students. These noise concerns may include, but are not limited to, equipment warm up and voice noise within the construction site that can be heard within the residence hall room or apartment, and the arrival of early morning deliveries of equipment, concrete, supplies, etc. No radios/CD players are to be used on site.

Working hours Monday through Friday during the summer can begin at 7:00 a.m., and 8:00 a.m. when school is in session. This will be standard unless a specific request is made 72 hours in advance of work outside of normal hours and is subject to approval by University Project Manager.

5. No eating, drinking, music or radios are allowed outside designated construction areas in residence hall buildings, apartment areas or classroom areas. Prior to the start of work, and with the approval of the University Project Manager, if space is available, one area may be designated for meal and coffee breaks. Eating and drinking in any other part of the facility are prohibited. Wrappers, cups and other trash shall be properly disposed of in receptacles after each break. No trash is to be left in the designated eating area.

SPECIAL CONTRACT CONDITIONS FOR WORKING ON BALDWIN WALLACE UNIVERSITY CAMPUS BALDWIN WALLACE UNIVERSITY – CODE OF CONDUCT

6. The Contractor and Contractor Personnel are required to wear appropriate work wear, hard hats, and safety footwear, as the case may be, while on campus. Articles of clothing must be neat and tidy in appearance, and cannot display offensive or inappropriate language, symbols, or graphics. The University has the right to decide if such clothing is inappropriate.
7. The Contractor and Contractor Personnel are not to use any of the buildings' furnishings at any time for any reason. In the event furniture has to be moved for access, the Contractor must notify the University Project Manager and return the furniture in good condition to its original location immediately after the work is done.
8. Baldwin Wallace University will provide escort to any area outside the immediate construction site/work area. Special security arrangements must be made in advance, with the University Project Manager in order to enter these areas.
9. The University Project Manager retains the right to require the Contractor or Contractor Personnel to remove a worker from the project, if the University Project Manager determines, in his/her sole discretion, that the worker violated a provision of this Agreement. The worker has the right to a meeting with the Project Manager and the Contractor at which time the University Project Manager will inform the worker of the allegations made against him/her. The worker will be given the opportunity to present his/her response before a final decision is made.

Security Requirements

1. Security of University facilities is of paramount concern. When a Contractor or Contractor Personnel signs for a key and/or access card, the Contractor or Contractor Personnel take full responsibility for that key and/or access card. A lost key may result in re-keying an entire building or complex, the cost of which will be charged to the Contractor or Contractor Personnel. Doors are not to be propped open at any time. Contractors or Contractor Personnel working in a secured building are not to let anyone in. When leaving a facility at the end of a workday, the Contractor or Contractor Personnel must make sure that the construction site is secure.
2. Except for emergencies special security arrangements must be made at least 72 hours in advance, with the University Project Manager in order to enter any occupied residential space, including a student room or apartment, or remove anything from a student's room or apartment. Special care is to be exercised when access is required into student's room or apartment or any other area outside the construction site. The University Project Manager or their designee must be notified in advance of this need and the University Project Manager will arrange access to this space through the Residential Life Office who will ensure compliance with all University safety and security standards and regulations. Should items need to be removed from a student occupied room or apartment the Residential Life Office will assist with and/or oversee the removal and replacement of the item.

A 72-hour notice must be given prior to any work being started or removal of any items. All of the above rules pertaining to tobacco, food and drink, furnishings and housekeeping apply when working in a student's room or apartment. Furnishings shall not be used for construction purposes. Everything in a student's room or apartment is a personal belonging and must be respected as such.

3. The Contractor or Contractor Personnel are required to wear identification. Jackets and/or shirts with the company names and logos are helpful.
4. The Contractor, Contractor Personnel, and University Project Manager are responsible to immediately respond to security and safety concerns, report to campus Security and notify Owner for immediate response and action.

Scheduling and Planning

1. Weekly construction or bi-weekly supervisor meetings will review the Contractor's or Contractor Personnel's need to access residential space or any other University areas not involved in the construction project. Approximate dates, locations, time periods and specific space where Contractors need access will be discussed at meeting.



TOBACCO AND SMOKE-FREE POLICY

EFFECTIVE JANUARY 1, 2017

In the interest of the health, safety, and comfort of students, faculty, staff, and campus visitors, smoking is prohibited on all university-owned or leased property. This policy applies to faculty, staff, students, visitors, subcontractors, consultants, and vendors. This prohibition includes all university buildings, athletic and recreational facilities, parking lots and university owned, or personal vehicles being driven or parked on campus.

Tobacco use means the personal use of any tobacco product, whether lighted or not, including but not limited to: cigarettes, pipes, cigars, e-cigarettes, and smokeless or chewing tobacco.

Employees are authorized and encouraged to communicate this policy with courtesy, respect and diplomacy. If an employee refuses to comply with this policy, Human Resources shall be notified. If a student refuses to comply with this policy, the Office of Student Affairs shall be notified. If Contractors, consultants, visitors, or vendors refuse to comply with the policy, the Safety and Security Department should be contacted. Individuals violating the policy should initially be reminded about the policy. Continuing violations may also result in appropriate disciplinary action up to and including dismissal.

Tobacco is a leading cause of death in the United States. Baldwin Wallace University encourages any employee or student who uses tobacco to quit. More information on tobacco and smoking cessation programs can be obtained from Human Resources or the Student Health Center.

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DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
AUGUST 10, 2017**

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DIVISION 0 – PROFESSIONAL SERVICES

SECTION 000000 – Section Index

005000 DESIGN PHASE CONSTRUCTION ESTIMATES

005001 DESIGN GUIDELINES FOR SUSTAINABILITY

SECTION AE – 005000 – DESIGN PHASE CONSTRUCTION SERVICES

PART 1: GENERAL

1.1 Scope of Standard

- A. The purpose of this section is to provide guidelines for preparation of design phase construction estimates and to promote consistency and accuracy in the estimates. Construction estimates should be completed as a deliverable at predetermined milestones or at the end of each design phase (Programming, SD, DD, and 90 to 95 percent CD). The estimates should be developed using the procedure below.

1.2 Responsibility

- A. The following people are responsible for following this SOP.
 - 1. Project Managers
 - 2. Cost Consultants (CC)
 - 3. Architects & Engineers (AE)

1.3 General Requirements

- A. The AE or design professional will be responsible for preparation of estimates for the Scope of Work under their contract (e.g. all items included in the bid packages they develop). The AE and Owner should agree upon a budget for the “Cost of Work” as defined in the AIA B101. It is advisable for the Owner and AE to review what is included and excluded from the estimate for Cost of Work. In summary, the estimates should predict the dollar amounts for the Scope of Work included in the bid package(s).
- B. Third Party Estimating: Third party estimating should be used on all projects with construction values over \$1,000,000. Third party estimating is optional for smaller projects. Baldwin Wallace University has Open End Task Order contracts with multiple professional estimating firms for this purpose. This service will be contracted directly to Baldwin Wallace University.

When third party estimating is used, both the AE and the third party estimator will prepare estimates based on the AE's design submission. Estimates should be done at least three times during design; at SD, DD and 90 to 95 percent CD. The AE and the third party estimator should meet early in the project to agree on the format of the estimate to facilitate comparison and reconciling. It is critical that CC meet prior to developing SD estimates. After both parties have completed their estimates, they will be compared and reconciled. The first step in the reconciliation process is for the two estimators to exchange estimates in order to ensure the format is comparable. After this step has occurred a formal meeting should be held with the Owner to review and reconcile the estimates. The Owner will make the final determination as to which estimate should be used for any line item where difference exists between the two estimates. If Value Engineering (VE) exercises are performed, the estimators should confirm the value of the VE items selected and incorporate them into a revised estimate.

- C. Furniture, Fixtures and Equipment (FFE): The costs for loose furniture, fixtures and equipment (FFE) should not be included in the estimates for the Cost of Work unless this is part of the AE Scope of Work or otherwise specifically requested. The AE should bring to the Owner's attention any items they consider questionable for inclusion in its cost estimates.
- D. AV Equipment and Technology: The cost for AV equipment and technology may or may not be included in the Construction estimate. This should be determined with consultation from the Project Manager.

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- E. Construction Estimates should be based on the design deliverables available at each design phase. Square-foot estimates are acceptable at Conceptual Stage. Estimates provided at SD, DD and 90 to 95 percent CD should be detailed and based on quantity take-offs from the drawings and other design deliverables. The level of detail should increase as the design progresses and detailed unit cost estimates, based on quantity take-offs are expected at the CD phase.
- F. All estimates shall be formatted and summarized to Baldwin Wallace University's requirements with a back-up consisting of:
1. Summary Page with percentages consistent among the two parties (see attached samples),
 2. Both the 2004 MasterFormat & UniFormat are acceptable but both parties must agree on the format **prior** to estimating,
 3. Quantity surveys with the unit prices used for each work item,
 4. Assumptions and qualifications, and
 5. Allowances where the Scope of Work is not determined.
- G. The level of detail contained in each estimate should be sufficient to provide Baldwin Wallace University with the information necessary to make firm, informed, and cost effective decisions.
1. Schematic Design (SD) Phase:
The Schematic Design cost estimate will be prepared in Construction Specifications Institute (CSI) MasterFormat 2004 (50 Divisions) or UniFormat as long as both parties agree on the same format prior to estimate. Based on the existing documentation (i.e., program requirements, drawings, specifications, etc.), the CC will prepare a detailed line item cost estimate for comparison and reconciliation with the Design Professional's estimate.
 2. Design Development (DD) Phase:
At Design Development, the design of the Project should reach a point where all the elements have been identified and designed. At this time the CC will prepare a detailed construction cost estimate based on quantity take-offs derived from drawings and specifications prepared by the Design Professional.
 3. Construction Documents (CD) Phase:
As the building design continues to develop, Baldwin Wallace University requires a final cost estimates at 90 to 95 percent CD. At this stage, the degree of detail in the estimate back-up will enable verification of the CC in-house estimating through trade Contractor input.
- H. Escalation and Contingencies
1. Escalation: The estimate should include an escalation factor to account for changes in construction labor and material costs from the time of estimate to the midpoint of the construction phase. Escalation factors should be based on market indicators or trends such as the Engineering News Record Construction Cost Index or other approved indices. All estimates should be dated.
 2. Contingency

Design Contingency: A design contingency should be included to account for unknown design elements and uncertainties in the design. The design contingency can be decreased as the design progresses; for example 10 percent at SD, 5 percent at DD and 1-2 percent at 90 to 95 percent CD.

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- a. Bid Contingency (or Market Contingency): A market contingency may be used to account for the potential differences between the construction estimates and the bids. Market volatility or market conditions should be considered when setting this contingency. A recommended value is 2 percent. The market contingency shall remain at CD.
 - b. Owner's Contingency: The Owner will maintain an Owner's Contingency outside of the budget for the Cost of Work to cover the errors, omissions, unforeseen conditions, and potential changes in the Work after bidding. This should not be included in the AE or CC estimates.
- I. Taxes: Construction estimates should reflect the 8.5 percent Ohio State sales tax on materials purchased by Contractors. Estimates should also include any local taxes. Materials and equipment purchased directly by the University are not subject to sales tax.

END OF SECTION 005000

SECTION AE – 005001 – DESIGN GUIDELINES FOR SUSTAINABILITY

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard is intended to help Project Managers, architects, and engineers understand Baldwin Wallace University policy and approach for incorporating sustainability practices into construction projects.
- B. Baldwin Wallace University will strive to incorporate sustainable practices into its operations and business processes, which includes (but not limited to): purchasing green products, incorporating LEED concepts into building design, promoting recycling throughout the university, and encouraging energy and water conservation in all campus buildings.
- C. Baldwin Wallace University projects may or may not choose to pursue certification under the Leadership in Energy and Environmental Design (LEED) Green Building Rating Systems created by the United States Green Building Council (USGBC). However, all Baldwin Wallace University projects are expected to apply sustainable practices to the greatest extent possible.
- D. The architect should complete a USGBC LEED checklist as a deliverable at predetermined milestones or at the end of each design phase (SO, DO, and CD) along with a narrative highlighting key aspects of sustainability goals and addressing the six categories of the LEED checklist.
- E. Sustainability goals and checklist should be reviewed at each phase with stakeholders and Baldwin Wallace University sustainability Director.

1.2 Reference Standard(s)

- A. U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design
- B. Baldwin Wallace University has a Sustainability Position Statement which follows:

Recognizing its social, economic, and educational leadership responsibilities within the state of Ohio, Baldwin Wallace University is committed to ensuring a more sustainable future for its students, faculty, and staff, and for the citizens of Ohio. Baldwin Wallace University will promote the use of sound sustainable principles and [Rev-O] 12/11 005001-1 practices through learning, teaching, research, and facilities management from both an educational and operational perspective.

1. Members of the Baldwin Wallace University community (faculty, staff, and students) will have a basic understanding of sustainable practices, communicated through informal learning sessions and the incorporation of sustainability issues into the University curricula.
2. Baldwin Wallace University will encourage and support sustainability scholarship and research.

Baldwin Wallace University will strive to incorporate sustainable practices into its operations and business processes, which includes purchasing green, incorporating green concepts into building design and maintenance, promoting recycling, and encouraging energy and water conservation in all campus buildings.

PART 2: EXECUTION

- A. Baldwin Wallace University has incorporated many sustainable principals/practices into the Baldwin Wallace University Design Guidelines & Construction Standards. Designs developed in compliance with these standards should result in a project that is equivalent to LEED Certified level.
- B. The sustainability goals for a project will be determined in the programming phase. If the goal of a project is to achieve formal LEED certification, this must be approved by the University as part of the project approval. All appropriate USGBC requirements should be followed.
- C. If the goal is not to pursue LEED certification, the following protocol should be followed:
 - 1. Follow USGBC guidelines and checklists as a metric and means for documenting sustainable features, but forgo the process of submitting paperwork to USGBC for formal approval and certification.
 - 2. Baldwin Wallace University would contractually require the architect to complete and submit a LEED checklist to the Owner during design and at the completion of construction documenting the probable LEED points achieved. The LEED checklist will be used to document the sustainable features of the facility. The purpose of the LEED checklist is to demonstrate that a project is equivalent to a “certified” level on the USGBC rating system.
 - 3. Baldwin Wallace University supports design phase energy modeling to support completion of LEED checklist.
 - 4. Baldwin Wallace University promotes third party commissioning on all major capital projects and will consider “enhanced commissioning” of large, complex facilities.
 - 5. Baldwin Wallace University targets 24 percent of optimizing energy performance under Energy and Atmosphere section of the LEED checklist.
 - 6. Baldwin Wallace University encourages energy-saving features that can show a life-cycle cost savings with respect to energy, maintenance, and/or operations.
 - 7. Baldwin Wallace University encourages involvement from LEED accredited professionals on the project team.

PART 3: VERIFICATION/VALIDATION

- A. During the design phase, the Architect shall maintain an appropriate level of documentation to substantiate that the sustainability goals have been incorporated into the project design. The documentation should support the LEED points being pursued on the checklist. The documentation should be sufficient to pass a sustainability audit by the Owner or their designee. For example, appropriate calculations must be completed to support any LEED points related to efficiencies requiring a “percent reduction”.
- B. During the construction phase, the contract documents shall also require the Contractor to submit appropriate documentation to validate and verify LEED points earned. For example if credits are being pursued for diversion of construction waste, appropriate documentation must be submitted. The standard submittal process may be sufficient to document points earned for certain products or equipment that earn LEED points.
- C. **All relevant LEED information and documentation must be compiled and delivered to Baldwin Wallace University at the completion of the project.**

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Note: A sample USGBC LEED checklist and sustainability LEED process are attached. The checklist is color coded noting the University standard or likelihood of pursuing various sustainable aspects or points.

Green = standard
Yellow = possible
Red = not probable

END OF SECTION 005001

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 1 – GENERAL REQUIREMENTS

SECTION 010000 – Section Index

013200 CONSTRUCTION PROGRESS DOCUMENTATION LONG

013200A CONSTRUCTION PROGRESS DOCUMENTATION SHORT

SECTION 013200 – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1: GENERAL

1.1 Related Documents

- A. Drawings and General Provisions of the Contract, including general and supplementary conditions and other Division 1 specification sections, apply to this section.

1.2 Summary

- A. This section includes administrative and procedural requirements for documenting the progress of construction during performance of the work, including the following:
 - 1. Preliminary Construction Schedule
 - 2. Contractor's Construction Schedule
 - 3. Submittals Schedule
 - 4. Daily construction reports
 - 5. Material location reports
 - 6. Field condition reports
 - 7. Special reports
 - 8. Construction photographs

1.3 Definitions

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 9. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 10. Predecessor activity is an activity that precedes another activity in the network.
 - 11. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of project.
- D. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration and contains no float.

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DIVISION 1 – GENERAL REQUIREMENTS

- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float or slack time, as calculated by Primavera SureTrak 3.0, using retained logic, associated with one chain or activities is defined as amount of time between earliest start date and latest start date or between earliest finish date and latest finish date for such activities, as calculated as part of the Construction Schedule. Float or slack time shown on the Construction Schedule is not for exclusive use or benefit of either the Owner or the Contractor and is available for use by either of them according to whichever first needs the use or benefit of the float to facilitate the effective use of available resources and to minimize the impact of Project problems, delays or changes in the Work which may arise during performance. Contractor specifically agrees that float time may be used by the Owner in conjunction with their review activities or to resolve Project problems. Contractor agrees that there will be no basis for any modification of the specific dates or an extension of the contract time, or a claim for additional compensation as a result of any Project problem, change order, or delay which only results in the loss of available positive float on the Construction Schedule.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the following activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Fagnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- H. Major Area: A story of construction, a separate building, or a similar significant construction element.
- I. Milestone: A key or critical point in time for reference or measurement.
- J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.
- L. Target Dates: The baseline start and finish dates for an activity. A schedule baseline is the target, or goal, of your schedule, and shows when you hope to accomplish each activity.

1.4 Submittals

- A. Qualification Data: For firms and persons specified in “Quality Assurance” article and in-house scheduling personnel to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Owners, and other information specified.
- B. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal
 - 2. Specification section number and title
 - 3. Submittal category (action or informational)
 - 4. Name of subcontractor
 - 5. Description of the Work covered

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 1 – GENERAL REQUIREMENTS

6. Scheduled date for Architect's final release or approval
- C. Preliminary Construction Schedule: Submit within 7 days after Notice to Proceed. Submit two (2) printed copies and one electronic copy formatted for Primavera SureTrak 3.0.
- D. Preliminary Network Diagram: Submit three (3) printed copies, large enough to show entire network for entire construction period.
 1. Submit an electronic copy of schedule, using Primavera SureTrak 3.0, on recordable compact disks (CD-R), and labeled to comply with requirements for submittals. Include type of schedule and date on label.
- E. Contractor's Construction Schedule: Submit three (3) printed copies of initial schedule, large enough to show entire schedule for entire construction period.
 1. Submit an electronic copy of schedule, using Primavera SureTrak 3.0, on recordable compact disks (CD-R), and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- F. CPM Reports: Concurrent with CPM schedule, submit three printed copies of each of the following computer-generated reports. Format for each activity in reports shall contain an activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float.
 1. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 2. Total Float Report: List of all activities sorted in ascending order of total float. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment. Path Report: List of all activities sorted in ascending order with a total float less than 7 days.
 3. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
 4. Critical Path Report: List of all activities sorted in ascending order with a total float less than seven (7) days.
- G. Construction Photographs: Submit progress photographs monthly or as required. Photographs may be in digital or hard copy format.
 1. Format for Hard Copy: 4 inches by 6 inches smooth-surface matte prints, on single-weight commercial-grade stock, enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project
 - b. Name and address of photographer
 - c. Name of Architect
 - d. Name of Contractor
 - e. Date photograph was taken.

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DIVISION 1 – GENERAL REQUIREMENTS

- f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
- 3. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped. Include a photo log with information specified under Subparagraph 2. Identification.
- H. Daily Construction Reports: Submit two (2) copies at weekly intervals.
- I. Material Location Reports: Submit two (2) copies at weekly intervals.
- J. Field Condition Reports: Submit two (2) copies at time of discovery of differing conditions.
- K. Special Reports: Submit two (2) copies at time of unusual event.

1.5 Quality Assurance

- A. Scheduling Consultant Qualifications: An experienced specialist in CPM scheduling and reporting.
- B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 1. Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including work stages, area separations, and interim milestones.
 - 4. Review time required for review of submittals and resubmittals.
 - 5. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 6. Review time required for completion and startup procedures.
 - 7. Review and finalize list of construction activities to be included in schedule.
 - 8. Review submittal requirements and procedures.
 - 9. Review procedures for updating schedule.

1.6 Coordination

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate Contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

- C. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to the project site, and the use of temporary facilities including temporary lighting.

PART 2: PRODUCTS

2.1 Related Documents

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 Contractor's Construction Schedule, General

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling".
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 30 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 1. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 4. Startup and Testing Time: Include not less than 30 days for startup and testing.
 5. Commissioning: Include commissioning activities completing before substantial completion.
 6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

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DIVISION 1 – GENERAL REQUIREMENTS

7. Punch List: Include activities to be performed to reach substantial completion.
- D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 1. Delivery dates indicated stipulate the earliest possible delivery date.
 2. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction
 - b. Limitations of continued occupancies
 - c. Uninterruptible services
 - d. Partial occupancy before Substantial Completion
 - e. Use of premises restrictions
 - f. Provisions for future construction
 - g. Seasonal variations
 - h. Environmental control
 3. Work Stages: Indicate important stages of construction for each major portion of the work, including, but not limited to, the following:
 - a. Subcontract awards
 - b. Submittals
 - c. Purchases
 - d. Mockups
 - e. Fabrication
 - f. Sample testing
 - g. Deliveries
 - h. Installation
 - i. Tests and inspections
 - j. Adjusting
 - k. Curing
 - l. Startup and placement into final use and operation
 - m. Commissioning
 - n. Punch list
 4. Area Separations: Identify each major area of construction for each major portion of the work

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DIVISION 1 – GENERAL REQUIREMENTS

Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

- a. Structural completion
 - b. Permanent space enclosure
 - c. Completion of mechanical installation
 - d. Completion of electrical installation
 - e. Substantial completion
- E. Target Dates: Define target dates once CPM schedule has been completed and before schedule is updated to show progress.
- F. Insert a list of major areas here if specific scheduling is required. List might include non-building work, such as roads, parking, landscape development, and similar work.
- G. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- H. Cost Correlation: At the head of schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of the work performed as of dates used for preparation of payment requests.
1. Refer to Division 1 for cost reporting and payment procedures.
 2. Contractor shall assign cost to construction activities on the CPM schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Architect's approval, be assigned to fabrication and delivery activities. Costs shall be under required principal subcontracts for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable), in the amount of 5 percent of the Contract Sum.
 3. Each activity cost shall reflect an accurate value subject to approval by the Architect.
 4. Total cost assigned to activities shall equal the total Contract Sum.
- I. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using Fragnet to demonstrate the effect of the proposed change on the overall project schedule.
- J. Computer Software: Prepare schedules using Primavera SureTrak 3.0 or similar approved software.

2.3 Preliminary Construction Schedule

- A. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

2.4 Contractor's Construction Schedule (CPM Schedule)

- A. General: Prepare network diagrams using AON (activity-on-node) format.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

- B. CPM Schedule: Prepare Contractor's Construction Schedule using a CPM network analysis diagram.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
 - 2. Conduct educational workshops to train and inform key Project Personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
 - 3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 4. Use “calendar day” as the unit of time.
- C. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work.
 - 1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals
 - b. Purchase of materials
 - c. Delivery
 - d. Fabrication
 - e. Installation
 - f. Startup and testing
 - g. Commissioning
 - 2. Processing: Process data to produce output data or a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 - 3. Format: Mark the critical path.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
 - 4. Target Dates: Define the target dates before schedule is updated to show progress.

2.5 Reports

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 - a. List of subcontractors at Project site
 - b. List of separate Contractors at Project site
 - c. Approximate count of personnel at Project site
 - d. Equipment at Project site

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

- e. Material deliveries
 - f. High and low temperatures and general weather conditions
 - g. Accidents
 - h. Meetings and significant decisions
 - i. Unusual events (refer to special reports)
 - j. Stoppages, delays, shortages, and losses
 - k. Meter readings and similar recordings
 - l. Emergency procedures
 - m. Orders and requests of authorities having jurisdiction
 - n. Change Orders received and implemented
 - o. Incidents involving students or public, specifically harassment
 - p. Construction Change Directives received
 - q. Services connected and disconnected
 - r. Equipment or system tests and startups
 - s. Partial Completions and occupancies
 - t. Substantial Completions authorized
 - u. Work performed, including concrete and structural steel deliveries and placement reports.
- B. Material Location Reports: At weekly intervals, prepare a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare a detailed report. Submit with a request for information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 Special Reports

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of unusual and significant nature occurs at the Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
- C. Reporting Accidents: When an accident occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons injured, witnesses, first responders, hospital or clinic where injured was treated. Notify Baldwin Wallace University's Environmental Health and Safety Department immediately when an accident resulting in an injury occurs.

PART 3: EXECUTION

1.4 Contractor's Construction Schedule

- A. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting using CPM scheduling.
 - 1. In-House Option: Owner may waive the requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Must submit qualifications.
 - 2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.
- B. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, target starts and finishes, and activity durations.
 - 3. As the work progresses, indicate Actual Completion percentage for each activity or remaining duration for each activity.
- C. Distribution: Distribute copies of approved schedule to Architect, Owner, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.
 - 3. Submit, with pay application, a comprehensive, fully developed, CPM horizontal Gantt-chart-type, Contractor's Schedule within 30 days of date established for commencement of the Work. Base schedule on the Preliminary Construction Schedule and whatever updating and feedback was received since the start of Project.
 - a. No invoices will be processed until the Contractor's Construction Schedule is submitted. No subsequent invoices will be processed until this schedule is approved by the University.

3.2 Construction Photographs

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 - 1. Date and Time: Include date and time in filename for each image.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.
- C. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
 - D. Preconstruction Photographs: Before starting construction, take color photographs of Project site and surrounding properties from different vantage points, as directed by Architect. Show existing conditions adjacent to property.
 - E. Periodic Construction Photographs: Take progress photographs on a weekly basis and submit monthly coinciding with cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since last photographs were taken.
 - F. Final Completion Construction Photographs: Take a minimum eight color photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.

3.3 Construction Videotapes

- A. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each videotape, record weather conditions from local newspapers or local television and the actual temperature reading at the Project site.
- B. Narration: Describe scenes on videotape by audio narration by microphone while videotape is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
 1. Confirm date and time at beginning and end of recording.
 2. Begin each videotape with name of Project, Contractor's name, videographer's name, and Project location.
- C. Preconstruction Videotape: Before starting construction, record videotape of Project site and surrounding properties from different vantage points, as directed by Architect.
 1. Flag construction limits before recording construction videotapes.
 2. Show existing conditions adjacent to Project site before starting the Work.
 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of construction.
 4. Show protection efforts by Contractor.

END OF SECTION 013200

SECTION 013200a – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1: GENERAL

1.1 Related Documents

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification sections, apply to this section.

1.2 Summary

- A. This section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preliminary Construction Schedule
 - 2. Contractor's Construction Schedule
 - 3. Submittals Schedule
 - 4. Daily construction reports
 - 5. Special reports

1.3 Definitions

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Major Area: A story of construction, a separate building, or a similar significant construction element.
- G. Milestone: A key or critical point in time for reference or measurement.
- H. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.4 Submittals

- A. Electronic Files: Where possible all information should be submitted in both hard copy and electronic files.
- B. Submittals Schedule: Submit three (3) paper copies of schedule. Arrange the following information in a tabular format:
1. Scheduled date for first submittal
 2. Specification section number and title
 3. Submittal category (action or informational)
 4. Name of subcontractor
 5. Description of the Work covered
 6. Scheduled date for Architect's final release or approval
- C. Preliminary Construction Schedule: Submit three (3) copies.
- D. Contractor's Construction Schedule: Submit three (3) copies of initial schedule, large enough to show entire schedule for entire construction period.
1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- E. Daily Construction Reports: Submit two (2) copies at weekly intervals.

1.5 Quality Assurance

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Division 01. Review methods and procedures related to the Preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
 2. Discuss constraints, including phasing, Work stages, area separations, interim milestones and partial Owner occupancy.
 3. Review delivery dates for Owner-furnished products.
 4. Review Schedule for Work of Owner's separate contracts.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

5. Review time required for review of submittals and resubmittals.
6. Review requirements for tests and inspections by independent testing and inspecting agencies.
7. Review time required for completion and startup procedures.
8. Review and finalize list of construction activities to be included in schedule.
9. Review submittal requirements and procedures.
10. Review procedures for updating schedule.

1.6 Coordination

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate Contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 1. Secure time commitments for performing critical elements of the Work from parties involved.
 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2: PRODUCTS

2.1 Submittals Schedule

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 2. Initial Submittal: Submit concurrently with preliminary CPM Schedule. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - a. At Contractor's request, show submittals on the Preliminary Construction Schedule, instead of tabulating them separately.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.

2.2 Contractor's Construction Schedule, General

- A. Procedures: Comply with procedures contained in AGC's "Construction Planning & Scheduling".
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by a Change Order.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 1 – GENERAL REQUIREMENTS

- C. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 4. Startup and Testing Time: Include not less than <Insert number> days for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
- D. Constraints: Include constraints and Work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work under More Than One Contract: Include a separate activity for each contract.
 3. Work by Owner: Include a separate activity for each portion of the Work performed by the Owner.
 4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Division 01. Delivery dates indicated stipulate the earliest possible delivery date.
 5. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Division 01. Delivery dates indicated stipulate the earliest possible delivery date.
 6. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction
 - b. Limitations of continued occupancies
 - c. Uninterruptible services
 - d. Partial occupancy before Substantial Completion
 - e. Use of premises restrictions
 - f. Provisions for future construction
 - g. Seasonal variations
 - h. Environmental control

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 1 – GENERAL REQUIREMENTS

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards
 - b. Submittals
 - c. Purchases
 - d. Mockups
 - e. Fabrication
 - f. Sample testing
 - g. Deliveries
 - h. Installation
 - i. Tests and inspections
 - j. Adjusting
 - k. Curing
 - l. Startup and placement into final use and operation
8. Area Separations: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural Completion
 - b. Permanent space enclosure
 - c. Completion of mechanical installation
 - d. Completion of electrical installation
 - e. Substantial Completion
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
 1. Notice of Commencement
 2. Notice of Intent (EPA)
 3. Notice of Termination (EPA)
 4. Permits Filed with City of Berea
 5. Move In Date
 6. Furniture Delivery Dates
 7. Punch List Date
 8. Punch List Completion Date

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

9. Deliverables (Technical Manuals, As-Builts, Drawings, Etc.)
 10. Training Dates
 11. Occupational Permit
- F. Contract Modifications: For each proposed contract modification and concurrent with its submission, indicate the effect of the proposed change on the overall project schedule.
- G. Computer Software: Prepare schedules using one of the following scheduling programs.
1. Microsoft Project or Primavera Suretrak 3.0

2.3 Preliminary Construction Schedule

- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven (7) days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first sixty (60) days of construction.

2.4 Construction Schedule (CPM Schedule)

- A. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized time-scaled program using the CPM method.
- B. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals
 - b. Mobilization and demobilization
 - c. Purchase of materials
 - d. Delivery
 - e. Fabrication
 - f. Utility interruptions
 - g. Installation
 - h. Work by Owner that may affect or be affected by Contractor's activities
 - i. Testing
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 1 – GENERAL REQUIREMENTS

4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Sub-networks on separate sheets are permissible for activities clearly off the critical path.

2.5 Reports

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 1. List of subcontractors at Project site
 2. List of separate Contractors at Project site
 3. Approximate count of personnel at Project site
 4. Equipment at Project site
 5. Material deliveries
 6. High and low temperatures and general weather conditions
 7. Accidents
 8. Meetings and significant decisions
 9. Unusual events (refer to special reports)
 10. Stoppages, delays, shortages, and losses
 11. Meter readings and similar recordings
 12. Emergency procedures
 13. Orders and requests of authorities having jurisdiction
 14. Change Orders received and implemented
 15. Change Directives received and implemented
 16. Services connected and disconnected
 17. Equipment or system tests and startups
 18. Partial completions and occupancies
 19. Substantial completions authorized

2.6 Special Reports

- A. General: Submit special reports directly to Owner within one (1) day of an occurrence. Distribute copies of report to parties affected by the occurrence.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 1 – GENERAL REQUIREMENTS

- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3: EXECUTION

3.1 Contractor's Construction Schedule

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Updated schedules should be submitted with monthly applications for payment.
 - 1. Post copies in Project meeting rooms and temporary field offices.

END OF SECTION 013200a

SECTION 020000 – Section Index

- 022100 SURVEYS
- 022400 ENVIRONMENTAL ASSESSMENT
- 023000 SUBSURFACE INVESTIGATION
- 024116 BUILDING DEMOLITION
- 024119 SELECTIVE DEMOLITION
- 025000 EXISTING MATERIAL ASSESSMENT
- 025800 SNOW CONTROL
- 028000 FACILITY REMEDIATION

SECTION 022100 – SURVEYS

PART 1: GENERAL

1.1 Baldwin Wallace University's surveyor of record has generally been Hoffman Metzger, a preferred local survey firm.

Hoffman Metzger
24 Beech Street
Berea, Ohio 44017
(440) 234-5544

END OF SECTION 022100

SECTION 022400 – ENVIRONMENTAL ASSESSMENT

PART 1: GENERAL

1.1 Baldwin Wallace University's currently uses two local geo-technical firms, for all environmental investigations, testing, sampling, etc.

Geo-Sci, Inc.
110 Blaze Industrial Parkway
Berea, Ohio 44017
(440) 234-8985

Solar Testing Laboratories Inc.
1125 Valley Belt Road
Brooklyn Heights, OH 44131
Phone: (216) 741-7007
Fax: (216) 741-7011

END OF SECTION 022400

SECTION 023000 – SUBSURFACE INVESTIGATION

PART 1: GENERAL

1.1 Baldwin Wallace University's currently uses two local geo-technical firms, for all soils sampling, geo-thermal testing, concrete and materials testing, etc.

Geo-Sci, Inc.
110 Blaze Industrial Parkway
Berea, Ohio 44017
(440) 234-8985

Solar Testing Laboratories Inc.
1125 Valley Belt Road
Brooklyn Heights, OH 44131
Phone: (216) 741-7007
Fax: (216) 741-7011

END OF SECTION 023000

SECTION 024116 – BUILDING DEMOLITION

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel. **Baldwin Wallace University may choose to perform its own building demolition or selective demolition.**

1.2 Performance Requirements

- A. All waste/demolition material shall become the property of the Contractor and shall be disposed of in accordance with local, state and federal laws.
- B. The Contractor, at the request of the Owner, shall provide documentation substantiating the proper disposal of all waste materials.
- C. All items denoted by Owner as salvageable, or recyclable, shall be removed and stored by Contractor in a location designated by the Owner. The Owner will review the site with Contractor and will designate any such materials before demolition begins.
- D. The Contractor shall verify that all utilities impacted by Building Demolition activities have been relocated, disconnected or capped prior to commencement.
- E. A statement of refrigerant recovery shall be submitted to the Owner in accordance with industry standards.
- F. A hazardous materials assessment shall be conducted prior to demolition.
- G. Explosive demolition is not permitted unless otherwise directed by the Owner.
- H. All demolition sites shall be uniformly graded, seeded and mulched upon completion of demolition activities.
- I. Burning of demolished materials will not be permitted on any area of the Owner's property.
- J. Adjacent property, streets, and structures shall be cleaned, if necessary, upon completion of demolition activities.
- K. CONTRACTOR MUST NOTIFY BALDWIN WALLACE UNIVERSITY'S BUILDINGS AND GROUNDS DEPARTMENT BEFORE CUTTING (WET OR DRY) ANY CONCRETE FOR AN EVALUATION OF CONDITIONS IN THE AREA.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 024116

SECTION 024119 – SELECTIVE STRUCTURE DEMOLITION

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following:
 1. Demolition and removal of selected portions of building or structure.
 2. Demolition and removal of selected site elements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction. Contractor shall legally dispose of them off-site, unless indicated to be removed and salvaged, or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstallation in accordance with this project.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 SUBMITTALS

- A. Qualification Data: For demolition personnel, including professional engineering if applicable.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building managers and other tenants' on-site operations are uninterrupted.
 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 3. Coordination for shutoff, capping, and continuation of utility services.
 4. Use of elevator and stairs.
 5. Locations of proposed dust and noise control temporary partitions and means of egress.
 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 7. Means of protection for items to remain and items in path of waste removal from building.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 2 – EXISTING CONDITIONS

8. Provide site safety plan and rigging plan to the Owner's Representative or Construction Manager.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- D. Owner will dispose of hazardous wastes.
- E. Demolition debris shall be delivered to and deposited in the designated waste container.

1.5 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Refrigerant Recovery: The Owner will recover the refrigerant with technicians that are certified by an EPA-approved certification program.
- C. Regulatory Requirements: Comply with governing EPA (U.S. Environmental Protection Agency) notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Standards: Comply with ANSI A10.6 and NFPA 241.
- E. Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 1. Review methods and procedures related to selective demolition including, but not limited to, the following:
 1. Inspect and discuss condition of construction to be selectively demolished.
 2. Review structural load limitations of existing structure.
 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review requirements of Work performed by other trades that rely on substrates exposed by selective demolition operations.
 5. Review areas where existing construction is to remain and requires protection.
- F. Quality Management Plan and Potential Problem Analysis (PPA):
 1. Review and follow the quality Management Plan.
 2. Participate and follow the PPA process where applicable.

1.6 PROJECT CONDITIONS

- A. Owner may occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Care is required to avoid interference with the Owner's ongoing operations.
- C. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 1. Before selective demolition, inform Owner, so that Owner can remove any desired items.
- D. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 2 – EXISTING CONDITIONS

- E. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner's Representative or Construction Manager and Architect. Owner will remove hazardous materials under a separate contract.
- F. Storage or sale of removed items or materials on-site is not permitted.
- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative or Construction Manager and Architect.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs and/or preconstruction videotapes.
 - 1. Comply with requirements specified in Division 1 sections.
- G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 2 – EXISTING CONDITIONS

- B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner and/or building manager will arrange to shut off indicated services/systems when requested by Contractor pursuant to the written notification.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
 - a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE STRUCTURE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction. Use methods required to complete the Work within limitations of governing regulations. Coordinate ALL drawings together for extent of demolition and new work.
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS

DIVISION 2 – EXISTING CONDITIONS

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Package or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner or Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

E. Demolition Equipment:

1. Equipment that has internal combustion engines that utilize gasoline or diesel fuel shall not be operated within the building. Coordinate with Owner or Construction Manager the vibration limits induced by the demolition process and noise generated from the demolition activities.

F. Dust control measures:

1. Take proactive measure to limit dust generation at the point of demolition.
2. Tackable walk off mats shall be provided and maintained in a tackable state immediately outside of entrances and exits of the demising partition surrounding the demolition zone.

3.5 SELECTIVE STRUCTURE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Coordinate with phasing if applicable and construction demolition plan. Demolish in small sections. Cut concrete to a depth of at least $\frac{3}{4}$ inch at junctures with construction to remain, using power-driven saw. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition. Neatly trim openings to dimensions indicated.
- B. Concrete: Coordinate with phasing if applicable and construction demolition plan. Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.
- C. Masonry: Coordinate with phasing if applicable and construction demolition plan. Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Coordinate with phasing if applicable and construction demolition plan. Saw-cut perimeter of area to be demolished, then break up and remove.
- E. Resilient Floor Coverings: Coordinate with phasing if applicable and construction demolition plan. Remove floor coverings and adhesive according to recommendations in RFCI-WP and its Addendum.
1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.
- F. Roofing: Coordinate with phasing if applicable and construction demolition plan. Remove no more existing roofing than can be covered in one day by new roofing and so that building interior remains watertight and weather tight.
1. Remove existing roof membrane, flashings, copings, and roof accessories.
 2. Remove existing roofing system down to substrate.
- G. Air-Conditioning Equipment: Coordinate with phasing if applicable and construction demolition plan. Remove equipment without releasing refrigerants.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain. Contractor shall remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

OWNER MAY CHOOSE TO PROVIDE DEMOLITION AND DISPOSAL. COORDINATE WITH BALDWIN WALLACE UNIVERSITY BUILDINGS AND GROUNDS.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

- B. Burning: Do not burn demolished materials.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 025000 – EXISTING MATERIAL ASSESSMENT

PART 1: GENERAL

1.1 Baldwin Wallace University currently uses Amianthus LLC as its environmental consultant for assessments of existing materials and conditions.

END OF SECTION 025000

SECTION 025800 – SNOW CONTROL

PART 1: GENERAL

1.1 The Contractor shall be responsible for control and/or removal of snow from the construction site.

END OF SECTION 025800

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 2 – EXISTING CONDITIONS

SECTION 028000 – ENVIRONMENTAL ASSESSMENT

PART 1: GENERAL

- 1.1 ALL CONTRACTORS MUST CONTACT BALDWIN WALLACE UNIVERSITY'S BUILDINGS AND GROUNDS DEPARTMENT PRIOR TO COMMENCING ANY REMEDIATION WORK IN ANY BALDWIN WALLACE UNIVERSITY-OWNED BUILDING.

END OF SECTION 028000

SECTION 030000 – Section Index

- 030000 PREFERRED MATERIALS: CONCRETE
- 033000 CAST-IN-PLACE CONCRETE
- 034113 PRECAST CONCRETE HOLLOW CORE PLANKS
- 038100 CONCRETE CUTTING

SECTION 030000 – PREFERRED MATERIALS: CONCRETE

A. Concrete Sealer:

1. Euco Super Diamond Clear Sealer
2. Euco Everclear 350

B. Wire Mesh:

1. 6 feet by 10 feet #6-gauge sheet
6 inches by 6 feet pattern mesh
2. 6 feet by 12 feet #6-gauge sheet
6 inches by 6 feet pattern mesh
3. 2 ½ inches by 5 feet #8-gauge zig-zag wire chair

C. Steel Reinforcement

1. #4 epoxy-coated rebar

*Note: NO ROLL WIRE!

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.1 Description of Work

- A. This section specifies cast-in-place concrete, including products/submittals, formwork, reinforcement, joints, mix design, placement, finishes, curing and quality control.
- B. See Division 32, Section 321216: Hot-Mix Asphalt Paving (General comments) for parking design and installation standards.

1.2 Standards

- A. International Building Code (IBC) 2000.
- B. International Existing Building Code 2003.
- C. ACI 117, 211.1, 301, 302.1, 305R, 306R, 315, and 318-02.
- D. CRSI 93, “Manual of Standard Practice” for placing reinforcement.
- E. Added Baldwin Wallace University design requirements (maintenance concerns):
 - 1. All sidewalks shall be no less than 5 ½ inches thick and 6 feet wide unless approved by the Owner.
 - 2. Vehicular pavement preferred thickness is 7 inches.
 - 3. Limit the number of steps in exterior design.
 - 4. Provide ADA accessibility unless otherwise approved by the Owner.
 - 5. Provide logical, recognizable and visible circulation patterns.
 - 6. Provide surface textures that are easily treatable and maintainable.
 - 7. Design should consider the use of fiber reinforcement in non-structural exterior slabs and sidewalks.
 - 8. In exterior slab/walk applications where reinforcement is required, consider use of epoxy coated or fiberglass reinforcement. Vehicular pavement reinforcing should be placed using “chairs”.

1.3 Submittals

- A. Product Data: For each type of manufactured material and product indicated.
 - 1. Design mixes for each concrete mix
 - 2. Admixtures
 - 3. Expansion joint fillers
 - 4. Water stops

B. Steel Reinforcement Shop Drawings

1. On request by Designer, submit manufacturer's and/or supplier's, and/or installer's affidavit that material or product provided complies with Contract Documents.

1.4 Delivery And Storage

1. Material deliveries and storage areas to be approved by Owner.
2. Material storage to comply with manufacturer's recommendations.

PART 2: PRODUCTS

2.1 Form Materials

- A. Conform to Section 1906 of IBC and ACI 318, Chapter 6.
- B. Prior to concrete being poured, the following items shall be met:
 1. Forms and formwork shall conform to shop drawings and be subject to the approval of the Designer and Owner twenty-four (24) hours prior to concrete being poured.
 2. All debris shall be removed.
 3. All forms shall be clean and oiled with an approved form-release agent each time they are used.
- C. Chamfer Strips: Wood, metal, polyvinyl chloride (PVC), or rubber strips, ½ by ½ inch minimum shall be installed at locations directed by Designer.
- D. Falsework to be designed by a Registered Engineer and approved by the Designer.

2.2 Steel Reinforcement

- A. Comply with ACI 318, Section 3.5
- B. Reinforcing Bars: ASTM A 615, Grade 60
- C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets

2.3 Reinforcement Accessories

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60

2.4 Concrete Materials

- A. Cement: ACI 318, Section 3.2 normally required; others must be pre-approved.
- B. Aggregates: Comply with ACI 318, Section 3.3 and ASTM C33, uniformly graded.
- C. Water: ACI 318, Section 3.4, potable; comply with ASTM C 94 and ACI 318, Section 3.4.

2.5 Admixtures

- A. General: Comply with ACI 318, Section 3.6, subject to approval by the design professional.
- B. Do not use admixtures containing calcium chloride.
- C. Air-Entraining Admixture: Comply with ASTM C 260.
- D. Water-Reducing Admixture: Comply with ASTM C 494.

2.6 Fiber Reinforcement

- A. Exterior concrete slabs shall be engineered for secondary reinforcement and crack control.
- B. Synthetic Fiber: Fibrillated fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, and ½ to 1-½ inches long.
- C. Acceptable products/manufacturers:
 - 1. Fibermesh, Fibermesh, Inc.
 - 2. Forta CR, Forta Corporation
 - 3. Grace Fibers, W.R. Grace and Company

2.7 Vapor Retarders

- A. Vapor Retarder: Section 1911, IBC, 6 mils polyethylene

2.8 Floor and Slab Treatments

- A. Chemical Hardener: As approved by Designer

2.9 Curing Materials

- A. Sealers: Saltgard-NY by ProSoco or equal (Forsoc, Preco, Meadows) or Linseed oil/Mineral spirit mixture as approved by Designer or Owner
- B. Membrane Curing Compound: ASTM C309, Type 1 (must be compatible with later applications)
- C. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9-oz./square yard dry
- D. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet

2.10 Related Materials

- A. Joint-Filler Strips: Asphalt-impregnated fiber (ASTM D 994), asphalt-saturated cellulose fiber (ASTM D 1751), or cork or self-expanding cork (ASTM D 1752), isomeric polymer foam or polyethylene foam
- B. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids epoxy resins with a Shore A hardness of 80 per ASTM D 2240 or Sika-flex self-leveling sealant
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene
- D. Water stop: Serrated split type with center bulb, extruded vinyl made only from virgin raw materials, highly resistant to alkalis, acids, oxygen, ozone, and waterborne chemicals, installed per manufacturer's recommendations.

Acceptable Manufacturers: Sealtight Products, Vinylex Corporation, and Vulcan Metal Products, Inc.

2.11 Concrete Mixes

Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases.

- A. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
 - 1. Minimum Compressive Strength (28 Days): 3000 pounds per inch (4000psi when exposed to freezing)
 - 2. Maximum Slump: 4 inches
- B. Slab-on-Grade and exposed walls: Proportion normal-weight concrete mix as follows:
 - 1. Minimum Compressive Strength (28 Days): 4000 pounds per inch
 - 2. Maximum Slump: 4 ½ inches
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent
- D. Maximum Water-Cementitious Materials Ratio: 0.45
- E. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated:
 - 1. Air Content: 5.5 percent for 1-½-inches nominal maximum aggregate size
 - 2. Air Content: 6 percent for 1-inch nominal maximum aggregate size
 - 3. Air Content: 6-7 percent for ¾-inch nominal maximum aggregate size
- F. Do not use air-entrained concrete for trowel-finished interior floors.

G. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
2. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required being watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 Fabricating Reinforcement

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice".

2.13 Concrete Mixing

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
1. When air temperature is between 85 and 90 degrees Fahrenheit reduce mixing and delivery time from 1-½ hours to 75 minutes; when air temperature is above 90 degrees Fahrenheit, reduce mixing and delivery time to 60 minutes.

PART 3: EXECUTION

3.1 Formwork, Embedded Pipes, and Construction Joints

A. Use typical Masterspec information.

3.2 Embedded Items

A. Install anchor bolts, accurately located, to elevations required

3.3 Removing and Reusing Forms

A. Use typical Masterspec information.

3.4 Vapor Retarders

- A. Vapor Retarder: Install vapor retarder per section 1911 of IBC 2000.
- B. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus ¾ inch.

3.5 Steel Reinforcement

A. Details of reinforcement: Comply with IBC Section 1907 and ACI 318, Chapter 7.

3.6 Joints

A. Contraction Joints in Slabs-on-Grade: Follow IBC 2000 and ACI 318, sectioning concrete into uniform areas (maximum 225 S.F.). Construct contraction joints for a depth equal to at least one-fourth of concrete thickness.

- B. Isolation Joints in Slabs-on-Grade: terminate full-width joint-filler strips not less than ½ inch or more than 1 inch below finished concrete surface where joint sealant, specified in Division 7, Section 079200: Joint Sealant and Expansion Control, are indicated.
- C. Dowel Joints: Install dowelled joints in expansion joints for exterior slabs and sidewalks. Use dowel sleeves or lubricate one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 Concrete Placement

- A. Before placing concrete, Owner to be notified a minimum of twenty-four (24) hours in advance of any concrete placement.
- B. The subgrade shall be moistened in advance on concrete placement, but shall not be muddy or excessively wet.
- C. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Install concrete to avoid segregation.
- E. Height limitation, 60 inches for dropping concrete in forms.
- F. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 - 2. Do not use vibrators to transport concrete inside forms. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - 3. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
- G. Cold-Weather Placement: Comply with IBC 2000 and ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 degrees Fahrenheit uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees Fahrenheit and not more than 80 degrees Fahrenheit at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- H. Hot-Weather Placement: Place concrete according to recommendations in IBC 2000 and ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 degrees Fahrenheit at time of placement.

3.8 Finishing Formed Surfaces

- A. Rough-Formed Finish: Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

3.9 Finishing Floors and Slabs

- A. General: Comply with recommendations in ACI 302.1R for screeding, re-straightening, and finishing operations for concrete surfaces. A guide for final finishing is the time at which the water sheen (from bleed water) has disappeared from the surface. Cracking (superficial surface hairline cracking) should be prevented by using stiffer mixes, timely troweling and immediate curing. Surface scaling should be prevented by using proper air entrainment, slump, mixing and curing procedures as well as limited use of deicers.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
 1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, Portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 2. Finish surfaces to the following tolerances, measured within twenty-four (24) hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface: Select floor flatness values and levelness values required for Project or revise values to suit type of floor. ACI 302.1R suggests first subparagraph values below be used for carpeted slabs; second and third, for thin floor coverings; and fourth, for very flat floors for high-speed forklifts, air pallets, and ice and roller rinks.

- a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15
3. Finish and measure surface so gap at any point between concrete surface and an unlevelled freestanding 10-foot long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
 - a. $\frac{1}{8}$ inch
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.10 Concrete Protection and Curing

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing. Curing procedures shall be compatible with subsequent floor coverings.

3.11 Concrete Surface Repairs

- A. Defective Concrete: Repair and patch defective areas when approved by the Architect. Remove and replace concrete that cannot be repaired and patched to Owner's approval.
- B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discoloration that cannot be removed by cleaning.
- C. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

3.12 Field Quality Control

- A. Testing Agency: The Owner will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cubic yard, but less than 25 cubic yard plus one set for each additional 50 cubic yard or fraction thereof. Initial samples shall be taken after $\frac{1}{4}$ cubic yard has been discharged. Subsequent samples shall be taken as specified herein or as specified by the Owner. If tests indicate the concrete is unacceptable, the unacceptable concrete shall be removed.

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DIVISION 3 – CONCRETE

2. Slump: ASTM C 143, one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064, one test hourly when air temperature is 40 degrees Fahrenheit and below and when 80 degrees Fahrenheit and above, and one test for each composite sample.
5. Compressive-Strength Tests: ASTM C 39. Cast and field cure a minimum of one set of three standard cylinder specimens for each composite sample.
 - a. Test one (1) field-cured specimen at seven (7) days and two (2) at twenty-eight (28) days.
 - b. A 28-day compressive strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 pounds per inch.
- E. Test results shall be reported in writing to the Owner, concrete manufacturer, and the Contractor within forty-eight (48) hours of testing. Reports of compressive-strength tests shall contain the following information: Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in the Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by the Owner.

END OF SECTION 033000

SECTION 034113 – PRE-CAST CONCRETE HOLLOW CORE PLANKS

PART 1: GENERAL

- 1.1 Contractor shall protect exposed hollow core planks from water infiltration. If, upon inspection, water infiltration is suspected, it shall be verified. If water infiltration has occurred, it shall be removed by the Contractor at the Contractor's expense, including the cost of verification.

END OF SECTION 034113

SECTION 038100 – CONCRETE CUTTING

PART 1: GENERAL

- 1.1 NO CONCRETE CUTTING OR DRILLING (WET OR DRY) SHALL BE COMMENCED WITHOUT NOTIFYING BALDWIN WALLACE UNIVERSITY'S BUILDINGS AND GROUNDS DEPARTMENT TO OBTAIN AN EVALUATION OF CONDITIONS IN THE AREA.

END OF SECTION 038100

SECTION 040000 – Section Index

042000 UNIT MASONRY ASSEMBLIES

SECTION 042000 – UNIT MASONRY ASSEMBLIES

PART 1: GENERAL

1.1 Design according to latest applicable building codes (including IBC, as per Ohio state law).

A. Design to prevent efflorescence in masonry walls.

1.2 Submittals

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each type and color of the following:

1. Concrete masonry units
2. Pre-faced concrete masonry units
3. Brick
4. Pigmented or colored-aggregate mortar
5. Stone trim
6. Weep holes/vents
7. Accessories embedded in masonry

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification.
2. Include test reports for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Table 21-D in the Uniform Building Code and Table 1 and Table 2 in ACI 530.1/ASCE 6/TMS 602.

E. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.3 Quality Assurance

A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for each type of unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.

- a. Include a sealant-filled joint at least 16 inches long in each exterior wall mockup.
 - b. Include flashing, weep holes, anchors, etc. in unit masonry wall mockup.
 2. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.4 Delivery, Storage, and Handling

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

PART 2: PRODUCTS

2.1 Masonry Units, General

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.2 Consideration for matching other masonry units nearby, on the same campus or elsewhere at Baldwin Wallace University should be considered in design reviews.

- A. Source for face brick, for *South Campus*, is Old Virginia Brick Co.

2.3 Masonry Construction Materials:

- A. See Chapter 21, IBC.

2.4 Mortar and Grout Materials

- A. See Chapter 21, IBC.

2.5 Reinforcement

- A. See Chapter 21, IBC.

2.6 Ties and Anchors

- A. See Chapter 21, IBC.

2.7 Mortar and Grout Mixes

- A. See Chapter 21, IBC.

2.8 Source Quality Control

- A. Contractor will engage a qualified independent testing agency to perform source quality-control testing indicated below:
 - 1. Payment for these services will be made by the Contractor.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- B. Clay Masonry Unit Test: For each type of unit furnished, per ASTM C 67 and Chapter 21, IBC.
- C. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140 and Chapter 21, IBC.

PART 3: EXECUTION

3.1 Installation, General

- A. Install in accordance with Chapter 21, IBC.

3.2 Control and Expansion Joints

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
 - 1. Form control joints in concrete masonry.
 - 2. Form expansion joints in brick.
 - 3. Provide horizontal, pressure-relieving joints.

3.3 Lintels

- A. Install in accordance with Chapter 21, IBC.
- B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.4 Flashing, Weep Holes, Cavity Drainage, and Vents

- A. Install in accordance with Chapter 21, IBC.
- B. The Owner will inspect all expansions, cavities and flashings and their installations. Contractor shall leave all walls “open” and notify the Owner so that such inspection can be made.

3.5 Field Quality Control

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
 - 1. Payment for these services will be made by the Owner.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at the Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 square feet of wall area or portion thereof.
- D. Mortar Test: For each mix provided, per ASTM C 270 and IBC Chapter 21.
- E. Grout Test (Compressive Strength): For each mix provided, per IBC Chapter 21.
- F. Prism Test: For each type of construction provided, per IBC Chapter 21.

END OF SECTION 042000

SECTION 050000 – Section Index

- 051200 STRUCTURAL STEEL FRAMING AND STEEL JOIST FRAMING
- 054000 COLD-FORMED METAL FRAMING
- 055000 METAL FABRICATIONS
- 055213 PIPE AND TUBE RAILINGS

SECTION 051200 – STRUCTURAL STEEL FRAMING AND STEEL JOIST FRAMING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for the design, fabrication and erection of structural steel building systems and steel joists and steel girders.

1.2 Related Standards

- A. Coatings and Paint Systems

1.3 Reference Standards

- A. AISC Specification for Structural Steel Buildings
- B. AISC Code of Standard Practice for Steel Buildings and Bridges
- C. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts
- D. AISC Manual of Steel Construction
- E. American Welding Society (AWS) D1.1 – Structural Welding Code – Steel
- F. American Society for Testing and Materials (ASTM) – Standard Specifications

1.4 Quality Control

A. Structural Steel

1. The structural steel fabricator shall provide evidence of successful fabrication of structural steel buildings of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.
2. The structural steel erector shall provide evidence of successful erection of structural steel buildings of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.
3. Qualifications for welding work: All welders and welding processes shall be qualified in accordance with AWS “Standard Qualification Procedure”. All welders shall have passed AWS qualification tests within the past six months. Welding certificates shall be furnished upon request.
4. The steel erector is required to visit the project site at least 30 days prior to start of erection to review existing site conditions such as site access, clearances, utilities, adjacent structures, overhead obstructions, site topography and security requirements.

B. Steel Joist and Joist Girders

1. The steel joist fabricator shall provide evidence of successful fabrication of steel joist systems of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.

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DIVISION 5 – METALS

2. The joist fabricator shall also employ and have on staff a qualified structural engineer licensed in the State of Ohio to prepare design calculations, shop drawings, and other structural data for steel joists and joist girders.
3. The steel joist erector shall provide evidence of successful erection of steel joist systems of similar size and complexity for a continuous period of at least five (5) years immediately prior to the bid date.
 - a. All steel shall be domestically manufactured, unless foreign sources are accepted by Baldwin Wallace University.
 - b. Baldwin Wallace University will contract with an independent testing agency to provide inspection services during the course of the project.
 - c. The testing agency may require access to the fabricator’s shop at any time during fabrication or just prior to shipment of the structural steel. In the design of structural steel systems, the testing agency and/or design engineer shall take into consideration the future flexibility of the system and the need to make frequent modifications to building systems.
 - d. Field erection test is required.
4. The joist erector is required to visit the project site at least thirty (30) days prior to start of erection to review existing site conditions such as site access, clearances, utilities, adjacent structures, overhead obstructions, site topography and security requirements.
5. Welding procedures and welder qualifications should be specified in accordance with American Welding Society (AWS) qualification procedures. Design documents shall include specifications and drawings, which comply with the provisions of the Steel Joist Institute (SJI) and AWS.

C. Design Considerations

1. In the design of structural steel systems, joist and joist girder systems the design engineer shall take into consideration the future flexibility of the system and the need to make frequent modifications to building systems.
2. Baldwin Wallace University prefers not to use “Weathering Steel sections or sheets”
3. All steel shall be domestically manufactured, unless foreign sources are accepted by Baldwin Wallace University.

1.5 Submittals Requirements

A. Fabricator shall submit, as a minimum, the following:

1. Mill certificates for all steel members
2. Complete shop drawings, including erection plans, member sizes, connections, connection details, bill of materials, and dimensions of members and locations of splices
3. All primers, coatings and cleaning methods
4. Submit shop drawings and calculations for all structural members signed and sealed by the qualified Registered Professional Engineer (licensed in Ohio) responsible for their preparation.

PART 2: PRODUCTS

- A. Specifications for structural steel materials shall meet the ANSI and ASTM criteria for each material and shall show compliance with the AISC Code and Specifications. All structural steel products which have an exterior exposure or which are designed for use in an area with high humidity or with possible exposure to caustic chemicals shall be hot dipped galvanized, except where such design has been reviewed and approved by Baldwin Wallace University on a case-by-case basis.

PART 3: EXECUTION

- A. The design documents shall require verification surveys by the Professional Engineer or Land Surveyor Registered in the State of Ohio for location of columns, elevation of base plates, and plumbness of columns.

END OF SECTION 051200

SECTION 054000 – COLD-FORMED METAL FRAMING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for cold-formed metal framing.

1.2 Reference Standards

- A. Aluminum Association (AA)
- B. American Society for Testing and Materials (ASTM)
- C. American Institute of Steel Construction (AISC)
- D. American Welding Society (AWS)
- E. Occupational Safety and Health Administration (OSHA)
- F. Steel Structures Painting Council (SSPC)

1.3 Quality Control

- A. Welding procedures and welder qualifications should be specified in accordance with AWS qualification procedures.

PART 2: PRODUCTS

- A. Specifications for cold-formed metal framing, accessories and sheathing shall meet the ANSI, ASTM, and manufactures specs for each material.

PART 3: EXECUTION

- A. The contract documents shall specify and detail the installation of all cold-formed metal framing assemblies, joints and connections to dissimilar materials, including compliance with requirements of ASTM C 1007 except where exceeded by other requirements.
- B. Cold-formed metal stud system: Studs and furring strips shall be spaced 16 inches on center, maximum.

END OF SECTION 054000

SECTION 055000 – METAL FABRICATIONS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for metal items manufactured to conventional details from standard metal shapes and plates that do not fit specifically in other locations.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern.

1.2 Reference Standards

- A. Refer also to Section 099100A, Coatings and Paint Systems for general guidance concerning the specific preferences of Baldwin Wallace University for exterior and interior coating and paint systems for brick, CMU, concrete, gypsum board, plaster, steel and stucco.
- B. Separate Sheet

1.3 Quality Control

- A. Galvanizing requirements: All exterior ferrous metals shall be hot-dip galvanized after fabrication.
- B. Lintels for plumbing, HVAC, and electrical installations: Specify that the General Contractor furnish lintels for all openings through walls when openings are shown on the architectural or structural (General Contract) drawings. Note all such lintels and openings to require coordination of work and exact locations, by affected Contractors. All such plumbing, HVAC, electrical, and sprinkler openings must be coordinated and shown on the Architectural and/or Structural Drawings.
- C. Galvanized metals: Accessibility, maintenance, and appearance each will govern the satisfactory use of galvanized materials. Coordinate design efforts through the Baldwin Wallace University project representative. Care must be taken to assure use with only compatible materials.
- D. Fabricated assemblies that are to be galvanized shall be assembled to the largest sections as possible in the shop to minimize field welding and resultant coating failure.
- E. Galvanized field welds shall be treated with compatible and approved galvanized paint.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 055000

SECTION 055213 – PIPE AND TUBE RAILINGS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for pipe and tube railings.

1.2 Reference Standards

- A. Current ADA requirements
- B. Life Safety 101
- C. AWS (Specs for Standard Handrails)
- D. Section 099100A

1.3 General Requirements

A. Metal Handrails

1. Acceptable materials include stainless steel, galvanized steel, anodized aluminum and fiberglass. The preferred color is black.
2. Handrails of rectangular cross sections are not acceptable.
3. Rails shall be oval or round and comply with current ADA requirements.
4. Rails shall not terminate with open ends.
5. Designer shall consider existing conditions and verify with Baldwin Wallace University project representative for rail color.
6. Metal handrails should be galvanized steel. Black is preferred.

B. Metal Rails

1. Exterior steps should have railings at open sides and a center railing (if required by applicable code), anodized aluminum, or stainless steel, 1-¼ to 1-½ inches in diameter, and securely anchored. Painted steel is not preferred.
2. All rails shall comply with current ADA requirements.
3. Provide for expansion and contraction.

C. End Caps

1. Where end caps or post caps are required, they should be permanently fastened by welding or with rivets or screws which cannot be easily removed.

D. Other Handrails

1. Fiberglass handrails may also be utilized.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 055213

SECTION 060000 – Section Index

- 061000 ROUGH CARPENTRY
- 061753 WOOD TRUSSES
- 062000 FINISH CARPENTRY
- 064023 INTERIOR ARCHITECTURAL WOODWORK

SECTION 061000 – ROUGH CARPENTRY

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for framing, sheathing, and decking using timber, lumber, and engineered wood products. Blocking and supports to join members and anchor framework to other construction.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for Baldwin Wallace University projects.

1.2 Reference Standards

- A. Forest Stewardship Council (FSC)
- B. American Forest and Paper Association (AFPA)
- C. American National Standards Institute (ANSI)
- D. American Plywood Association (APA)
- E. American Society of Mechanical Engineers (ASME)
- F. American Society for Testing and Materials (ASTM)
- G. American Wood Preservers Association (AWPA)
- H. Federal Specification (FS)
- I. International Conference of Building Officials (ICBO)
- J. International Building Code (IBC), Chapter 23: Wood
- K. U.S. Department of Commerce, National Institute of Standards and Technology

1.3 Quality Control

- A. Contractor shall provide UL label for fire retardant material.
- B. Contractor shall provide certification for preservative treated material.
- C. Lumber shall be kiln dried, bearing stamp of Southern Pine Inspection Bureau or equivalent agency.
- D. Lumber shall be kiln dried moisture content not to exceed 19 percent.
- E. All lumber shall be milled to established industry dimensions. Example: 2 inches by 4–1½ inches by 3½ inches. Un-milled lumber may be used if a design issue and requires the approval of the Baldwin Wallace University Project Representative.
- F. Use of urea formaldehyde is not acceptable.

1.4 General Requirements

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DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES

- A. All older campus building should be thoroughly checked for termites and other insect infestations, and specifications should address treatment measures required if termites or other infestations are found during renovation.
- B. Wood nailers, bucks, grounds and the like shall be construction grade lumber, pressure treated.
- C. Wood Framing: Stud and furring strip spacing shall be 16 inches on center, maximum.
- D. Marine Plywood is to be used at all window sills.
- E. No arsenic may be used in any treatment process.

PART 2: PRODUCTS

- A. Provide appropriate blocking. Metal blocking should be 6 inches wide minimum and be a minimum of 20-gauge or fire retardant plywood manufactured for back blocking.

PART 3: EXECUTION

- A. Fasten carpentry in accordance with applicable codes and standards. Install wood furring 16 inches maximum on center. Install blocking behind all ADA required grab bars, door stop locations, and other areas as required.

END OF SECTION 061000

SECTION 061753 – WOOD TRUSSES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for wood trusses. Blocking and supports to join members and anchor framework to other construction.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for Baldwin Wallace University projects.

1.2 Quality Control

- A. Roof trusses are to be designed, fabricated and installed to carry a roof live load as per the latest edition of the International Building Code (IBC) and any applicable dead loads.
- B. Shop Drawings shall show all details of truss construction including design of truss and:
 - 1. Engineering analysis showing the determination of both axial forces and bending moments for each member, and shear at ends of trusses, under full load.
 - 2. Each reaction force.
 - 3. Plate type, thickness or gauge, size, basic plate design value, the dimensioned location of each plate and a design analysis of each joint showing that proper plates have been used.
 - 4. Lumber size, species, and grade for each member.
 - 5. Connections to poles and to beams.
 - 6. A certification by a professional engineer, currently registered in West Virginia, shall be submitted with the shop drawings. The certificate shall certify that the trusses, truss connections to the poles and with bracing to the poles will carry the loads called for.
- C. All lumber used in the design of wood trusses shall be kiln dried and graded in accordance with the current and applicable grading rules.
- D. The design and fabrication criteria of all wood trusses shall meet with “National Design Specifications for Stress-Grade-Lumber and Its Fastenings” by National Forest Products Association (latest revision); “Timber Construction Standards” by American Institute of Timber Construction (latest revision); and “Design Specifications for Light Metal Plate Connected Wood Trusses” by Truss Plate Institute (latest revision), the same as if those specifications and all their references were set out in full herein.
- E. Connector plate approvals shall meet current code requirements.
- F. Trusses shall be of uniform sizes and camber.
- G. Gang nail connector plates shall be galvanized steel.

- H. Any trusses, or parts of trusses with defective materials or if improperly fabricated, installed or protected against damage, and including loose or improperly installed gang nail connectors, will be rejected.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 061753

SECTION 062000 – FINISH CARPENTRY – INTERIOR AND EXTERIOR

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for finish carpentry – interior and exterior products. Blocking and supports to join members and anchor framework to other construction.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for Baldwin Wallace University projects.

1.2 Reference Standards

- A. Comply with Architectural Woodwork Institute (AWI) Custom Standard
- B. American Wood Preserver’s Association (AWPA)

1.3 General Requirements

- A. Special Submittal Requirements
 - 1. Submit product data, shop drawings, finish samples, quality assurance submittals (test data, certifications), and manufacturers’ stock numbers and O&M submittals.
- B. Special Construction/Handling Requirements
 - 1. Coordinate installation of woodwork with other work to assure proper installation.

PART 2: PRODUCTS

2.1 TREATED LUMBER

- A. Treatment: Posts and door frames (as required) shall be pressure treated with “womanized” CCA preservative in accordance with AWPA Standard C2 latest editions.
- B. Post and exterior wood shall meet requirements for “soil contact”.
- C. All treated wood shall bear the AWPA stamp.
- D. A letter of certification shall be furnished from the wood preserver certifying that the wood is treated in accordance with the AWPA C2 requirements.
 - 1. Continuous length is preferred.

PART 3: EXECUTION

- A. Install and finish carpentry in accordance with applicable codes and standards.
- B. All millwork must be protected during and after delivery. It should be stored in well ventilated spaces and where it is not exposed to extreme changes in temperature or humidity. Doors or millwork should not be installed until after plaster is dry.

END OF SECTION 062000

SECTION 064023 – INTERIOR ARCHITECTURAL WOODWORK

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for fine shop fabricated woodwork, requiring expert craftsmanship and joinery.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Refer to AWI “Premium” Grade.

1.3 Quality Control

- A. Types of wood in specific areas: In remodeling work, match existing. For new construction where there is no existing to match, use AWI “Premium” grade as the guideline.
- B. In no instance shall particleboard be used for cabinet carcass material selection and typical storage shelving. Domestic pre-finished plywood or equal shall be used.
- C. Grain matching: Book matched for any wall paneling or stained wood is used on door faces is preferred.

1.4 General Requirements

- A. Plastic laminate preference: Refer to AWI “custom” grade. Any requirement for chemical resistant laminate shall be clarified with the Baldwin Wallace University project representative.
- B. Cabinet hardware: Review proposals with Project Manager. Blum, Glass or Salice 35mm concealed cup hinges, or approved equal, shall be used.
- C. Pre-finished woodwork/In-field finish: Provide pre-finished woodwork where possible. Where in-field finish is performed, coordinate environmental concerns, ventilation requirements, shutdowns, etc. with the Baldwin Wallace University Project Representative, who will coordinate with Environmental Health and Safety. When in field finish is required, it shall be completed in a dust free environment.
- D. Delivery of woodwork to project: Any area where woodwork is to be installed shall have been satisfactorily conditioned for temperature and humidity control prior to introducing and during storage of woodwork into the space.
- E. Installed of any of these materials may not begin until the structure is dried out and a reliable HVAC is operating.
- F. All wood trim items shall be “back primed” prior to installation.
- G. Kiln dried to 10-14 percent.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 064023

SECTION 070000 – Section Index

- 070100 PLAZAS AND DECKS OVER OCCUPIED SPACES
- 071113 BITUMINOUS DAMP PROOFING
- 072100 THERMAL INSULATION
- 072150 SOUND INSULATION
- 072400 EXTERIOR INSULATION AND FINISH SYSTEMS
- 075000 ROOFING SYSTEMS
- 078400 FIRE STOPPING
- 079200 JOINT SEALANT AND EXPANSION CONTROL

SECTION 070100 – PLAZAS AND DECKS OVER OCCUPIED SPACES

PART 1: GENERAL

1.1 Scope of Standard

- A. The scope of this standard includes recommendations for the design and maintenance (retro-fit) of plazas and decks over occupied space(s). In general, plazas and decks over human occupied space are not recommended.

1.2 Related Standards

- A. Refer to Exterior Improvement, Division 32 of this document.

1.3 General Requirements

- A. All plazas and decks situated over occupied space(s) shall have a redundant, bi-level drainage system to protect the occupied space(s) from water infiltration and damage.
 - 1. The primary drainage system shall be at the top wearing surface exposed to weather and traffic.
 - 2. Secondary drainage shall be provided below the wearing surface, at the membrane level, to drain any moisture that infiltrates down below the primary level protection at the wearing surface. The secondary drainage shall be provided by a pre-fabricated drainage grid, paver pedestals, or other method as required to provide free flow to the drains at the secondary level.
 - 3. Where possible, provisions for overflow should be incorporated to account for clogged drains.
- B. It is preferable to select a system that allows water to flow both on top of and below the wearing surface.
 - 1. A closed joint system generally consists of concrete surfaces or individual paver units with gaps filled with porous grout or sand, or the individual paver units placed in a lean mortar setting bed.
- C. Paver units are preferable to large, monolithic concrete sections because pavers enhance drainage at the secondary level and long-term maintenance is simplified due to accessibility of the substrate (both the structural deck and the waterproofing system).
- D. Provide a sloped substrate to insure adequate drainage at both the primary and secondary levels. Tapered insulation, sloped structural deck, variable pedestal heights, or other method(s) shall be used to accomplish this goal.
- E. The design of plazas and decks situated over occupied space(s) should be considered early in the design development of a project since the effect on the structural design and overall cost can be significant.
- F. Walking surfaces shall be designed to be nominally level. Abrupt changes in elevation of walking surfaces shall not exceed ¼ inch. The slope in the direction of travel shall not exceed 1 in 20. The slope perpendicular to the direction of travel shall not exceed 1 in 48.

PART 2: PRODUCTS

2.1 Paver System

- A. Paver system: Color and pattern should be related to existing building materials or other campus pavers located in the proximity.

2.2 Monolithic Concrete System

- A. Paver systems are preferred. However alternatives can be reviewed with the project representative.
- B. Where a monolithic system is required, the monolithic concrete sections shall be designed in such sizes as to be removable for future repair of the substrate, including jointed, sealed sections with lifting inserts, or other method as may accomplish this goal.

PART 3: EXECUTION – NOT USED

END OF SECTION 070100

SECTION 071113 – BITUMINOUS DAMP PROOFING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific references to moisture penetration through foundation walls and similar surfaces subject to high humidity, dampness and direct water contact, but not subject to hydrostatic pressures.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern a study of test boring data to determine amounts of ground water present in the construction site and determine if hydrostatic pressure is a concern.

1.2 Quality Control

- A. Damp proofing shall be compatible with the substrate or primer on which it is adhered. Also, verify compatibility of flashing material and adhesives with damp proofing materials.
- B. Material must be installed per manufacturer instructions. Coating thickness shall be protected from backfill by a soft (compressible) material.
- C. All concrete slabs (including walks and parking areas) shall be placed on 6 mils plastic. Reinforcing shall be held in place using non penetrating chairs or supports.

1.3 General Requirement

- 1. Normally all below grade building spaces should be protected by either a membrane or a bituminous coating of waterproofing on alteration projects.
- 2. Slabs on grade should be protected by either a membrane, med mat, or by plastic sheets, depending on conditions.
- 3. Slabs above grade in potentially wet areas shall receive a waterproof membrane system. System shall be non-slip. Sleeves and openings in the slab shall be properly flashed. This protection is required over occupied spaces and under docks or penthouse floor slabs.
- 4. Penthouse floors, especially under large air handlers and interior cooling towers shall receive a waterproof coating with proper drainage.
- 5. All containment including dikes, curbs, shall be properly waterproofed with proper drainage. Curbs shall be a minimum of 3 inches.
- 6. All horizontal areas should be tested by flooding after the waterproof membrane system has been applied.
- 7. A five year guarantee is required for all waterproofing work.

A. BELOW GRADE CONSTRUCTION

- 1. Sheet or Roll Membrane

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DIVISION 7 – THERMAL AND MOISTURE PROTECTION

- a. All surfaces shall be primed with a manufacturers approved primer. Membrane overlapped 2-½ inches minimum at seams. Apply elastomeric mastic to all seams and edges. At all corners, cracks, and construction joints, two layers of membrane shall be applied.

2. Liquid Applied Damp proofing

- a. Acceptable Products and Manufacturers: Bituthene by Grace Construction Products Division Polyguard No. 650 by Polyguard Products, Inc; Tremco System.
- b. Protective board shall be used against foundation walls. Stone fill shall be used from 2 feet to top of footer for drainage, 2 feet wide.

B. VAPOR BARRIERS/RETARDANTS

1. A vapor barrier is required for all Baldwin Wallace University buildings applied to exterior walls and roofs.
2. The vapor barrier for exterior walls shall be made of either a polyethylene sheet or a butyl rubber liquid compound.
3. Vapor barriers over pools and freezers require added protection.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 071113

SECTION 072100 – THERMAL INSULATION

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for organic or inorganic insulation applied for thermal protection in walls, ceilings, attics, crawl spaces, under concrete slabs on grade and at the perimeters of foundations
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. International Building Code
- B. International Energy Conservation Code for insulation R-values

1.3 General Requirements

- A. Baldwin Wallace University does not recommend blown in place loose insulation, it is recommended that certain conditions may require consideration of this method. The project Manager will approve method and material.
- B. The perimeter of slab on grade concrete shall be insulated 3 feet minimum wide at perimeter. Insulation shall be 2 inches thick.
- C. Perimeter foundation walls adjacent to slab on grade concrete shall be insulated 3 feet deep. Insulation shall be 2 inches thick.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 072100

SECTION 072150 – SOUND ISOLATION

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of Baldwin Wallace University for bats, boards, block infill, etc. to provide sound reduction between rooms and/or areas.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

- A. Isolation for sound transmission shall isolate areas such as: conference rooms, counseling rooms, classrooms, janitor closets, electrical closets containing transformers, toilets, meeting rooms, mechanical rooms, residence halls, and other areas requiring confidentiality.
- B. Project requirements may dictate having an acoustic consultant on the consultant team. Review acoustic issues in project planning.
- C. In some cases a Sound Transmission Class (STC) rating may be listed that will determine the construction method.

1.3 General Requirements

- A. Methods to use shall incorporate sound attenuation blankets, full height woven within drywall assembly to structural deck above ceilings, sound sealant, proper spacing of air grills, sound transmission boots, etc. Doors or windows assembly STC ratings shall be the minimum rating of the entire wall assembly.
- B. Insulation at concrete masonry unit (CMU) divider walls and at exterior walls for sound control shall be a “poured-in” perlite, or equal material, poured into CMU cavities.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 072150

SECTION 074000 – EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of Baldwin Wallace University for exterior-surfacing systems that provide both thermal insulation and decorative/protective finish.

PART 2: PRODUCTS

- A. These systems are not approved for use at Baldwin Wallace University.

PART 3: EXECUTION – NOT USED

END OF SECTION 072400

SECTION 075000 – ROOFING SYSTEMS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for roofing systems.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. Division 07, Section 070100: Plazas and Decks
- B. Division 07, Section 079200: Sealants
- C. The Secretary of the U.S. Department of the Interior’s Standards for Rehabilitation.

1.3 Reference Standards

- A. National Roofing Contractors Association (NRCA) Roofing and Waterproofing Manual
- B. Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) Architectural Sheet Metal

1.4 Quality Control

- A. Roofing Contractors shall be certified by the roofing system manufacturer as qualified to install the specified system and to receive the specified warranty. Contractors must not have any complaints filed against them and have at least five years’ experience.

1.5 General Requirements

- A. Baldwin Wallace University’s general preference for roofing systems is listed below. These preferences are based on a desire for reliable, durable, low maintenance and long lasting roof systems. The selection of a roofing system shall also consider roof traffic, budget, exposure to chemicals and building type.
 1. Built-up roof systems are NOT TO BE USED.
 2. Fully adhered “Duralast” membrane, or approved equal.
 3. EPDM Roofing is NOT TO BE USED.
 4. Shingled (where applicable). GAF Lifetime shingles, or approved equal, shall be used and installed by a certified roofing Contractor. A “System Plus Warranty” shall be provided. See warranty information on file in Owner’s offices.
 5. Vegetative roofs are acceptable for LEED projects.

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- B. No Speedy or Fast Track warranties permitted. Interim inspections by roofing manufacturer to be conducted once a week or every 100 squares. Reports included. Warranty shall be minimum twenty (20) years on all roofs with thirty (30) years on shingled roofs.
- C. All roofs shall follow these general guidelines:
 - 1. Nailer to be pressure treated wood.
 - 2. All wood nailers shall be treated in accordance with Section 06300 Wood Treatment.
 - 3. Drain pans shall be insulated.
 - 4. All piping shall be insulated horizontally to first elbow turning vertically.
 - 5. Roof-drain bodies to have 3 inches of insulation.
 - 6. All pipes to have 1 ½ inches minimum insulation.
 - 7. All piping shall be insulated 6 feet vertically, where possible.
- D. Re-roofing projects shall be historically accurate and be reviewed by the Baldwin Wallace University historical preservation committee.
- E. Re-roofing projects shall be tested for asbestos, lead and asphaltic substances whose removal may require abatement or special environmental handling. Removal and disposal shall be the responsibility of the roofing Contractor.
- F. Roofs shall have positive drainage with no ponding. Always provide slope to drains ¼ inch per foot at a minimum where possible.
- G. Provide minimum 6 inches diameter roof drains in all new construction. Always provide cast iron drain assemblies with flashing ring, sediment bucket, and dome cover. Scuppers shall be for overflow backup.
- H. Entire assembly shall meet FM Global I-90 rating, minimum.
- I. Preferred minimum insulation value equal to wall insulation, but never less than R 30 where possible. Two (2) layers of insulation with staggered seams.
- J. At vertical projections through roof, provide minimum 8 inches clearance between top of flashing and roof surface. Always provide cricket on uphill side of any projection that interferes with drainage
- K. It is desirable to avoid pitch pockets. If a pitch pockets cannot be avoided, provide gooseneck or hood over and fill completely with pourable sealant.
- L. At areas where frequent foot traffic will occur (mechanical units, electrical boxes, roof drains, etc.), provide walk pads. Path of pads shall follow most convenient route between roof access and destination. At unit provide additional non-slip pads for tool boxes or maintenance equipment around perimeter of all units.
- M. No torches or kettles are allowed on roof without special permission of Baldwin Wallace University project representative (a fire protection plan shall also be submitted with the request).
- N. When determining set-up location, keep well away from fresh air intakes and on adjacent buildings.

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- O. Ballast shall NOT BE USED.
- P. Contractor shall take necessary precautions to protect new roofing systems, and adjacent, against damage until substantial completion.
- Q. Owner representative shall be present when manufacturer conducts warranty walk-through.
- R. Fall arrest and restraints are required and in compliance with all OSHA, federal, state, and local regulations.
- S. Thermal Imaging – Baldwin Wallace University reserves the right to include in each roofing replacement bidding document that the Contractor shall provide third party independent thermal imaging testing for roofing replacement projects. Baldwin Wallace University also reserves the right to require testing at any time during the construction process where there is concern of water or moisture infiltration. The following conditions apply:
 - 1. Testing may be written into the bidding documents or be required if there is justifiable concern that there may be water that infiltrated the roof system.
 - 2. The cost for third party independent testing will be the Contractor’s responsibility if written into the bidding documents.
 - 3. The cost for thermal imaging will be the Owners cost if the Owner asks for the testing after bid award and it was not included in the bid package and there is no evidence of moisture infiltration. Baldwin Wallace University will pay only the actual testing costs and allowable sub-Contractor markup.
 - 4. The cost for testing and for repairs will be the sole cost of the Contractor if moisture is found or if included in the original bidding specifications.
 - 5. Written testing results must be provided to Baldwin Wallace University by the testing company. This may include graphs or testing images to substantiate their findings. Based on the findings, Baldwin Wallace University may require that the roof be replaced.
 - 6. Final warranty inspection shall include review and documentation of the testing results. The warrantor must agree to warranty the roof based on the findings of the thermal testing.
 - 7. Test results will become part of the permanent file kept by Baldwin Wallace University.

PART 2: PRODUCTS

- 2.1 Built-Up Roof Systems are, generally, NOT USED on the Baldwin Wallace University Campus.
- 2.2 “Duralast” Roofing System: Manufacturer’s standard installation. System will be approved Class A, UL listed roof. The aggregate surfacing will be factory applied by the manufacturer to the cap sheet. Additional aggregate needed for seams or penetrations to be applied by Contractor on site. A FULLY ADHERED SYSTEM IS PREFERRED.
 - A. Primer: Use primer recommended by manufacturer for this application.
 - B. Base Sheet: Modified bituminous base sheet with glass fiber reinforcing mat.

C. Modified Bituminous Sheet Membrane: Modified asphalt sheet with glass fiber reinforcing mat. A white surface is preferred.

1. Manufacturers are subject to compliance with requirements, provide products of one of the following acceptable Manufacturers
 - a. Firestone
 - b. Tremco
 - c. Suprema
 - d. Durbigum

D. Auxiliary Materials

1. Sheet Seaming System: Manufacturer's standard materials for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by membrane manufacturer.
2. Cant Strips: New cut pressure treated wood, cedar, or fiber is to be used. Nailed into both wood nailer and blocking or just wood nailer when blocking is NOT USED. Penetrate into nailer and blocking a minimum of 1-¼ inches.
3. Tapered Edge Strips and Flashing Accessories: Types recommended by membrane manufacturer, mechanical anchors, including adhesive tapes, flashing cement, and sealants.
4. Flashing Material: Manufacturer's standard system compatible with multi-ply membrane.
5. Wood Blocking and Nailer: Southern Pine, No. 2 grade free from warping and visible decay and pressure treated. Use alternating pattern when attaching wood to substrate.
6. Surfacing Aggregate: Stone, free of sharp edges, complying with ASTM D-1863. Adhere aggregate to the roofing system using cold applied adhesive.
 - a. Where ASTM D-1863 aggregate is not available, provide aggregate complying with gradation size six (6), seven (7), and sixty-seven (67) of ASTM of ASTM D-448, provide that moisture content by weight is three (3) percent or less and aggregate meets other requirements of ASTM D-1863.
7. Walkway protection: Prefabricated pads designed specifically for protection of modified bitumen sheet roof systems, placed to provide access from roof hatch or down to all rooftop equipment, roof drains and equipment disconnects.
8. Cold Applied Membrane Adhesive: As recommended by membrane manufacturer for particular substrate and project conditions, formulated to withstand minimum 90-psf uplift force, and is part of a UL approved roofing system.
9. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints and filling voids.
10. Torch cap not acceptable.
11. Duralast fascia material is preferred – color to be selected.

E. Insulating Materials

1. General: Provide insulating materials to comply with requirements indicated for materials and with referenced standards in sizes to fit applications indicated, selected from manufacturer's specifications for thickness, widths, and lengths.
2. Polyisocyanurate Board Roof Insulation: Top layer to be minimum 2.0 pounds per cubic foot density bonded to roofing felt facer sheets (two sides). Underlying and tapered layers may be of lesser density. Provide in thickness indicated, with a minimum k-value of 0.17 when tested according to ASTM C-518 after insulation is conditioned per RIC/TIMA 281-1 conditioning procedure. Provide a minimum of 4 inches of insulation.
3. Tapered insulation is to be used only when a truly flat structure is the substrate.

F. Warranty

1. Twenty (20) years

2.3 EPDM Roofing: (This section is included for information ONLY. EPDM Roofing Systems are, generally, NOT ACCEPTABLE.)

A. General

1. Total system warranty
 - a. 60 mils – Twenty (20) years
 - b. 90 mils – Thirty (30) years
2. Black preferred
3. EPDM to be used around kitchen exhaust and in high traffic areas.
4. Shall not be used in or around chemical sensitive area.
5. Following manufacturers are acceptable:
 - a. Firestone
 - b. Carlisle

2.4 Shingled

Basis for design of asphalt shingles is GAF Lifetime.

- A.** Provide minimum 5/8 inch 3- ply plywood substrate or 5/8 inch tongue and groove plywood substrate. Plywood clips shall be used between rafters.
- B.** Minimum slope 4 inches in 12 inches
- C.** Hot dipped galvanized nails
- D.** Thirty (30) pounds felt
- E.** Ice Guard to be used in all valleys and two (2) courses at all perimeters up from edge or gutter line.

2.5 Shingle Re-Roofs

- A. Remove shingles down to plywood.
- B. Install GAF ice guard two (2) courses up from gutter line and in all valleys around any roof penetrations (i.e. chimneys).
- C. Replace all old existing flashings and counter flashings.
- D. Use GAF shingles and all foot products for full GAF warranty.
- E. Use GAF Ridge Vents: Use GAF edge vent if there are no vents in eaves or overhangs. Install edge vent four (4) shingle courses up from gutter line – approximately 20 inches.

2.6 Metal Roofing

- A. Where metal roof is proposed standing seam, double-lock connections are preferred.
- B. Provide a sufficient number of mechanically fastened metal snow guards, especially at entrances.

2.7 Sheet Metal

A. Counter flashing

- 1. Copper is first choice for historical preservation. If steel is used, provide twenty-four (24)-gauge minimum. For exposed steel, provide Kynar finish, or approved equal, from manufacturer's standard colors.
- 2. No surface mounted counter flashing shall be allowed. Reglet preferred.

B. Scuppers/Gutters/Down spouts

1. General

- a. All detailing shall conform to manufacturers specifications.
- b. Where architecturally acceptable, 16 ounces copper is preferred.
- c. If steel (24 gauge minimum) is used, provide Kynar finish, or approved equal, from the manufacturer's standard colors. Match existing, where historical demands require.

- 2. Overflow Scuppers: Make exterior perimeter high and place overflow scuppers such that bottom of scupper is ½ inch above top of finished roof.

3. Scuppers and gutters as part of roof drainage system.

- a. Place crickets between scuppers.
- b. Provide conductor head with down spout at scupper.
- c. Connect all down spouts to underground storm drainage systems. If not possible, configure down spout so that it, and its discharge, drain away from base of building. Provide cleanout at base of down spout.

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- d. Provide expansion joints in gutters. Do not fasten the back of the gutter to the building. “Flange-back” gutters are preferred.
- e. Avoid internal gutters.

2.8 Re-roofing

- A. Inspect existing roof:
 - 1. Core existing roof to verify conditions.
 - 2. Determine whether pull-out testing is required.
 - 3. If existing roof is mechanically fastened, determine how to remove roof and methods to repair substrate.
- B. Test for asbestos, lead, and asphaltic substances whose removal may require abatement or special environmental considerations.
- C. Inspect existing skylights and report to Baldwin Wallace University project representative whether it would be prudent to include skylight re-work with roof repairs. Likewise, for roof scuttle and other rooftop accessories.
- D. Remove existing roof to bare substrate. Never remove more roof than can be dried-in prior to completion of day’s work or in the event of rain.
- E. Provide for substrate repair/replacement in Base Bid (by assumed quantities or percentages, and unit prices, if necessary).
- F. Replace all nailers. Provide unit prices with bid to allow existing nailers to remain if determined to be satisfactory.
- G. Re-use of existing counter flashing is permissible if Baldwin Wallace University’s Project Representative agrees. Verify height of finished roof and include repairs to counter flashing in Base Bid. Remove and replace caulk top of existing counter flashing where caulking exists.

PART 3: EXECUTION – NOT USED

END OF SECTION 075000

SECTION 078400 – FIRE STOPPING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for the materials and products to prevent the spread of fire through openings in floors, walls and other building components.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. Compatibility of materials: All fire stopping must be a UL approved assembly.
- B. Fire stopping shall comply with Ohio Fire Code, NFPA, and Life Safety 101.

1.3 Quality Control

- A. Baldwin Wallace University Fire Marshall shall review fire-resistive assemblies and comment favorably.

1.4 General Requirements:

- A. Asbestos: In no instance will any product containing asbestos be acceptable for use.
- B. Fire Stopping: Assemblies must make a smoke tight and water tight seal.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 078400

SECTION 079200 – JOINT SEALANT AND EXPANSION CONTROL

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for jointing of exterior vertical surfaces for the following materials:
 - 1. Concrete
 - 2. Masonry
- B. Baldwin Wallace University recognizes that project conditions and requirements vary, thus precluding absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. Structural Systems
- B. The Secretary of the U.S. Department of the Interior’s Standards for Rehabilitation
- C. Conservation of Building and Decorative Stone, 2 volumes, John Asbury
- D. Technical Notes on Brick Construction, Brick Industry Association
- E. Masonry Veneer (Second Edition), Masonry Institute of America

1.3 Definitions

- A. Construction joint
 - 1. Construction joints shall be located where construction will be facilitated or where the lack of a joint could cause the lack of structural integrity in the completed structure.
 - 2. Construction joints are theoretically undetectable in the completed structure and shall not cause any reduction in structural capacity or integrity.
- B. Control joint
 - 1. Control joints include expansion and contraction joints and are intended to provide for movement in the structure in order to “control” any possible movements that may have an impact on the structural integrity of the completed structure.
 - 2. Control joints also act as construction joints.
 - 3. Control joints are often referred to as movement joints.

C. Expansion joint

1. Expansion joints are control joints that are designed to allow for the expansion of the concrete or masonry.
2. Expansion joints also act as contraction joints.

D. Contraction joint

1. Contraction joints are control joints that are designed to allow for the contraction of the concrete or masonry.

1.4 General Requirements:

- A. Jointing shall be integral with the architectural/structural design and detailing, not added at the end of the design process to satisfy minimum requirements.
- B. This standard gives some general guidelines for the locations and sizes of joints. However, jointing design is dependent on the materials selected, the makeup of the materials, environmental conditions, and the architectural/structural design and detailing. Factors to be considered are:
 1. Temperature effects
 2. Shrinkage effects
 3. Creep
 4. Stresses caused by the architectural/structural design
 5. Moisture effects
- C. All expansion and contraction joints shall be shown and detailed by the Engineer or Architect.
- D. Critical construction joints shall be planned for and shown on the drawings, with guidelines for other construction joints specified in Division 03, Section 033000: Cast-in-place Concrete, to be prepared as a part of the contract documents. Other proposed construction joints as specified in section 033000 shall be submitted by the Contractor to the Engineer for review and approval during construction.

PART 2: PRODUCTS

2.1 Joint Sealant

- A. Unless otherwise required for specialized conditions, joint sealant shall be a moisture-cured, single-or multi-component (depending on the application and required expansion/contraction capabilities), polyurethane-base, non-sag, electrometric sealant.
- B. Sealant depth-to-width ratio at the center of the joint shall be 1:2.
- C. Allowable expansion/contraction of the joint shall be plus/minus 25 to 50 percent of joint width, depending on the product capabilities.
- D. Where applicable, provide a compatible sealant primer.

2.2 Backer

- A. Joint sealant backer is required for all applications.
- B. Unless otherwise required for specialized conditions, joint sealant backer shall be a closed-cell, polyethylene rod.
- C. Where limitations prevent the use of a backer rod, specify a polyethylene, self-adhesive, bond-breaker tape shall be used.

2.3 Filler

- A. Joint filler shall be specified to provide filling of the gap and to prevent displacement and improper location of the backer.
- B. Joint filler shall be a continuous, non-bleeding material compatible with the joint conditions.

PART 3: EXECUTION

3.1 Construction Joints

- A. Locate construction joints where anticipated stresses are low.
- B. Before placing new material against the completed side of the joint, clean the joint thoroughly and specify a bonding agent, mortar, lean grout, etc., as required to meet the definition and function of a construction joint.
- C. Structural reinforcing shall be 100 percent continuous across the joint.
- D. Where applicable, water stops shall be provided for water tightness.

3.2 Control Joints

- A. Expansion joints
 1. Locate expansion joints to accommodate anticipated expansion at abrupt changes in the structure, where butting up to existing structures, and at least one corner of windows, doors, and other rectangular openings.
 2. The spacing of joints shall be contingent on the material's capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).
 3. Structural reinforcing shall be discontinuous across the joint. Terminate by reinforcing a minimum of 2 inches from the faces of the joint.
 4. Smooth reinforcing dowels, properly detailed, shall be provided to prevent movement out of the plane of the vertical surface and to provide for shear transfer (as required).
 5. The minimum expansion joint width shall be ¼ inch.
 6. Expansion joints shall be sealed.
 7. Where applicable, water stops shall be provided for water tightness.

B. Contraction joints

1. Locate contraction joints to accommodate anticipated contraction, usually at a set spacing of between 15 – 30 feet.
2. The spacing of joints is contingent on the material's capacity to sustain expansion without damage to the concrete or masonry (usually based on the amount of reinforcing).
3. Maximum structural reinforcing shall be 50 percent continuous across the joint. Terminate non-continuous reinforcing a minimum of 2 inches from the faces of the joint.
4. Smooth reinforcing dowels properly detailed can be provided to prevent movement out of the plane of the vertical surface and for shear transfer across the joint if the normal reinforcing detailed is not adequate.
5. The minimum contraction joint depth shall be $\frac{3}{4}$ to 1 inch.
6. Typically, contraction joints are sealed.
7. Where applicable, water stops shall be provided for water tightness.

C. Control joints

1. Shall not abruptly terminate in the middle of a vertical surface. (For example, do not discontinue joints at parapets, but continue joints through the parapet.)

3.3 Concrete: The following guidelines are in addition to those noted above and refer specifically to concrete:

A. Contraction joints in concrete shall be installed according to one of the following methods:

1. Pre-manufactured strips that are set in with the concrete and removed during or after the curing process of the concrete.
2. Saw-cutting. To be effective, saw-cutting must occur as soon as possible after concrete placement. Many factors influence the timing of saw-cutting, including weather conditions, concrete mix design, curing, and time of placement. However, the following general guidelines shall apply:
 - a. Hot/dry conditions. Saw-cut within four (4) to twelve (12) hours.
 - b. Cool/moist conditions. Saw-cut within twenty-four (24) hours.

B. Contraction joints in concrete shall be provided at the following locations:

1. At major changes in wall heights
2. At changes in wall thickness

3.4 Masonry: The following guidelines are in addition to those noted above and specifically to masonry:

A. Expansion joints in masonry shall be provided at the following locations:

1. Below shelf angles or structural frames supporting masonry walls or panels
2. Above masonry walls or panels abutting structural frames

3. At major changes in wall heights
 4. Near wall intersections
 5. At regular intervals, not to exceed 25 feet
- B. Contraction joints in masonry shall be provided at the following locations:
1. At major changes in wall heights
 2. At changes in wall thickness
 3. Above joints in foundations
 4. At columns and pilasters
 5. At one or both sides of wall openings
 6. Near wall intersections

END OF SECTION 079200

SECTION 080000 – Section Index

080000	PREFERRED MATERIALS: DOORS AND WINDOWS
081113	HOLLOW METAL DOORS AND FRAMES
081416	FLUSH WOOD DOORS
083113	ACCESS DOORS AND FRAMES
083323	OVERHEAD COILING DOORS AND COUNTER DOORS
083513	FOLDING DOORS
084113	ALUMINUM-FRAMED ENTRANCES
087100	FINISHED HARDWARE
088000	GLAZING

SECTION 080000 – PREFERRED MATERIALS: DOORS AND WINDOWS

1. Continuous Door Hinge Manufactures:

A. Select

B. Roton

2. Metal Doors: 18-Gauge Thickness

3. Windows:

A. Pella Fibrex

B. Marvin Infinity

*NOTE: ALUMINUM FRAMES NOT DESIRED!

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the assemblies of doors, sidelights, bulkheads, sills, etc., including, but not limited to, glass doors for exterior or interior applications.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Steel Door Institute

1.3 Quality Control

- A. Knock-down frames are not acceptable. Use pre-welded hollow metal frames. All frames shall have a minimum of three (3) jam band and floor anchor per jamb.
- B. Glass lite shall be in metal frames, unless required by code for fire rating, frames are not to be grouted.
- C. Metal doors and door frames which are at an exterior condition shall be heavy duty SDI grade 3, galvanized and painted.
- D. All fire rated doors and frames shall have a label mechanically attach indicating the class and rating.
- E. Equipment rooms:
 - 1. Doors shall open either to the outside or to the corridor. They shall not open to a classroom, office, lab or other occupied areas.
 - 2. Access doors will be a minimum of 48 inches wide by 72 inches tall and shall not open into the equipment room.

PART 2: PRODUCTS

2.1 General

- A. Minimum gauge shall be 16-gauge for interior frames and 14-gauge for exterior frames.
- B. Minimum door face sheet shall be 18-gauge for interior door and 16-gauge for exterior doors.
- C. Close top and bottom of doors, do not leave an open channel.
- D. Consultants shall coordinate security system and hardware requirements with this section to provide necessary cut outs and reinforcing as part of the construction contract.

PART 3: EXECUTION –NOT USED

END OF SECTION 081113

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SECTION 081416 – FLUSH WOOD DOORS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for wood doors and panels; fire-rated and non-fire-rated; flush wood doors and panels with veneer facings.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for Baldwin Wallace University projects.

1.2 Reference Standards

- A. National Wood Window and Door Association Standards (NWWDA)

1.3 Quality Control

- A. Interior core of door products: In no instance shall hollow core doors be allowed.

1.4 General Requirements

- A. Finish: Painted birch or stained book-matched wood veneer. Light color stain is preferred over a dark colored stain. Verify wood door appearance will either match or coordinate with woodwork used elsewhere throughout the Project.
- B. Warranty: Maximum warranty available will be required. Lifetime warranty preferred.
- C. Core: Use staved lumber core.
- D. Vertical Edges: Same species as face, lumber or veneer; sanded ease, no visible joints allowed. Fire rated, mineral core doors shall have minimum 1-³/₈ inches thick solid edges and solid blocking at hinge and lockset locations.
- E. Horizontal Edges: same species as face having as minimum of 1 ½ inches thickness.
- F. Field tolerance for planning shall not exceed ¼ inch.

PART 2: PRODUCTS

2.1 General

- A. Doors shall comply with NWWDA standards.
- B. Contractor shall not be permitted to install doors prior to building having conditioned air.
- C. Coordinate with hardware specifications for size of solid blocking required at lock set.

PART 3: EXECUTION – NOT USED

END OF SECTION 081416

(Revision – 0) 05/01/2013

081416-1

SECTION 083113 – ACCESS DOORS AND FRAMES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for doors and frames for ceilings, floors, and walls.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 General Requirements

- A. General locations: Access doors are to be provided for all maintenance points where immediate access is required. As a standard in non-accessible ceilings, provide an access door no less than every 200 square feet. Specify that above non accessible ceilings, Contractor shall coordinate trades to locate items needing maintenance access in grouped locations to minimize access doors. Coordinate access door layout with project representative in advance of installation.
- B. Locking: Provide lockable access doors when they are located in public areas or where providing access to crawl spaces. Coordinate keying with hardware section.
- C. All doors shall be prime coated for field finishing.
- D. Minimum sizes: Coordinate with mechanical divisions and with specific job requirements.
 - 1. In wall, 10 by 10 inches square door: Plumbing valves, reset buttons, controls manometers, etc.
 - 2. In wall, 24 by 24 inches square door: Plumbing fittings at toilets, mechanical filters banks, access hatches, areas requiring work access for unit replacement, etc.
 - 3. In ceiling, 12 by 12 inches square door: Above ceiling cut-off valves, duct dampers, fire and/or smoke dampers, meters, registers, etc.
 - 4. In ceiling, 24 by 30 inches square door: HVAC filter units, remote duct dampers, remote fire dampers, remote electrical J-boxes, access hatches, etc.
- E. Larger sizes are permitted to suit special requirements recommended by the design professional.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 083113

SECTION 083323 – OVERHEAD COILING DOORS AND COUNTER DOORS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for doors with operators, tracks, controls, etc.; includes operators and special hardware as required by design professional.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

- A. Types:
 - 1. Standard Service – Interior Use
 - 2. Insulated Standard – Exterior use
- B. Fire Rated as required by code enforcement.
- C. Metal is preferred
- D. Finish as required by design professional.

1.3 General Requirements

- A. Operation: Motorized. Provide access to motor. Provide access at the jamb for the chain operation assembly.
- B. Fire rated: When in a fire rated assembly, the unit shall be rated appropriately. The unit shall be connected to the fire alarm system unit shall not be a “release and gravity drop” type.
- C. Locking: Locking device shall be mechanical type.
- D. All locks shall work with standard mortise or rim cylinders

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 083323

SECTION 083513 – FOLDING DOORS

PART 1: GENERAL

1.1 Scope of Standard

- A. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 General Requirements

- A. Use of these is not preferred.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 083513

SECTION 084113 – ALUMINUM-FRAMED ENTRANCES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Fixed Aluminum Frame System.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. ASTM E283, E330 and E331 for air and water infiltration requirements.

1.3 Quality Control

- A. Prior approval by the Project Manager will be required for use of a mill finish product.
- B. Where utilizing in a remodel project, finish shall match existing.

1.4 General Requirements

- A. Factory pre-finish is required.
- B. There is no color standard at this time.
- C. Provide thermal break provided at exterior locations.
- D. Window units are to be fixed, non-operable, set in neoprene gasketing.
- E. Systems shall accommodate building deflection without damage to system, components or seal.
- F. Provide minimum five years manufacturer's warranty.
- G. All door stiles shall be Heavy Duty and a minimum of 5 inches width.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 084113

SECTION 087100 – FINISHED HARDWARE

PART 1: GENERAL

1.1 Scope and Standard

- A. In most of the division sections herein, a statement that allows variances occurs in this space. NOT SO for hardware. This section is to be adhered to in total. The bidder is given three (3) choices of manufacturer which satisfies State Code.
- B. Furnish hardware for man doors, including necessary fasteners, drop plates, and other devices necessary for proper application of hardware as the building needs dictate.
- C. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:
 - 1. Windows
 - 2. Cabinets of all kinds, including open wall shelving
 - 3. Signs, except as noted
 - 4. Toilet accessories of all kind, including grab bars
 - 5. Overhead doors, except cylinders where scheduled

1.2 References

The following material was used as references:

- A. The Door and Hardware Institute (DHI) various publications
- B. American National Standards (ANSI)/Builders Hardware Manufacturer Association (BMHA)
- C. National Fire Prevention Association (NFPA)
 - 1. NFPA 80 Standard for Fire Doors and Fire Windows
 - 2. NFPA 101 Life Safety Code
 - 3. NFPA 105 Smoke and Draft Control Door Assemblies
- D. Underwriters Laboratories (UL)
 - 1. UL 10C – Fire Tests of Door Assemblies
 - 2. UL 305 – Panic Hardware
- E. International Building Code
- F. American Disabilities Act (ADA) – 1990 Civil Law

1.3 Submittals

- A. Hardware schedule shall be compiled by an Architectural Hardware Consultant.
- B. Schedules are to be typed in accordance with DHI “Sequence and Format for the Hardware Schedules” vertical format including:
 - 1. Types, style, function, size, and finish of each hardware item
 - 2. Names and manufacturer of each item
 - 3. Fastenings and other pertinent information
 - 4. Cross-reference hardware sets to location indicated on drawings
 - 5. Explanation of all abbreviations, symbols, and codes contained in the schedule
 - 6. Mounting locations for hardware (per DHI standards)
 - 7. Door and frame sizes and materials
- C. Product and Data catalog cuts will be included and attached to the hardware schedule.
- D. Samples may be required per the Architect and will be submitted; and after approval, be incorporated into the work or returned in like-new condition.
- E. A key schedule is to be submitted after a meeting between the Owner, Baldwin Wallace University Lead Locksmith, Architect, and hardware supplier. Provide a keying schedule, listing the levels of keying as well as an explanation of the key system’s function, the key symbols used, and the door numbers controlled per the DHI format and nomenclature. To ensure timely delivery, the keying schedule must be submitted with the hardware schedule submittals to be to be coordinated through the office of the Lead Locksmith.
- F. Wiring Diagrams and other pertinent electrical information for the proper installation of all electrical, electromechanical, and electromagnetic products will be submitted with the hardware schedule.
- G. Operation and Maintenance Data: At the completion of the job, furnish to the Owner two (2) copies of the Owner’s operation and maintenance manual. The manual will consist of a hard cover and three-ring binder with the project name on the front. Included in the manual will be: the final copy of the hardware schedule, the catalog cuts for the schedule, the finalized keying schedule, the names and phone numbers of the maintenance representatives for each item supplied and any specialized tools needed to maintain the hardware. Coordinate this delivery with the post-installation job site meeting.

1.4 Quality Assurances

- A. Standards: Manufacturers and model numbers listed are to establish a standard of quality required by Baldwin Wallace University.
- B. Substitutions: Products are to be specified to ensure a uniform basis of acceptable materials. No other substitutions will be allowed. Certain products have been selected for their unique characteristics and particular project suitability. Any deviation must be approved in writing through design and construction.
 - 1. Items specified, as “no substitution” shall be provided exactly as listed.

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2. Items listed with no substitute manufacturers have been requested by Owner/Architect to match existing for continuity and/or future performance and maintenance standards or because there is no known equal product.
 3. If no other products are listed in a category other than the one specified, then “no substitution” is implied.
 4. Voluntary alternate pricing will not be accepted without the written authorization from the Lead Locksmith.
- C. Supplier qualifications: The hardware supplier must be engaged regularly in contracting work and be staffed to expedite work. The supplier must have on staff an Architectural Hardware Consultant (AHC) who will be available at reasonable times throughout the job to help with the proper selection, scheduling, detailing installation, and adjusting of the hardware.
- D. Single source responsibility: Obtain each type of hardware (one latch and lock manufacturer, one hinge manufacturer, one closer manufacturer, etc.) from a single manufacturer. This will be enforced for mechanical and electrical products.
- E. Fire-Rated Openings: Provide door hardware for fire-rated openings that comply with NFPA standard No. 80 and the requirements of Authorities Having Jurisdiction.
1. Where emergency exit devices are required on fire rated doors (with supplementary marking on door UL labels indicating “Fire Doors to be equipped with Fire Exit Hardware”) provide UL label on exit devices indicating “Fire Exit Hardware”.
- F. Electronic Security Hardware: When electrified hardware is scheduled in the hardware specification, the hardware supplier must employ an Architectural Hardware Consultant (AHC), knowledgeable in electrified components and systems and who is able to produce wiring diagrams and consult as needed. Coordinate installation of the electronic security hardware with the Architect and electrical engineers and provide installation and technical data to the Architect and other related sub-Contractor. Upon completion of electronic security hardware installations, verify that all components are working properly, and state in the required guarantee that this inspection has been performed. All wiring must be eighteen (18) gauge or thicker. Provide electrical door hardware from the same source manufacturer as mechanical door hardware. (Some wiring may be smaller than eighteen (18) gauge due to manufacturer.)

1.5 Delivery, Storage, and Handling

- A. Marking and Packaging: The hardware will be delivered to the job site in the manufacturer’s original packages, marked to correspond with the approved hardware schedule and opening numbers. Include installation instructions with each piece of hardware.
- B. Delivery: Some items of hardware may be delivered to fabricators for factory installation. The balance of the hardware will be delivered to the job site once the Contractor has secured a dry and heated room in which to lock and store the material. This delivery fee will be included in quoted price of the material. The supplier will deliver and inventory the material in the presence of the Contractor and the installer. At this time, installation tips or special instructions will be reviewed. Coordinate this meeting with the pre-installation job site meeting.
1. The Owner’s Hardware Representative will perform with the Installing Contractor a pre-install training when the hardware is delivered on site. After install, the Owner’s Hardware Representative will perform a post-inspection to verify that the hardware was installed to the manufacturer’s specifications so not to void any warranties.
- C. Items damaged in shipment will be replaced promptly at Contractor’s expense.

1.6 Warranty

- A. Starting date for all warranty periods will be from the date of Substantial Completion.
- B. No liability is to be assumed where damage or faulty operation is due to improper installation, improper use or abuse.

Provide warranty from the hardware supplier as follows:

- 1. Hinges: Life of building
 - 2. Closers: Ten (10) years, electronic closers, two years
 - 3. Exit devices: Three (3) years, electrified devices, one year
 - 4. Locksets: Ten (10) years, electrified devices, one year
 - 5. All other hardware: One (1) year
- C. Products judged to be defective during the warranty period must be replaced or repaired in accordance with the manufacturer instruction and warranty, at no additional cost to the Owner.

1.7 Maintenance

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2: PRODUCTS

2.1 Manufacturers

The following manufacturers have been selected for this project.

- A. Note that even though an acceptable substitute manufacturer may be listed, the product must provide all the functions and features of the specified product or it will not be approved.

<u>Description</u> <u>Substitution</u>	<u>Specified</u>	<u>Acceptable</u>
Hinges (Heavy Duty)	Hager	McKinney
Hinges (Continuous)	Pemko	Markar, Roton, Select
Hinges (Pivots)	Ives	Brookline, Rixon
Locks, latches, deadlocks	Schlage	
Electromechanical locks (stand-alone)	Schlage	
Cylinders and keying	Schlage, Medeco	
Cylinders and keying – Housing	Schlage, Medeco	
Exit devices	Von Duprin	
Electric strikes	Von Duprin	Von Duprin
Removable mullions	Von Duprin	Sargent
Closers	LCN	
Power operators	LCN	

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<u>Description</u>	<u>Specified</u>	<u>Acceptable</u>
Flush Bolts, Dust Proof Strikes	Ives	Trimco, DCI
Coordinators	Ives	Trimco, DCI
Overhead Stops/ HOLDERS	Glynn-Johnson	Sargent
Card Swipe	Specified on line in electrics specifications	Blackguard
ADA Openers	LCN	Besam
Magnetic Holders	LCN	Sargent
Stops/Holders	Ives	Rockwood
Push/Pull/Kick Plates	Ives	Rockwood
Thresholds	NGP	Pemko, Reese, Zero
Seals/Door Bottoms	NGP	Pemko, Reese, Zero
Weather-Strip	NGP	Pemko, Reese, Zero
Key Cabinets	Lund	Telkee, HPC
Wired and Wireless Door Hardware	Schalge	

- B. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation of door movement as shown. Show doors as working now so that they may be listed left hand/right hand. No reverse bevel.
- C. Where the exact types of hardware specified are not adaptable to the finished shape or size of the members requiring hardware, furnish suitable types having as nearly as possible the same operation and quality as the type specified, subject to Locksmith approval.

2.2 Materials

A. Screws and Fasteners

1. Provide hardware manufactured to conform to published template, generally prepared for machine screw installation.
2. Furnish screws for installation with each hardware item. Finish exposed (under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of the other work as closely as possible including “prepared for paint” surface to receive painted finish.
3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent that no standard units of type specified are available with concealed fasteners. Do not use through-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely.

B. Hinges/Bolts

1. The following is a guide for hinge type required for their specification:
 - a. 1 ¾ inches doors up to and including 3 feet wide:
Exterior: heavy weight (.180), ball bearing, bronze/stainless steel 4 ½ inches by 4 ½ inches –N/R pin.
Interior: standard (.180) ball bearing steel, 4 ½ inches by 4 ½ inches.
 - b. 1 ¾ inches doors over 3 feet wide:
Exterior: heavy weight (.180), ball bearing, bronze/stainless steel, 5 inches by 5 inches N/R pin.
Interior: heavy weight (.180), ball bearing, steel, 5 inches by 5 inches.

2. The width of hinges shall be sufficient to clear all trim. Furnish one pair for all doors up to 60 inches high. Furnish one and one half pair for 7 feet high.
3. Hinge pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel hinges: Steel pins
 - b. Non-ferrous Hinges: Stainless steel pins
 - c. Out-swing Exterior Doors: Non-removable pins
 - d. Interior Doors: Non-rising pins

C. Continuous Hinge

1. Provide continuous hinges of the type and style noted in the hardware sets.
 - a. Continuous hinges will be of pin and barrel construction with a .25 diameter 304 stainless steel pin, gear type hinges are not acceptable.
 - b. Continuous hinges must be successfully tested for 1,500,000 cycles.
 - c. Continuous hinges will be full mortise installation with template hole pattern.
 - d. Aluminum doors will have continuous hinges made of extruded aluminum 6063-T6 alloy with standard aluminum powder coating finish by hinge manufacturer.

- D. Automatic and manual flush bolts shall have forged bronze face-plate with extruded brass lever and with wrought brass guide and strike. Flush bolts for hollow metal doors up to 7 feet – 6 inches in height shall have 12 inches steel or brass rods. Manual flush bolt rods for doors over 7 feet – 6 inches in height shall be increased by 6 inches for each additional 6 inches of door height. Provide dust proof strikes.

E. Coordinators

1. Where pairs of doors are equipped with automatic flush bolts or astragal, provide a bar type coordinating device, surface applied to the underside of the stop at the frame head.
2. Finish of the coordinator to be prime coat to receive the same finish paint as the door frame.
3. Provide a filler bar of the correct length to span the entire width of the opening, and appropriate brackets for parallel arm door closers and surface vertical rod strikes.

F. Mortise Locks

1. Locks shall be ANSI A156.13, Grade 1 mortise locksets, manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
2. Locks are to have a standard 2 ³/₄ inches backset with a full ³/₄ inch throw stainless steel mechanical anti-friction latch bolt. Deadbolt shall be a full 1 inch throw, constructed of stainless steel.
3. Lever trim shall be cast or forged in the design specified, with 2-¹/₈ inches diameter roses. Levers shall be thru- bolted to assure proper alignment. Locks will include screws to accommodate door thickness.

4. All inside thumb-pieces are to have the Americans with Disabilities Act (ADA) disability turns.
5. Locks meeting this specification:

Schlage:
L9000 93A

G. Cylindrical Locksets and Latchsets.

1. Heavy-duty cylindrical locksets and latchsets shall conform to ANSI A156.2, Series 4000, Grade 1. Functions as listed in “Hardware Sets”.
2. Locks shall have field reversible handing.
3. Lever support shall be sustained by use of two independent spring cartridges, one for each lever.
4. Locks shall have special tapped holes in outside mounting plate to resist loosening of thru-bolt.
5. Springs to be full compression type.
6. Strike to be sixteen (16) gauge, with 1 inch deep box construction, curved lip of sufficient length to clear trim and protect clothing.
7. Locks shall have free wheeling lever to eliminate the ability to exert excessive force on the end of the lever.
8. Locks to have inner spindle that independently operates lever when locked.
9. Locks meeting this specification:

Schlage:
Series Rhodes, Vandal-Guard

H. Exit Devices

1. Exit devices shall be touch-pad type, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard architectural finishes to match the balance of the door hardware.
2. Exit devices shall be tested to ANSI/BMHA A156.3 test requirements by a BMHA certified testing laboratory. A written certification showing successful completion of a minimum of ten millions (10,000,000) cycles must be provided.
3. Touch-pad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D finishes.
4. All devices to incorporate a security Dead Latching (DL) feature. Devices without DL feature will not be acceptable.
5. Provide Roller Strikes (RS) for all rim and surface mounted vertical rod devices. Devices without roller strikes will not be acceptable. Absolutely no concealed vertical devices.
6. Mechanism case shall sit flush on the face of all doors. Devices shim kits must be used to eliminate pinch points. Glass trim for doors with cutouts shall not extend beyond face of door.
7. All non-fire related exit devices shall have cylinder dogging where needed.

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8. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
9. All exit devices shall incorporate a fluid damper or other device, which eliminates noise associated with exit device operation. Touch-pad shall extend a minimum of one half of the door width. End-cap will be flush design, heavy duty die-cast alloy with a sloped backed low profile.
10. A key removable mullion is the Owner's preferred application on pairs of hollow metal doors and frames.
11. On fire-rated pairs of doors the "LBR" option will be used.
12. Where lever trim is required, break-away trim will be used.
13. Exit devices meeting this specification:

Von Duprin:
33 Series
99 Series

I. Electric Strikes

1. Electric strikes shall be UL1034 Burglary Listed, ANSI/BHMA 156.1, Grade 1, manufactured with investment cast stainless steel, internal steel components, die cast aluminum back box, high-density steel keeper, stamped steel faceplates, and have Latch Bolt Strike Monitoring (LBSM).
2. Strikes are to be dual-voltage 12 or 24 volts DC, field reversible for fail-safe/fail-secure applications, non-handed, tamper resistant, and have self-contained (internal) solenoid.
3. Electric strikes meeting this specification:

Von Duprin

J. Door Closers

1. All closers will utilize a stable fluid withstanding temperature range of 120 to 30 degrees Fahrenheit without seasonal adjustment of closer speed to properly close the door. Closers on fire rated doors will be provided with temperature stabilizing fluid that complies with Standard UL 10C for "Positive Pressure Fire Test of Door Assemblies" and UBC 7-2 (1997).
2. Cylinder body shall be 1 ½ inches in diameter, and double heat-treated pinion shall be 1¹/₁₆ inch in diameter. Door closer shall have hydraulic, full rack and pinion action with a high strength cast iron cylinder.
3. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and back check. A written certification showing the successful completion of a minimum of ten millions 10,000,000 cycles for exterior door closers must be provided.
4. All closers shall have solid forged steel main arms (and forged forearms for parallel closers).
5. Closer cylinders, arms, and metal covers shall have a powder coating finish which has been certified to exceed 100 hours salt spray testing by ETL, and independent testing laboratory used by BHMA for ANSI certification. For metal components that cannot be powder coated, a Special Rust Inhibiting (SRI) finish must be used.

6. All closers will not be seen on the public side or hallway side of the door. The appropriate drop or mounting plates will be used as conditions dictate. The door closer will never be used as a stop and will never have a built in holder.
7. Door closers meeting the specification:
LCN:
1461 Series (Interior Light Traffic Doors)
4041 Series (All Exterior Traffic Doors)

K. Power Operators

1. Where low kinetic energy, as defined by ANSI Standard A156.19, power operators are indicated for doors required to be accessible to the disabled, provide pneumatically and electrically powered operators complying with the 1990 ADA for opening force and time to close standards.
2. Full closing force shall be provided when the power or assist cycles ends.
3. All power operator systems shall include the following features and functions:
 - a. Provision for separate conduits to carry high and low voltage wiring in compliance with the National Electric Code, Section 725-31.3.
 - b. When obstruction or resistance to the opening swing is encountered, the operator will pause, then reattempt to open the door. If the obstruction or resistance remains, the operator will again pause the door.
 - c. The operator will be designed to prevent damage to the mechanism if the system is actuated while the door is latched or if the door is forced during the cycle.
 - d. All covers, mounting plates, and arm systems shall be powder coated and successfully pass a minimum of 100 hours testing as outlined in ANSI Standard A156.18.
 - e. UL listed for use on labeled doors.
 - f. All operators shall be non-handed with spring power over range of one (1) thru six (6).
 - g. Provisions in the control box or module shall provide control (inputs and outputs) for: electric strike delay, auxiliary contacts, sequential operation, fire alarm systems, actuators, swing side sensors, stop side sensors.
 - h. Easily accessible main-power and maintain hold open switches will be provided on the operator.
 - i. An electronically controlled clutch to provide an adjustable opening force.
 - j. Provide units that incorporate a microprocessor to control all motor and clutch functions.
 - k. Provide an on-board power supply capable of delivering both 12 volts and 24 volts outputs up to a maximum of 1.0 ampere combined load.
 - l. Slow blow fuses shall protect all input and output wiring. These fuses shall be easily replaceable without special tools or component replacement.

m. Power Operators meeting this specification:

LCN:

LCN 4600/4800

L. Push Plates

1. Push plates shall be 8 inches wide by 16 inches high by .050 inches thick. Where door stile does not allow 6 inches plates, 4 inches plates may be used.

M. Door Pulls and Push Bars

1. Pulls shall be 1 inch diameter solid bar stock, 10 inches center to center, with a projection of 2½ inches and clearance of 1 ½ inches and a back plate as scheduled. Push bars shall be 1 inch diameter solid bar stock, of sufficient length to span from center to center of each stile.

N. Protective Plates

1. Provide kick, mop, or armor plates of .050 material with four (4) beveled edges on the push side of all doors that have an automatic closing device and that have through traffic. Where scheduled, supply protective plates on the pull side of doors. Edge guards may be required as necessary (see hardware schedule). Protection plates must be sized appropriately not to conflict with any louvers. Furnish with machine or wood screws, finished to match plates.

Sizes of the plates shall be as follows:

Kick plates: 10 inches high by 2 inches less than door width (LTDW) on singles, 1 inch (LTDW) on pairs.

Mop plates: 4 inches high by 1 inch (LTDW) on singles, 1 inch (LTDW) on pairs.

Armor plates: 36 inches high by 2 inches (LTDW) on singles, 1 inch (LTDW) on pairs.

Size width of plates on pull side of doors at 1 inch (LTDW). (LTDW) less than door width.

O. Door Stops and Holders

1. It shall be the responsibility of the hardware supplier to provide door stops for all doors in accordance with the following requirements:
 - a. Wall stops shall be used wherever possible.
 - b. At no time will a hinge pin stop be acceptable.
 - c. At any opening where a wall stop cannot be used, a heavy duty overhead stop will be required.
 - d. All exterior doors will have an overhead stop and may, at the Owner's option, be a stop and holder. **This overhead stop will not be built into the closing device, but will work in conjunction with the closer.**
2. Wall stops that meet this specification:

Ives

Rockwood

P. Thresholds and Gasketing

1. Furnish as specified and per details. Match finish of other items as closely as possible. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available. Thresholds, sweeps, and weather-stripping will be supplied to weather proof the exterior doors. The thresholds will be supplied to fit the particular sill conditions and not conflict with the American Disabilities Act (ADA). Exterior pairs of doors will have split astragal to prevent air infiltration. Interior doors may require gasketing; thresholds and sweeps to act as a sound barrier per the Owner's request.

2. Thresholds and Gasketing that meet this specification:

NGP
Pemko
Reese
Zero

Q. Silencers

1. Furnish "push-in" type silencers for each hollow metal or wool frame, three (3) for each single frame or two (2) for each pair frame. Omit where gasketing is scheduled, unless the frames are factory pre-drilled.
2. Silencers that meet this specification:

Ives
Rockwood.

R. Magnetic Holders

1. Where magnetic holders are scheduled, provide a surface of wall mounted electromagnetic door release with a minimum of twenty-five (25) pounds of holding force, or positive release button to initiate the closing motion. Where magnetic holders are used on fire-rated doors, they must be wired as recommended by factory.

2.3 Finishes

- A. All hardware will be of stainless steel, dull chrome or sprayed aluminum finish. Verification of finishes to be provided through Locksmith.

2.4 Keying

A. Key System

1. All cylinders shall be furnished and supplied into the existing Baldwin Wallace University Patented/Restricted Key System as directed by Owner.

- B. Orders to the manufacturer for all products pertaining to the key system, shall be accompanied with a "Letter of Authorization" by an authorized University representative.

C. Keying Meeting

1. The keying meeting(s) shall be initiated by the supplier within sixty (60) days of award of contract and be conducted by a supplier representative, a Baldwin Wallace University authorized representative and a manufacturer authorized representative. A final keying schedule shall be detailed and produced by the supplier and submitted through the Architect to the Owner for final approval.

D. Construction Keying

1. All cylinders are to be furnished with a split key construction system. The University is responsible for removing construction key inserts upon taking possession of the facility or any part thereof. Contractor shall remove all cylinders. Baldwin Wallace University is responsible for installing cylinders.

E. Key Cylinders

1. Shall have a utility patent and produced solely by the manufacturer (OEM cylinders or key blanks will not be allowed).
2. All cylinders shall be keyed and assembled by the manufacturer.
3. Standard cylinders shall be 6 pin and manufactured of solid brass using nickel silver bottom pins, brass master pins, and phosphorus bronze springs Tumbler Springs. (Brass bottom pins or steel tumbler springs are not allowed.)
4. Interchangeable core cylinders are preferred on new construction and renovation. This will be determined between Baldwin Wallace University Representative and Manufacturer.

F. Keys and Key Blanks

1. All cut keys and/or key blanks of any type are to be manufactured of nickel silver and patented to guard against unauthorized duplication.
2. Furnish quantities as follows: 3 each per Change Key, 6 each per Master key, 3 each Permanent Control Keys, 12 each Split Key Construction Keys, 6 each Split Key removal tools, 12 each Interchangeable Core Construction Keys, 6 each Interchangeable Core Control Keys, and 100 each Key Blanks.
3. All construction and permanent keys of any type are to be shipped to the authorized Owner's representative directly from the manufacturer using the PKI System.
Note to Contractor: Contact the Owner's representative for construction keys.
4. ANY DEVIATION FROM THE SPECIFICATION MUST BE APPROVED IN WRITING THROUGH THE ARCHITECT TO THE OWNER.

2.5 Key Control

- A. Provide a key control system, including envelopes, labels, tags with Self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project.
 1. Provide complete cross-index system set up by the hardware supplier, and place keys on markers and hooks in the cabinet as determined by the final schedule.
 2. Provide piano hinged panel type cabinet for wall mounting.

PART 3: EXECUTION

3.1 Examination

- A. Prior to installation of any hardware, examine all doors, frames, walls, and related items for conditions that would prevent proper installation of finish hardware. Correct all defects prior to proceeding with installation.
- B. Prior to hardware installation, the general Contractor will set up a pre-install job sit meeting with the hardware supplier, hardware installer, and any other trades people deemed necessary (i.e. electrical Contractor, security Contractor, etc.) for communication to assure trouble free installation. This meeting would be best coordinated with the delivery requirements detailed in Section 087100, paragraph 1.5: Delivery, Storage, and Handling.
- C. The hardware supplier will observe the installation of the first lockset, closer, and exit device.
- D. Baldwin Wallace University Representative will review all hardware installation prior to substantial completion.

3.2 Installation

- A. All hardware will be installed by qualified tradesmen skilled in the application of commercial grade hardware. For technical assistance if necessary, installers may contact the manufacturer's representative for the item in question, as listed in the hardware schedule.
- B. Mount hardware units at heights indicated in "Recommended Locations for Builders Hardware for Standard Steel Doors (and Wood Doors) and Frames" by the Door and Hardware Institute.
- C. Install each hardware item in compliance with the Manufacturer's instructions and recommendations, using only the fasteners provided by the Manufacturer.
- D. Do not install surface mounted items until finishes have been completed on the substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- F. All operating parts shall move freely and smoothly without binding, sticking, or excessive clearance.
- G. Set thresholds for exterior door in full bed mastic sealant complying with the requirements specified in Division 7, Section 079200: Joint-Sealant and Expansion Control.

3.3 Adjusting, Cleaning, and Demonstrating

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly at substantial completion.
- B. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- C. Clean adjacent surfaces soiled by hardware installation.

- D. Instruct Owner's personnel in the proper adjustment, lubrication, and maintenance of door hardware and hardware finishes.

3.4 Field Quality Control

- A. Six-month Adjustment: Approximately six months after the date of Substantial Completion, the installer, accompanied by representatives of the manufacturers of latchsets and locksets, door control devices, and of other major hardware suppliers, shall return to the Project to perform post installation job site meeting:
 1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
 4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.
 5. Deliver Operation and Maintenance Data (described in Section 087100, 1.3 Submittals – G) and any other special tools needed to maintain the hardware.

3.5 Protection

- A. Provide for the proper protection of all items of hardware until the Owner accepts the project as complete. Damaged or disfigured hardware shall be replaced by the responsible party.

3.6 Hardware Schedule

- A. Provide hardware for each door to comply with requirements of Division 08, Section 087100: Finished Hardware and hardware set numbers indicated in the door schedule.
- B. It is intended that the following schedule includes all items of finish hardware necessary to complete the work. If a discrepancy is found in the schedule, such as a missing item, improper hardware for a frame, door or fire codes, the preamble will be the deciding document.

END OF SECTION 087100

SECTION 088000 – GLAZING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for transparent and translucent glass for general and special purpose applications.
- B. This standard also provides general guidance concerning the specific preferences for etched, stained, beveled, sandblasted, or carved glass, in historic buildings.
- C. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

- A. In no instance will glass with a film coating be acceptable.
- B. Wire glass: Use of this type product is not preferred. This type of glass in doors and walls will be in metal frames that wrap walls and doors.
- C. Historic Glass is to be replaced with a reproduction of like kind. In other instances, consult with the Project Manager.

1.3 General Requirements

- A. Other: For exterior glazing, use of clear low E insulated glass is preferred. No reflective glass is to be used. If shading is necessary refer all information to Project manager for discussion guidance.
- B. Manufacturers stamp is to be provided on all glass required by code to be “heat tempered”, “heat strengthened”, or “safety”.
- C. Asbestos: In no instance will any product containing asbestos be acceptable for use.
- D. Lead: In no instance will any product containing lead be acceptable for use.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 088000

SECTION 090000 – Section Index

- 090000 PREFERRED MATERIALS: WALL AND FLOOR FINISHES
- 092216 NON STRUCTURAL METAL FRAMING
- 092900 INTERIOR GYPSUM BOARD
- 093000 TILING
- 095123 ACOUSTICAL TILE CEILING
- 095123A CEILING SUSPENSION
- 096500 RESILIENT FLOORING
- 096813 CARPET TILING
- 096816 SHEET CARPETING
- 099100 PAINTING
- 099100A COATINGS AND PAINT SYSTEMS

SECTION 090000 – PREFERRED MATERIALS: WALL AND FLOOR FINISHES

1. Walls to be painted eggshell finish
 - A. Sherwin Williams ProMar200, Superpaint, Cashmere, or Duration
2. Install rubber/plastic corner guards 5 feet up from floor in all main corridors and high traffic areas.
3. Metal doors and frames to painted satin
 - A. Benjamin Moore Advance
4. Staining to be Sherwin Williams products (wood classics or Sherwood)
5. Cove Base – combination rubber and vinyl
 - A. Johnsonite cove base C.D. (Duracove)
6. Stair Treads
 - A. Nora – Norament Grand with visual impaired safety treads
 - B. All Nora stair treads are to be installed using Nora Epoxy Nosing Caulk.
7. Carpet – Carpet squares: See Project Manager
 - A. Shaw Contract Group

SECTION 092216 – NON-STRUCTURAL METAL FRAMING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for non-structural metal framing.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines shall govern the design and specifications.

1.2 Related Standards

- A. Wood blocking

1.3 Reference Standards

- A. Refer to UL managed assemblies
- B. Refer to current ASTM standards

1.4 General Requirements

- A. Non-load bearing partitions; metal studs shall be minimum 33000 kilopound per square inch:
 - 1. 20 gallons standard metal studs, 3-5/8 inches wide, 16 inches on center
 - 2. Hot dipped galvanized
 - 3. Gypsum drywall, 5/8 inch thick
 - 4. Taping and finishing to Level 4
 - 5. Insulation, 3-1/2 inches fiberglass batts
 - 6. Include stiffeners
- B. Load bearing partitions; metal studs shall be minimum 33000 kilopound per square inch:
 - 1. 16 gallons, 3-5/8 inches wide, 16 inches on center
 - 2. Gypsum drywall, 5/8 inch thick
 - 3. Taping and finishing to level 4
 - 4. Insulation, 3-1/2 inches fiberglass batts
 - 5. Include stiffeners

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 092216

SECTION 092900 – INTERIOR GYPSUM BOARD

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for unfinished and pre-finished gypsum board, gypsum and cementitious backing board, metal framing, trim, and accessories
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. Floor to floor full height assemblies: Refer to Section 072100: Thermal Insulation of this document.
- B. Fire Stopping: Refer to Section 078400: Fire Stopping of this document for locations where this type of assembly is to be constructed.

1.3 Reference Standards

- A. Refer to UL rated assemblies manual for expansion and construction required to be rated by code.
- B. Refer to U.S. Gypsum Standards for control joints.

1.4 Quality Control

- A. Drywall – $\frac{5}{8}$ inch thickness or greater; fire rated, type X where required; long edge tapered; moisture resistant in moisture prone locations
- B. Plumb: All assemblies shall have a tolerance of $\frac{1}{8}$ inch in 10 feet maximum.
- C. Trim: All outside corners shall be floated with metal corner bead screwed to stud.
- D. Interior corners and panel joints shall be taped and floated.
- E. Finish: See Section 099100: Painting

1.5 General Requirements

- A. Asbestos: In no instance will any product containing asbestos be acceptable.
- B. Provide cementitious board for walls and ceilings in moisture prone areas, such as restrooms, janitor closets, and wet labs.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 092900

SECTION 093000 – TILING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for tile surfaced units made of fired clay.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Tile Council of America assemblies: Adhere to these guidelines.
- B. Refer to Section 096500: Resilient Flooring of this document.

1.3 Quality Control

- A. Finish: Finish shall be glazed on walls, matte on floors. Grout must be sealed per manufacturer's written recommendations. A dark color grout shall be used on floors.
- B. All white-pearl (light colored) grout will be 100 percent solid epoxy resin compound.
(Example: Hydroment Color Epoxy or equal)
- C. Size: Consult with Baldwin Wallace University project representative. Align grout joints at wall and floor. For exceptions, consult with the Baldwin Wallace University project representative.
 - 1. All field tile will meet sanitary base at walls, not on top. See Baldwin Wallace University field representative for exceptions.
 - 2. All corners where tile on walls meet shall be caulked with approved caulk color to match grout before grouting.
- D. Accessories and trim units: Use appropriate units, where available, for special locations or applications.
- E. Patterns: Patterns shall be a "controlled" type and shall be approved by the Baldwin Wallace University project representative.
- F. Renovation guidelines: Renovation design shall maintain design of the existing areas. Construction must be sensitive to avoid damage to existing areas. Use or return to the project representative any salvageable materials.

1.4 General Requirements

- A. Over-stock: Provide 5 percent overage for all jobs, for all type, color, and size of tile shall be required. Verify storage with the Baldwin Wallace University project representative.
- B. Tile is preferred on all floors and on walls up to minimum of $\frac{3}{4}$ the wall height in all toilets, locker rooms, showers, toweling areas and kitchens Floor tile shall contain non-slip grit and be of appropriate hardness for the intended use.

- C. Tile (ceramic and/or quarry) may be used at building entrance lobbies in conjunction with entrance mats.
- D. Provide written cleaning and maintenance instructions with substantial completion close-out documentation.
- E. Contractor shall provide information on tile in substantial completion close-out documentation. Include manufacturer, type, grade, pattern and color.

PART 2: PRODUCTS

- A. Substrate: Use ¾ inch cement board in lieu of using water resistant gypsum board (greenboard) at wet locations with 6 inches screw pattern.
- B. In wet locations ceramic coved based tiling is preferred. For ceramic, quarry or other tile coved base, install coved base first, and install floor tile to meet coved base.
- C. At above-grade rest rooms, showers, other wet locations, floors shall receive fluid-applied waterproofing to floor substrate before tile is applied.

PART 3: EXECUTION – NOT USED

END OF SECTION 093000

SECTION 095123 – ACOUSTICAL TILE CEILING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for acoustical ceiling tiles and panels, perforated metal pan ceiling systems, and materials manufactured as finished acoustical ceiling surfaces.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Refer to Section 095123A of this document for suspension system.

1.3 Quality Control

A. Patterns:

- 1. Patterns shall be fissured and non-directional unless otherwise specified.

B. Color:

- 1. White-latex capable of being cleaned and repainted.

C. Ceiling grid shall be centered no less than 6 inches around edge; edge trim shall be “L” type – wall angle.

D. Fire resistant assemblies:

- 1. Acoustical ceilings are not desirable.

E. Asbestos:

- 1. In no instance will any product containing asbestos be acceptable for use.

1.4 General Requirements

- A. Over-stock: Provide 5 percent overage for attic stock.

PART 2: PRODUCTS

2.1 Ceiling Tiles

A. General

- 1. Tile: 24 inches by 24 inches by $\frac{5}{8}$ inch or $\frac{3}{4}$ inch and 24 inches by 48 inches by $\frac{5}{8}$ inch or $\frac{3}{4}$ inch laying acoustical ceiling tile fissured with standard heavy duty grid.
- 2. Hold down clips shall be used on as-needed basis. Verify with the Baldwin Wallace University project representative.

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3. Tiles below a mechanical or electrical device above ceiling shall have a color coded dot 14 inches diameter. (Example: Red for electrical, blue for water, green for mechanical.) Verify colors with Baldwin Wallace University Project Manager.

B. Preferred products

1. Cortega tile, $\frac{15}{16}$ inch grid, square lay-in, medium texture: Armstrong 824 (24 inches by 24 inches by $\frac{5}{8}$ inch) and Armstrong 823 (24 inches by 48 inches by $\frac{5}{8}$ inch)
2. Fine fissured, $\frac{15}{16}$ inch grid, square lay-in, medium texture: Armstrong 1810 (24 inches by 24 inches by $\frac{3}{4}$ inch) and Armstrong 1811 (24 inches by 48 inches by $\frac{3}{4}$ inch)

Tile with NRC 0.70 rating is to be used where fire rating is required, as in unsprinklered spaces.

3. Fine fissured, $\frac{15}{16}$ inch grid, square lay-in: Armstrong 1713 (24 inches by 24 inches by $\frac{3}{4}$ inch) and Armstrong 1714 (24 inches by 48 inches by $\frac{3}{4}$ inch) for general use
4. Athletics uses: Armstrong Optima 3251, square tegular, (24 inches by 24 inches by 1 inch) when using $\frac{9}{16}$ inch grid, Armstrong Optima 3250, square tegular, (24 inches by 24 inches by 1 inch) when using $\frac{15}{16}$ inch grid, and Armstrong 1912, beveled tegular, (24 inches by 24 inches by $\frac{3}{4}$ inch)

TELE/DATA Room Requirement:

The room should have a ceiling to cut down on dust.

PART 3: EXECUTION – NOT USED

END OF SECTION 095123

SECTION 095123A – CEILING SUSPENSION

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for exposed or concealed grid systems for suspension of gypsum board, acoustical tile, metal panels, and other ceiling finish materials.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications for Baldwin Wallace University projects.

1.2 Reference Standard

- A. Section 095123: Acoustical Tile Ceiling of this document

1.3 Quality Control

- A. Concealed grid systems: In no instance will this system be acceptable for mineral fiber ceiling systems.
- B. Gyp. Bd. Ceiling systems: Where there is a need for access above the ceiling, items to be accessed should be “grouped” as much as possible so that quantity of access doors is at a minimum. It is preferred at all campuses that use of this type ceiling system be minimal, and used only at areas where security or privacy are of concern or is required for fire separation required by code.
- C. Asbestos: In no instance will any product containing asbestos be acceptable for use.

1.4 General Requirements

- A. Plaster ceiling system: It is preferred to avoid use of this type system. It is recognized that decorative design, acoustical consideration, special ogee trims, etc. may be required to accomplish features desired by the Design professional. Contact Baldwin Wallace University Project Manager to establish scope of work.
- B. Metal ceiling panel systems that snap into support grid must include release tools provided by installer.
- C. Other ceiling materials not mentioned shall be submitted to the Project Manager for use approval.
- D. Ceiling grid shall be centered no less than 6 inches around edge. Edge trim shall be “L” type.
- E. Suspension wire shall meet commercial standards.

PART 2: PRODUCTS

2.1 Grid

- A. Preferred type: Traditional Grid – 1250/095323, Chicago Metallic Grid, Fire front Seismic 1250, ¹⁵/₁₆ inch exposed, with square edge.

PART 3: EXECUTION – NOT USED

END OF SECTION 095123A

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SECTION 096500 – RESILIENT FLOORING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for tile and roll flooring of resilient materials such as asphalt, cork, vinyl, rubber, etc.; includes stair nosing, treads, base, and trim of resilient materials.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

- A. Asbestos: Asbestos-containing materials shall not be used.
- B. In a large open area, 4 inches continuous-type coved base is preferred. Base material shall be combination of rubber and vinyl (See materials/methods list).
- C. Pattern: Consult Baldwin Wallace University and/or the Architect prior to determining use of a directional layout.
- D. Rubber and cork flooring: May be used in areas where there is a need to provide sound control. Consult Baldwin Wallace University and/or the Architect for approval.
- E. Colored or stained and sealed concrete flooring is preferred under fixed seating, versus resilient floor tiles.
- F. Cleaning: Adhere to the recommendations of the product manufacturer for cleaning and/or waxing. Initial waxing products will be provided by the Baldwin Wallace University. Wax shall be non-slip type.
- G. Contractor shall include written cleaning and maintenance instructions with substantial completion closeout documentation.
- H. Special floor non-porous treatments shall be used for specialty locations such as food service areas.
- I. Contractor shall include information on tile used as part of substantial completion close-out documentation. Include manufacturer, type, grade, pattern and color. If multiple types are used, provide locations.

1.3 General Requirements

- A. Over-stock: Provide 5 percent overage for all jobs, for all type, color, and size of tile shall be required. Verify storage with project representative.

PART 2: PRODUCTS

The following products are preferred by Baldwin Wallace University.

2.1 Solid Vinyl Composition Tile

A. General:

1. Solid Vinyl Floor Tile: Johnsonite Azrock VCT.
2. Class: ASTM F 1066, Class 2 – through pattern.
3. Type: Smooth Surface
4. Thickness: $\frac{1}{8}$ inch (3.2 millimeters) and $\frac{3}{32}$ inch (2.4 millimeters).
5. Size: 12 inches by 12 inches (305 mm by 305 millimeters). Larger tile may be considered if approved by Baldwin Wallace University and/or Architect
6. Fire-Test-Response Characteristics: NFPA 101 Life Safety Code

2.2 Nora Flooring Products

2.3 Resilient Molding Accessory

A. General:

1. Thermoplastic .080 inch or $\frac{1}{8}$ inch gauge, 4 inches or 6 inches height by continuous roll.
2. Description:
 - a. Duracove coved base; rubber-vinyl composition (preferred).
3. Material: Rubber
 - a. Profile and Dimensions: Thermoplastic .080 inch or $\frac{1}{8}$ inch gauge, 4 inches or 6 inches height by continuous roll. In a large open area, continuous-type base may be appropriate. Consult with the Project Manager for use of continuous-type base. Corners interior and exterior are to be pre-molded rubber. Base shall be coved.
4. Colors and Patterns:
 - a. Duracove, from manufacturer's approved colors.

2.4 Entrance Mats:

A. General:

1. All vestibules and main entries should have recessed entrance mats, such as #323 smart step with arrow trax as manufactured by Notrax Floor Matting or Nora, Norament Grand with safety strips for the visually impaired.

2.5 Stairs

A. Norament Stair Treads

TELE/DATA Closet Floor Requirements:

It is preferred to have a floor that is grounded (Static Free Floor). If static free floor tile is unavailable, a vinyl tile floor should be waxed with an anti-static coating.

PART 3: EXECUTION – NOT USED

END OF SECTION 096500

SECTION 096813 – TILE CARPETING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for carpet manufactured in the form of precut surfacing units.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. All carpet used must satisfy the latest Baldwin Wallace University Fire Marshall Specifications.

1.3 Quality Control

- A. Maintenance Instructions: Any maintenance required shall adhere to the carpet tile manufacturer's recommendations.
- B. Static Control: All carpet shall be rated less than 3.5 kilovolts for general use, less than 2 kilovolts for computer labs.
- C. Size: There is currently no Baldwin Wallace University standard for carpet tile size.
- D. Carpet Construction: $\frac{1}{12}$ -gauge, 10 stitch per inch, tufted, level loop, with appropriate backing to provide moisture barrier.
- E. Warranty: Fifteen (15) years for carpet material and one (1) year for carpet installation.

1.4 General Requirements

- A. Percentage Over-stock: Provide 5 percent overage, with a minimum of one (1) box of tile for attic stock for each color and style.
- B. Asbestos: In no instance will any product containing asbestos be acceptable for use.
- C. Filler and glues should done where off hours ventilation is possible. SDMS sheets must be kept on site. All adhesives and carpet materials must be low VOC.

PART 2: PRODUCTS

- A. See Craftsman Foreman.

PART 3: EXECUTION – NOT USED

END OF SECTION 096813

SECTION 096816 – SHEET CARPETING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for carpet manufactured in sheet form, backing, underlay, and fastening strips.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Refer to the updated Fire Marshall Specifications carpet memorandum.

1.3 Quality Control

- A. Maintenance and Cleaning Recommendations: Follow the carpet manufacturer's recommendations.
- B. Warranty: Fifteen (15) years for carpet material and one (1) year for carpet installation.
- C. Static Control: All carpet shall be rated less than 3.5 kilovolts for general use, less than 2 kilovolts for computer labs.
- D. Unless pre-approved by Baldwin Wallace University project representative, carpet shall not be installed in rooms which house copy machines, water fountains, sinks, and other areas with fluids.
- E. Carpet Construction: $\frac{1}{12}$ -gauge, 10 stitch per inch, tufted, level loop, with backing structured to provide moisture barrier.

1.4 General Requirements

- A. Installation: Carpeting shall not be installed by stretching over padding unless special conditions. Consult the Baldwin Wallace University project representative for exceptions or special conditions. Seams should be placed in less traffic area where possible.
- B. Percentage Over-stock: Provide a 5 percent overage for attic stock for each color and style.
- C. Filler and glues should be applied where off hours ventilation is possible. SDMS sheets must be kept on site. All adhesives and carpet materials must be low VOC.

PART 2: PRODUCTS

- A. See Craftsman Foreman.

PART 3: EXECUTION – NOT USED

END OF SECTION 096816

SECTION 099100 – PAINTING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for exterior and interior painting materials.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines shall govern the design and specifications.
- C. In particular, no stone surfaces shall be painted.

1.2 Reference Standards

- A. Mechanical Piping Schedule: Refer to Division 21, 22, and 23 of this document for painting requirements of mechanical piping.
- B. Lead: In no instance shall any product containing lead be acceptable for use.
- C. Refer also to Section 099100A: Coatings and Paint Systems for general guidance concerning the specific preferences for exterior and interior coatings and paint systems for CMU, concrete, gypsum board, plaster, steel and stucco.
- D. Latest editions of the following reference standards, where applicable.
- E. American Society for Testing and Materials (ASTM)
- F. Steel Structures Painting Council (SSPC)

1.3 Quality Control

- A. Interior wall finish: Standard drywall finish type shall be “satin”, trim shall be “semi-gloss”, and ceilings shall be “eggshell”.
- B. For renovations of occupied spaces, use oil base paint in lieu of epoxy paint at wet locations. Epoxy is preferred for new construction.

1.4 General Requirements

- A. Interior Paint Schedule:
 - 1. A level 4 finish is required: All appropriately prepared gypsum board surfaces shall have one coat of drywall primer applied to yield a properly painted surface and one separate coat of topcoat material applied to yield a properly painted surface over the drywall primer. Paint shall be applied to the mils film thickness and application conditions specified by the paint manufacturer. The recommended level of paint finish over gypsum board wall and ceiling surfaces varies depending on the location in the structure, the type of paint applied, the finish achieved on the gypsum board substrate prior to final decoration, and the type of illumination striking the surface.

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- 2. All services shall receive one (1) coat of primer, with two (2) coats of final coat paint.
- B. Top, edges, and bottoms of doors shall be finished to match finish applied to face of door.
- C. Contractor shall submit a painting schedule as part of pre-substantial completion close-out documentation. Include manufacturer, type, grade, color, pigment formula, and locations where each type is used.

PART 2: PRODUCTS – PROFESSIONAL LINE PRODUCTS

2.1 General

- A. Interior Wall Surface: Satin, acrylic, latex, enamel
- B. Interior Trim (Doors and Jams): Alkyd, semi-gloss; if odor is a problem, latex
- C. Interior Wood doors: Polyurethane, satin, natural finish
- D. Exterior: Alkyd, oil base, satin; if odor is a problem, latex
- E. Sherwin Williams: Pro Mar 200, latex enamel
- F. Sherwin Williams: Super Paint, alkyd, eggshell enamel

2.2 Paint Materials

- A. Standard Classroom Colors preferred by Baldwin Wallace University:

	Manufacturer	Color	Finish	Specification
1	Sherwin Williams	Pure White	Eggshell	SW 7005
2	Sherwin Williams	Dover White	Eggshell	SW 6385
3	Sherwin Williams	Champagne	Eggshell	SW 6644
4	Sherwin Williams	Bagel	Eggshell	SW 6114
5	Sherwin Williams	Vanillin	Eggshell	SW 6371
6	Sherwin Williams	Harvester	Eggshell	SW 6373
7	Sherwin Williams	Inviting Ivory	Eggshell	SW 6372
8	Sherwin Williams	Quicksilver	Eggshell	SW 6245
9	Sherwin Williams	Blissful Blue	Eggshell	SW 6527
10	Sherwin Williams	Krypton	Eggshell	SW 6247

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	Manufacturer	Color	Finish	Specification
11	Sherwin Williams	Indigo	Eggshell	SW 6531
12	Sherwin Williams	Icelandic	Eggshell	SW6526
13	Sherwin Williams	Searching Blue	Eggshell	SW6536
14	Sherwin Williams	Cosmos	Eggshell	SW6528
15	Sherwin Williams	Scanda	Eggshell	SW6529
16	Sherwin Williams	Revel Blue	Eggshell	SW6530
17	Sherwin Williams	Butter Up	Eggshell	SW6681
18	Sherwin Williams	Banana Cream	Eggshell	SW6673
19	Sherwin Williams	Lilly	Eggshell	SW6693
20	Sherwin Williams	Interactive Cream	Eggshell	SW6113

B. Standard Exterior Colors

1. Not specified, per Project Manager approval

C. Any additional paint selections need to be approved by the Baldwin Wallace University project representative.

D. Match color swatch by computer matching.

PART 3: EXECUTION – NOT USED

END OF SECTION 099100

SECTION 099100A – COATINGS AND PAINT SYSTEMS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for exterior and interior coatings and paint systems for the following substrates:
 - 1. Brick
 - 2. Concrete Masonry Unit (CMU)
 - 3. Concrete
 - 4. Gypsum Board
 - 5. Plaster
 - 6. Steel
 - 7. Stucco
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Related Standards

- A. Section 099100: Painting.

1.3 Reference Standards

- A. Mechanical piping schedule: Refer to Division 21, 22, and 23 of this document for painting requirements of mechanical piping.
- B. Lead: In no instance shall any product containing lead be acceptable for use.
- C. Refer also to Section 099100A: Coatings and Paint Systems for general guidance concerning the specific preferences for exterior and interior coatings and paint systems for CMU, concrete, gypsum board, plaster, steel, and stucco.
- D. Latest editions of the following reference standards, where applicable.
- E. American Society for Testing and Materials (ASTM)
- F. Steel Structures Painting Council (SSPC)

1.4 General Requirements

- A. After making initial preliminary selections of the generic classes of products for the intended substrates, verify with the proposed manufacturers the following:

1. Suitability of products selected
 2. Recommended thickness
 3. Recommended surface preparation
 4. Recommended application procedures
- B. Occupied spaces or areas adjacent to occupied spaces that could be effected by the work:
1. Coatings and paint systems selections shall be made so as not to disrupt normal operations, unless otherwise specifically authorized by the Baldwin Wallace University project representative.
 2. For exterior work, assess the building's air intake system and whether by closing particular louvers and/or altering set-up, the impact on the building's occupants can be lessened.
 3. Do not use mineral-spirit based sealants at occupied buildings.
 4. Proper ventilation based on product specs. MSDS sheets must be on site.
- C. For coatings and paint systems that will potentially be in contact with chemicals, consult with the manufacturers to assure compatibility with the anticipated exposure. In addition, consult with Environmental Health and Safety (EHS) thru the Project Manager to assure that proper exposure assumptions are being made.
- D. Consider aesthetic impact and implications of pertinent antiquities, regulations and/or laws that any application may produce. This is particularly true of buildings over fifty (50) years old, but must be considered whenever aesthetic changes are made.
- E. Lead: In no instance will any product containing lead be acceptable for use.
- F. Concrete block filler and enamel paint shall be applied at all areas of painted concrete blocks.

PART 2: PRODUCTS

2.1 Definitions

- A. The words "paint" and "coatings" can be used interchangeably, but their usage tends to imply the following:
1. Paint: easy to apply, readily available, consumer oriented, tending to have a more decorative than functional requirement.
 2. Coatings: high grade, industrial or institutional, professional, tending to have a more functional than decorative requirement.

PART 3: EXECUTION – NOT USED

END OF SECTION 099100A

SECTION 100000 – Section Index

- 100000 PREFERRED MATERIALS: BATHROOM AND SIGNAGE
- 101100 VISUAL DISPLAY BOARDS
- 101400 SIGNAGE AND PLAQUES
- 102100 CTeC AND GENERAL PURPOSE CLASSROOM
- 102113 TOILET COMPARTMENTS
- 102800 TOILET AND BATH ACCESSORIES
- 104413 FIRE EXTINGUISHERS AND CABINETS

SECTION 100000 – PREFERRED MATERIALS: BATHROOM AND SIGNAGE

1. Toilet Partitions:

- a. Use solid plastic
- b. Smooth finish: Recommend Metpar
- c. Comtec, general – 8 inches wrap around hinge
- d. Heat-sink metal strip on bottom of door
- e. Full height wall brackets

2. Signage:

- a. Use Innerface Architectural Signage, Inc. to match existing buildings.

SECTION 101100 – VISUAL DISPLAY BOARDS

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for visual display boards.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

A. Chalk Boards

- 1. Chalk boards should be 3 feet from the floor to the bottom of the marker board and 7 feet from the floor to the top of the chalk board.
- 2. Chalk boards shall be standard green or black with trim, 2- $\frac{1}{4}$ inches chalk rails, and track for map hooks. Sliding boards can be utilized to allow greater flexibility where applicable.
- 3. Materials and Construction: Chalk boards shall be porcelain-enamel steel and shall be manufactured in accordance with Porcelain Enamel Institute's specification. Porcelain-enamel finish shall be fusion bonded to a 24 gauge steel substrate at temperature necessary to reduce steel and porcelain stresses and achieve superior enamel bond and hardness.
 - a. Face Sheet: 24-gauge steel
 - b. Core Material: $\frac{1}{4}$ inch hardboard, $\frac{7}{16}$ inch medium-density fiberboard (MDF) or $\frac{3}{8}$ inch particle board
 - c. Panel Backing: aluminum foil or sheet moisture barrier
 - d. Laminations: hot type neoprene contact adhesive to both surfaces with minimum of 80 percent coverage. Laminations shall be made by face sheet manufacturer.
- 4. Tray: Standard continuous, solid box type aluminum tray with ribbed section and injection molded end closures.
- 5. Map rail: Standard continuous, 2 inches map rail with cork insert and end stops at the top of each board. Furnish four (4) adjustable map hooks every eight feet.

B. Marker Boards/White Boards

- 1. Designs: All product specifications, accessory items, colors, finishes, applications and details are to be reviewed and approved by the Baldwin Wallace University project representative prior to the final development of the Construction Documents. Writing surface shall be standard black.

2. Materials and Construction: Marker boards shall be porcelain-enamel steel and shall be manufactured in accordance with Porcelain Enamel Institute's specification. Porcelain-enamel finish shall be fusion bonded to a 24 gauge steel substrate at temperature necessary to reduce steel and porcelain stresses and achieve superior enamel bond and hardness.
 - a. Face Sheet: 24 gauge steel
 - b. Core Material: ¼ inch hardboard, 7/16 inch MDF or ¾ inch particle board
 - c. Panel Backing: aluminum foil or sheet moisture barrier
 - d. Laminations: hot type neoprene contact adhesive to both surfaces with minimum of 80 percent coverage. Laminations shall be made by face sheet manufacturer.
3. Tray: Standard continuous, solid box type aluminum tray with ribbed section and injection molded end closures.
4. Map rail: Standard continuous, 2 inches map rail with cork insert and end stops at the top of each board. Furnish four (4) adjustable map hooks every 8 feet.
5. Marker boards should be 3 feet from the floor to the bottom of the marker board and 7 feet from the floor to the top of the marker board.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

3.1 Installation

- A. Marker boards shall not be glued to the wall. Marker boards shall be mechanically attached in accordance with manufacturer's specification. Marker boards must be attached to a wall that is attached to the structure with proper blocking. Marker boards cannot be attached to floating walls.

END OF SECTION 101100

SECTION 101400 – SIGNAGE AND PLAQUES

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for signs.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standard

1.3 Quality Control

A. Signs

- 1. Baldwin Wallace University has a standardized system for all campus signage. All proposals require approval of the campus signage committee and the Baldwin Wallace University project representative and the Baldwin Wallace University Provost prior to finalization of the Construction Documents.

B. Plaques

- 1. Each new or renovated building may have Building Memorial plaques and/or Donor Recognition plaques or areas of Donor Recognition. Consult with the Baldwin Wallace University Project Representative and the Baldwin Wallace University Provost for details applicable to each project.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 101400

SECTION 102100 – CTcC AND GENERAL PURPOSE CLASSROOM

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for General Purpose and CTcC Classroom construction.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However, unless there is adequate written justification, it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standard

1.3 General Requirements

- A. Classroom sizing will be configured during the planning phase of design.
- B. Fixed auditorium seating to be minimum width of 24 inches. Exact specifications for seating shall be determined during programming. Refer to Division 12 for seating specifications.
- C. ADA stations are required. One station per classroom as per ADA desk standard. Larger auditoriums shall include ADA station in front of room and table in back row if accessible.
- D. Shades:
 - 1. Vertical blinds and black out shades shall be required. For classrooms with large numbers of windows, motorized shades shall be considered.
- E. Acoustical Panels
 - 1. Armstrong Soundsoak
- F. White boards
 - 1. No general purpose classrooms will use whiteboards. Wall Talker or approved equal preferred.
- G. Floor coverings
 - 1. Carpet to be used in aisles and in instructor area; VCT or sealed and/or stained concrete beneath seats.

PART 2: PRODUCTS

- A. Projection Screens
 - 1. Da-Lite Senior Electrol
 - 2. Controller – Chief Model #82434 low voltage/IR controller
 - 3. HDTV format

B. Projector Mount

1. Chief RPA-U, Universal Mount
2. CMS-445 Ceiling Panel
3. CMA-006W 6 inches extension (Actual length to be determined by ceiling height.)
4. Color : White

C. Projector Lift: (for larger classrooms with higher ceilings)

1. Display Devices DUB-I2.5 Series Projector Lift
2. RS-232 Serial Control Interface OPT-9
3. Field Modification, as required

D. Vinyl Composition Tile (VCT) Flooring

E. Cove Base

F. Acoustical Tile Ceilings

1. Armstrong Model #1713
2. Fine Fissured
3. Size – 24 inches by 24 inches
4. Color: White

G. Ceiling Grid

1. Armstrong Prelude
2. Color: White
3. ¹⁵/₁₆ inch Tee System

H. HVAC Diffusers (Alternate for high airflows)

1. Titus Model MB-30, Krueger Model ASDT 24 or equal
2. Color: White
3. Slotted: 1inch
4. Discharge air diffusers to be insulated

I. Ductwork Insulation

1. All supply ductwork shall be insulated externally only.
2. 2 inches thick rolls of fiberglass batt, 0.75 pound per cubic foot density and a thermal conductivity (k value) of 0.29 at 75 degrees Fahrenheit mean temperature

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 10 – SPECIALTIES

3. Blanket shall contain vapor barrier facing of an aluminum and craft paper lamination sandwiching a fiberglass scrim, (FSK), for reinforcing
4. Insulation shall not be compressed more than 25 percent

J. Painting

K. Sprinkler Heads

1. Reliable Model GI or equivalent approved by Baldwin Wallace University
2. Color: White

L. Black Chalk Boards

1. Approved Vendors:

- i. A-I Visual Systems
- ii. AARCO Products Inc.
- iii. ADP/Lemco Inc.
- iv. Bangor Cork Company Inc.
- v. Best-Rite Manufacturing
- vi. Claridge Products & Equipment Inc.
- vii. Ghent Manufacturing Inc.
- viii. Marsh Industries Inc.
- ix. Platinum Visual Systems-A division of ABC School Equipment Inc.
- x. PolyVision Corporation

2. Porcelain-Enamel Chalk Board Assembly

- i. Balanced
- ii. High pressure
- iii. 3-ply construction consisting of backing sheet, core material, and porcelain-enamel face sheet with matte finish

3. Accessories

- i. Aluminum frames and trim not less than 0.062 inch thick, extruded aluminum; manufacturers standard chalk tray, continuous extruded aluminum, box type with slanted front, grooved tray and cast aluminum end closures
- ii. Continuous map rail 1 to 2 inches wide, end stops at each end of map rail, extruded aluminum paper holder

4. Installation

- i. Board to be 4 feet high with length to be determined by project
- ii. Install with bottom 3 feet AFF
- iii. Center on wall leaving enough room for lectern polytrack

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 10 – SPECIALTIES

M. Ceiling Speakers

1. Will depend on room configuration and use. Direct all questions to the Baldwin Wallace University IT Department.

N. Lectern

1. Refer to Baldwin Wallace University drawings for standing and sitting lecterns
2. Lecterns are purchased by the Baldwin Wallace University IT Department from Spectrum Industry.

O. Pencil Sharpener

1. Sanford Giant Pencil Sharpener, Model #51131 (or approved equal)
2. Installed to right of blackboard

P. Chair Rail

1. Brand Name: Pawling
2. Height: 12 inches
3. Install: 36 inches AFF to bottom

Q. Wire Mold

1. Hubbell PS3BC Super Base Track
2. Color: Office White or approved Baldwin Wallace University color.
3. Includes all fittings and accessories

PART 3: EXECUTION – NOT USED

END OF SECTION 102100

SECTION 102113 – TOILET COMPARTMENTS

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

1.1 References

A. ASTM International (ASTM)

1. A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
2. B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
3. E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

B. National Fire Protection Association (NFPA)

1. 286 – Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.2 System Description

A. Compartment Configurations

1. Toilet Partitions, Privacy Screens and Entry Partitions: Floor mounted, overhead braced
2. Urinal Screens: Wall mounted

1.3 Submittals

A. Submittals for Review

1. Shop Drawings: Include dimensioned layout, elevations, trim, closures, and accessories
2. Product Data: Manufacturer's descriptive data for panels, hardware, and accessories

1.4 Quality Assurance

A. **Manufacturer Qualifications:** Minimum ten (10) years experience in manufacture of solid plastic toilet compartments with products in satisfactory use under similar services conditions

B. **Installer Qualifications:** Minimum ten (10) years experience in work of this section

1.5 Warranties

A. Provide manufacturer's twenty-five (25) year warranty against breakage, corrosion, and delamination under normal conditions.

PART 2: PRODUCTS

2.1 Manufacturers

- A. Contact Documents are based on products by Scranton Products Hiny Hiders.
- B. Substitutions: Products by Metpar Corporation, Westbury, NY.

2.2 Materials

- A. Doors, Panels, and Pilasters
 1. High Density Polyethylene (HDPE), fabricated from polymer resins compounded under high pressure, forming single thickness panel
 2. Waterproof and non-absorbent with self-lubricating surface, resistant to marks by pens, pencils, markers, and other writing instruments
 3. 1 inch thick with edges rounded to ¼ inch radius
 4. Color: To be selected from manufacturer's full color range
- B. Aluminum Extrusions: ASTM B221, 6463-T5 alloy and temper
- C. Stainless Steel: ASTM A167, Type 304.

2.3 Hardware

- A. Hinges
 1. 8 inches long, fabricated from heavy-duty extruded aluminum with bright dip anodized finish, wrap-around flanges, adjustable on 30-degree increments, through bolted to doors and pilasters with stainless steel, Torx head sex bolts.
 2. Hinges operate on field-adjustable nylon cams, field adjustable in 30 degree increments.
- B. Door Strike and Keeper
 1. 6 inches long, fabricate from heavy-duty extruded aluminum with bright dip anodized finish, with wrap-around flanges secured to pilasters with stainless steel tamper resistant Torx head sex bolts.
 2. Bumper: Extruded black vinyl
- C. Latch and Housing
 1. Heavy-duty extruded aluminum
 2. Latch housing: Bright dip anodized finish
 3. Slide bolt and button: Black anodized finish
 4. Slide latch and paddle

D. Coat Hook/Bumper

1. Combination type, chrome plated Zamak
2. Equip outswing handicapped doors with second door pull and door stop.

E. Door Pulls: Chrome plated Zamak

2.4 Components

- A. Doors and Dividing Panels:** 55 inches high, mounted 14 inches above finished floor with aluminum heat-sinc fastened to bottom edges
- B. Pilasters:** 82 inches high, fastened to pilaster sleeves with stainless steel tamper resistant Torx head sex bolt
- C. Pilaster Sleeves:** 3 inches high, one-pieces molded HDPE, 20-gauge stainless steel, secured to pilaster with stainless steel tamper resistant Torx head sex bolts
- D. Wall Brackets:** 54 inches long, heavy-duty aluminum, bright dip anodized finish fastened to pilasters and panels with stainless steel tamper resistant Torx head sex bolts
- E. Headrail:** Heavy-duty extruded aluminum, anti-grip design, clear anodized finish, fastened to headrail bracket with stainless steel tamper resistant Torx head sex bolt and at top of pilaster with stainless steel tamper resistant Torx head screws
- F. Headrail Brackets:** 20-gauge stainless, satin finish, secured to wall with stainless steel tamper resistant Torx head screws

PART 3: EXECUTION

3.1 Installation

- A.** Install compartments in accordance with manufacturer's instructions and approved Shop Drawings
- B.** Install rigid, straight, plumb, and level
- C.** Locate bottom edge of doors and panels 14 inches above finished floor
- D.** Provide uniform, maximum $\frac{3}{8}$ inch vertical clearance at doors
- E.** Not Acceptable: Evidence of cutting, drilling, or patching

3.2 Adjusting

- A.** Adjust doors and latches to operate correctly

END OF SECTION 102113

SECTION 102800 – TOILET AND BATH ACCESSORIES

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for toilet and bath accessories.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Quality Control

A. Toilet Accessories

- 1. All product specifications, accessory items, colors, finishes, applications and details are to be reviewed and approved by the Baldwin Wallace University project representative prior to the final development of the Construction Documents. Baldwin Wallace University has selected standard products for use. All proposals shall require approval of the Baldwin Wallace University project representative prior to finalization of the Construction Documents.
- 2. Toilet Accessories are considered Fixed Equipment and shall be included in the Construction Documents.
- 3. All restrooms require a shelf to be installed. (See Products.)

B. Commercial Toilet Accessories.

- 1. Baldwin Wallace University will provide the following toilet accessories:
 - a. Paper towel dispensers
 - b. Toilet tissue dispenser
 - c. Waste receptacles
 - d. Soap dispenser
- 2. Baldwin Wallace University will also prefer to incorporate family restrooms where baby changing stations will be required.
- 3. Baldwin Wallace University also encourages at least one baby changing station in all Baldwin Wallace University buildings.

PART 2: PRODUCTS

2.1 Manufacturer

- A. Basis of Design: Bobrick Washroom Equipment, Inc., www.bobrick.com.

- 1. Location of Manufacturer: United States

2.2 Shelves

A. Surface-Mounted Stainless Steel Shelves:

1. Basis of Design: Bobrick Model B-298X24
 - a. Width: 8 inches (203 millimeters)
 - b. Length: 24 inches (610 millimeters)
2. Shelf: 18-8, Type 304, 18 gauge (1.2 millimeters) stainless steel with satin finish; ¾ inch (19 millimeters) return edges, hemmed front edge
3. Mounted Brackets: Welded to back return of shelf, 18-8, Type 304, 16 gauge (1.6 millimeters) stainless steel with satin finish; secured inside front hem of shelf

PART 3: EXECUTION

3.1 Installation

- A. Install products in strict compliance with manufacturer's written instructions and recommendations, including the following:
 1. Verify blocking has been installed properly.
 2. Verify location does not interfere with door swings or use of fixtures.
 3. Comply with manufacturer's recommendations for backing and proper support.
 4. Use fasteners and anchors suitable for substrate and project conditions.
 5. Install units, rigid, straight, plumb, and level, in accordance with manufacturer's installation instructions and approved shop drawings.
 6. Conceal evidence of drilling, cutting, and fitting to room finish.
 7. Test for proper operation.

3.2 Cleaning and Protection

- A. Clean exposed surfaces of compartments, hardware, and fittings.
- B. Touch-up, repair or replace damaged products until Substantial Completion.

END OF SECTION 102800

SECTION 104413 – FIRE EXTINGUISHERS AND CABINETS

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences for fire extinguishers and cabinets.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standard

- A. Reference Publications: NFPA 10R, NFPA Fire Protection Handbook

1.3 General Requirement

- A. Fire extinguisher cabinets shall be incorporated into all projects as required by code and sized for the required extinguisher.
- B. Contract specifications shall identify the extinguisher type size and note that extinguishers shall be provided and installed by the Baldwin Wallace University.

1.4 Quality Control

A. Fire Extinguishers

1. All portable fire extinguishers and non-valve cabinets shall be furnished and installed by the General Contractor. All portable fire extinguishers and components shall conform to National Fire Protection Association (NFPA) Pamphlet 10, latest edition. Each extinguisher shall be approved by Underwriter's Laboratory (UL) and bear their label.

B. Fire Extinguisher Cabinets

1. Cabinets for fire extinguishers shall be recess mounted. Cabinet exterior finish shall be brushed stainless steel or baked enamel finish.
2. The selection and locations of fire extinguishers are subject to the review and approval of the Baldwin Wallace University Project Representative and designated Baldwin Wallace University Fire Control and Ohio Fire Marshall.
3. Penetration of walls by cabinets or other penetrations, unless openings and voids are sealed with fireproof materials, is prohibited. Fire-rated walls must not have the rating reduced by penetrations or reduction of thickness.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 104413

SECTION 110000 – Section Index

117000 FUME HOODS

SECTION 117000 – FUME HOODS

PART 1: GENERAL

BALDWIN WALLACE UNIVERSITY USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS SECTION.

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.
- 1.2 The Baldwin Wallace University Project Manager shall be notified when fume hood acceptance testing is to start. The Project Manager shall contact the Environmental Health & Safety (EH&S) representative in charge of hoods for witness purposes. Copies of the testing reports shall be sent to EH&S.
- 1.3 Recommended minimum duct velocities:
 - A. Vapors, gases, smoke: 1000 – 2000 feet per minute
 - B. Welding fumes: 2000 – 2500 feet per minute
 - C. Light dust: 2500 – 3000 feet per minute
 - D. Dry medium dust: 3000 – 4000 feet per minute

PART 2: PRODUCTS

- 2.1 Allowable brands: Fisher Hamilton, TSI
- 2.2 Flammable storage cabinets shall be the ventilated style.
- 2.3 For general laboratory usage, a bypass hood shall be used.
- 2.4 If a Building Automation System is not available, then a continuous monitoring local alarm shall be mounted on all fume hoods. The hood alarm shall not use a sensor in the direct airstream such as a thermal anemometer or pilot tube. The method of detection for the alarm monitor shall be approved by Baldwin Wallace University Project Manager. The AFA 1000 model from Temperature Electronics Ltd. is preferred.
- 2.5 Auxiliary air hoods are not allowed.
- 2.6 Stack discharges with adjusting nozzles are not allowed.
- 2.7 Perchloric acid fume hoods:
 - A. Ductwork shall be 316 stainless steel with smooth-welded seams. All ductwork shall slope back to the hood at a rate not less than 8 percent. The ductwork shall use the steepest, straightest, and shortest route to exit the building.
 - B. The interior surfaces of the entire hood, duct, fan, and stack surface must be equipped with water wash capabilities.
 - C. An induction exhaust fan is preferred for this type system. This is a type of fan where the exhaust gases do not contact the motor or fan blades.

- D. All surfaces of the hood shall be materials that will not react with the acid to form flammable or explosive compounds.
- E. The exhaust system shall not be manifold or joined to other non-perchloric acid exhaust systems.
- F. Organic materials, including gaskets, shall not be used unless it is known they will not react with perchloric acid.
- G. The hood shall be labeled “Perchloric Acid Hood”.

PART 3: EXECUTION

- 3.1 No uncoated galvanized ductwork shall be used. All ductwork joints shall be sealed.
- 3.2 Flammable storage cabinets shall be directly connected to main laboratory exhaust ductwork.
- 3.3 Room supply air shall be introduced into the laboratory as far as possible from the fume hood.
- 3.4 Face velocity shall be between 80 – 120 feet per minute but 100 feet per minute is preferred.
- 3.5 Laboratories shall get 6 – 12 air changes per hour. Afterhours the airflow can be reduced to 4–6 air changes per hour.
- 3.6 Laboratory exhaust shall terminate 10 feet above the roof on the highest point of the building.
- 3.7 Exhaust fans shall not be installed in series.
- 3.8 Laboratory air shall not be recirculated.
- 3.9 Manifold exhaust systems are preferred. These systems shall have redundant fans with VFD’s.
- 3.10 Laboratory exhaust systems, fume hoods, control valves, and supply air handlers shall be tied to emergency power generators.
- 3.11 Sound levels, in the laboratory, due to individual fume hoods and room ventilation shall be 40 decibels A or less.
- 3.12 Fume hoods shall be installed on the opposite side of the room from the entrance. They shall also be installed away from working and main walking area.
- 3.13 Laboratories shall have negative air pressure when compared to adjacent spaces.
- 3.14 Control valve on fume hood exhaust shall fail open.
- 3.15 Any ductwork passing through potentially cold air spaces shall be insulated to prevent condensation.
- 3.16 All ductwork shall slope back to hood.
- 3.17 If high acid usage is expected then a specially coated duct is mandatory. Plain stainless steel is not acceptable.
- 3.18 Recommend corrosive and flammables cabinets be installed in base cabinet below hood.

END OF SECTION 117000

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 12 – FURNISHINGS

SECTION 120000 – Section Index

120000 PREFERRED MATERIALS: COUNTERTOPS

120000 FURNISHINGS

SECTION 120000 – PREFERRED MATERIALS: COUNTERTOPS

1. Solid Surface Countertop Manufacturers:
 - a. Wilsonart
 - b. LG Hi-Macs
 - c. 909 Surfaces

2. Laminate Manufacturers: (Laminated cabinets to use General Purpose or Post Form Grade Laminate, not Verticle 32.)
 - a. Wilsonart
 - b. Nevamar
 - c. Pionite

3. All solid surface countertops must have all edges backed up with a second piece of solid surface edging.

SECTION 120000 – FURNISHINGS

PART 1: GENERAL

BALDWIN WALLACE USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS DIVISION OR SECTION.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 120000

SECTION 130000 – Section Index

130000 SPECIAL CONSTRUCTION

SECTION 130000 – SPECIAL CONSTRUCTION

PART 1: GENERAL

BALDWIN WALLACE USER GROUPS ARE TO BE ENGAGED IN THE SELECTION OF EQUIPMENT DEFINED UNDER THIS DIVISION OR SECTION.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 130000

SECTION 140000 – Section Index

142000 CONVEYING SYSTEMS AND ELEVATORS

SECTION 142000 – CONVEYING SYSTEMS AND ELEVATORS

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.
- 1.2 Use of a holeless hydraulic elevator is preferred in situations with a maximum rise of 40 feet. In cases where heavy use is anticipated, a traction elevator should be considered.
- 1.3 In all cases, where hydraulic elevators are installed, car speed shall not exceed 150 feet per minute.
- 1.4 The car capacity for any passenger elevator installed on campus will be a minimum of 2,500 pounds, with a maximum of 5,000 pounds
- 1.5 The manufacturer of the elevator shall have been in business fabricating elevator equipment for a minimum of five (5) years. The installation Contractor is required to provide the Baldwin Wallace University Project Manager with a listing of at least five (5) comparable installations completed within the last twelve (12) months.
- 1.6 For overhead machine rooms, install trap door and lifting beam to move motors.
- 1.7 Guarantee and Warranties
 - A. Warrant the equipment installed under these guidelines against defects in material and workmanship, and corrects any defects not due to ordinary wear and tear or improper use of car, which may develop within one (1) year from the date the elevator is completed and placed in permanent operation and accepted by the Owner.
 - B. The warranty shall be written and issued at the completion of each unit prior to final payment.
 - C. During the one (1) year warranty period, the elevator installer shall provide emergency service on a 24 hour basis at no cost to the University. A first response of a qualified University technician shall not void the warranty.
 - D. All service and maintenance shall be by the installing Contractor for the first year warranty period.
 - E. The installer shall replace all hydraulic cylinder seals six (6) months after the elevator is placed in service.
- 1.8 Permits, Testing, and Inspections
 - A. File necessary drawings for approval of all authorities having jurisdiction, obtain and pay all required fees for permits and inspections, etc., which may be required for the execution of this work. Copies of all permits shall be forwarded to the Baldwin Wallace University Project Manager.
 - B. Obtain, arrange, and/or pay for any necessary tests and inspections.
 - C. Furnish all test instruments and materials required at the time of final inspection. The inspection outlines in the ASME A17.2 Inspector's Manual (latest edition) will be followed.
 - D. After-hours testing of systems, such as emergency generators or fire service, shall be conducted at no extra cost to the Owner.

BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 14 – CONVEYING SYSTEMS AND ELEVATORS

- E. Obtain Ohio Division of Labor usage permit required to reach substantial completion.
- F. At substantial completion, the Contractor shall provide a minimum of two (2) hours training to Baldwin Wallace University personnel.

1.9 Maintenance and Instruction Materials

- A. Baldwin Wallace University shall be provided with three complete sets of all electrical schematics, including printed circuit boards, mechanical drawings, service manuals, and diagnostic/service tools that are available to elevator manufacturer's installers and service personnel. These shall include all control wiring, shall show all solid-state circuits, and shall identify all electric and electronic components as originally installed including all field adjuster notes. The name of the manufacturer and the manufacturer's catalog number shall be provided for all components not manufactured by the elevator installer.
- B. A complete parts list, recommended lubricants and a recommended spare parts list shall also be provided.
- C. The Baldwin Wallace University Facilities Project Manager must receive all required drawings, manuals and parts lists before final payment is made to the Contractor. The fact that a drawing, manual or maintenance tool may contain proprietary information is not considered by the University to be sufficient reason for refusing to furnish any drawing or manual.
- D. Furnish one (1) complete set of all diagnostic tools, equipment, and documentation required for the complete maintenance of all aspects of the control and dispatch system. Any diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the serviceman and the controls. The documentation shall include a description of component function, a hard copy of all as-built schematics, a hard copy set of source codes utilized in developing any control software, and an electronic copy of all source codes utilized. Any and all such systems shall be free from secret codes and decaying circuits that must be periodically reprogrammed by the manufacturer.

1.10 All national and local codes shall apply especially Federal ADA Standards, ASME A17, National Electric Code, IBC, ANSI A117.1 and 117.2, and the State Fire Code.

PART 2: PRODUCTS

2.1 Machine Room

- A. The elevator machine room shall be independently heated/air conditioned. The HVAC unit must be tied to emergency power. Ambient room temperature shall be maintained between 60 and 90 degrees Fahrenheit. The room shall be accessed by means of an outwardly swung fire-rated door measuring at least 3 feet by 7 feet. The door must be outfitted with a spring closer and lockable handset.
- B. Hydraulic elevators over two (2) stops shall have oil coolers.
- C. Non-elevator related equipment or piping may not be run through this room.
- D. The elevator mainline electrical disconnect and the machine room light switch must be located adjacent to the machine room door and arranged so they may be accessed without entering the room. Electrical main disconnect and 110v disconnect must both be fused.
- E. Clearance shall be provided for all control panels and equipment cabinet doors to open at least 90 degrees, and at least 3 feet free of obstructions shall be provided on all sides of machinery.
- F. The machine room must be equipped with a minimum of one (1) wall-mounted fire extinguisher.

2.2 Controls

- A. Single elevator installations shall be provided with simplex selective collective operation from a riser of hall pushbutton stations. The registration of one or more car calls shall dispatch the car to the designated floor in the order in which the floors are reached by the car, irrespective of the sequence in which the calls were registered. The car shall also respond to registered hall calls in the same direction of travel. Car and hall calls shall be cancelled when answered.

When traveling in the up direction, the car shall stop at floors for which car calls or up hall calls have been registered. It shall not stop at floors where a down hall floor is in response to a registered car call, or unless the down hall call is at the highest floor for which any call has been registered. Likewise, a down-traveling car shall not stop at a floor where only an up hall call has been registered unless the stop for that floor is in response to a registered car call, or unless the up call is at the lowest floor for which any call has been registered.

- B. Where two (2) elevators are installed side-by-side and intended to operate as a group; these installations shall be provided with duplex collective operation from a riser of hall push-button stations. Elevators shall automatically travel to landings for which a call demand exists. Stops in response to calls that are registered at either the car or corridor push-button stations shall occur in the natural order of progression in which the floors are encountered, depending on the direction of car travel, and irrespective of the order in which calls are registered. Means shall also be provided to periodically review and modify strategies for corridor call assignment in order to improve traffic flow. Only one (1) elevator shall respond to a particular corridor call.
- C. A non-proprietary microprocessor-based controller shall be provided, including necessary starting switches together with all relays, switches, and solid-state components required for operation. Microprocessor shall be an “off the shelf” industrial type programmable controller utilizing ladder logic such as Allen Bradley, Square D, Omron, etc. Microprocessor shall have opto-isolated inputs and outputs. Shall be isolated with Dry Relay contacts. Controller shall have all diagnostic and trouble-shooting readouts located directly on the unit. Controller shall have the ability to be replaced by a unit of different model or manufacturer without the necessity of replacing any other related items (door operators, selectors, buttons etc.). Installer shall supply a hard copy printout of all ladder logic programming as well as one additional set of programmed chipsets. Motion Control Engineering is Baldwin Wallace University preferred controller.

D. Motor Control:

1. Variable frequency AC type motor controllers shall:
 - a. Limit total harmonic distortion of regenerated power to 5 percent Per IEEE 519.
 - b. Provide means for absorbing regenerated power when elevator system is operating on standby power.
2. Soft start motor control shall be of the Wye delta, closed transition type.

- E. The University insists that each elevator shall be controlled by the fire alarm system as required by the Ohio Division of Labor or the Fire Marshal.

2.3 Elevator Car

- A. MCE “Smart Trak” Gearless Door Operator or equal is preferred as the Baldwin Wallace University standard.

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DIVISION 14 – CONVEYING SYSTEMS AND ELEVATORS

- B. All push buttons are to be vandal resistant stainless steel with 100,000 hours life LED type indicators.
- C. Adams ICU 47 infrared car door protective device or equal is the preferred University standard.
- D. Clear inside car dimensions shall be determined by door configuration provided.
 - 1. Where side-opening doors are installed, the minimum dimensions are 5 feet–8 inches wide by 4 feet-6 inches deep.
 - 2. Where center-opening doors are installed, the minimum dimensions are 6 feet–8 inches wide by 4 feet-6 inches deep.
- E. Minimum door openings shall be 3 feet wide by 7 feet high.
- F. Provide stainless steel protective pad hooks in all cars; in freight and combination passenger/freight cars, provide one (1) set of quilted fire-retardant pads.
- G. Provide stainless steel handrails on back and sides of cab, which are thru-bolted to the elevator cab shell.
- H. The car roof hatch shall be removable by thumb screws from the top of the car only.
 - I. Provide a ceiling-mounted, two-speed exhaust fan with automatic shut-off during equipment nonuse. The fan shall be controlled from the car control panel via a three (3) position key switch.
- J. Provide a car-top-operating device including service light and switch, and a mobile control for inspection and servicing, as well as one (1) 120-volt, 20-amp A/C duplex receptacle.
- K. The car lighting shall be connected to a normal and emergency lighting circuit.

2.4 Signal Fixtures

- A. All hall and car control stations shall comply with the latest regulations of federal ADA law, Ohio Department of Labor and Industry, and ASME A17.1 provisions for the handicapped.
- B. All car operating panels shall contain, at a minimum, the following:
 - 1. A call button for each floor served
 - 2. “Door Open” and “Door Close” buttons
 - 3. “Alarm” button, connected to a normal and separate emergency circuit
 - 4. “Emergency Stop” key switch
 - 5. Car position indicator
 - 6. Hands-free in-car communications system (This telephone shall operate on a dedicated telephone line.)
 - 7. Three (3) position firefighter key-operated switch, call cancel button, and illuminated/visual/audible signal system
 - 8. Phase II firefighter’s service operating procedures engraved directly to the care-operating panel face

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DIVISION 14 – CONVEYING SYSTEMS AND ELEVATORS

9. A locked service cabinet containing the key switches required to operate and maintain the elevator, including, but not limited to:
 - a. Light switch
 - b. Independent service key switch
 - c. Fan switch
 - d. Duplex OFT receptacle
 10. The operating panel shall be a surface-mounted type with heavy-duty hinges and secured with tamperproof screws.
 11. Control panel faceplates shall have factory-provided knock-outs to receive a Baldwin Wallace University approved system cylinder and core, where required. All key switches shall match the building lock
 12. Wiring and other such provisions shall be installed to facilitate future installation of video cameras.
 13. Wiring and other such provisions shall be installed to facilitate future installation of a Public Address system.
- C. Hall call stations shall provide a single button at each terminal floor and two (2) button units at all intermediate floors. Faceplates should be engraved: “In case of fire, do not use elevator”. Mounted with tamper-proof screws. Install a firefighter key switch at the main egress floor station. Engrave Phase I firefighter’s service operating procedures directly to call station faceplates.
- D. Cab lanterns shall provide a visual and audible signal mounted in the face of the return post on each side of the car with concealed fastenings. The lens shall project a minimum of ¼ inch and shall be of solid plexiglass. Car lanterns shall indicate the direction of the car when doors are ¾ inch open. The unit shall sound once for the “up” direction and twice for the “down” direction.

2.5 Pit and Shaft

- A. Guide rails shall be the “T” type and able to support the weight of the car.
- B. Car guides shall be of the roller type.
- C. The pit ladders, pit light switch and emergency stop button shall be so arranged so that all can be reached before entering the shaft. There shall be one ladder for each elevator.
- D. Provide a sump pit, within the elevator pit, covered with a steel grate flush with the floor.
- E. Paint the pit floor and sump with a “battleship gray” waterproof paint, made for the purpose.
- F. GFI convenience outlet shall be installed in the pit.
- G. Apply EPA provisions for hydraulic elevators to handle any oil and water. Such things may include an oil/water separator or a switch that shuts of the sump pump if oil is detected.

PART 3: EXECUTION

1. Elevators, when installed, must service all floors.
2. Elevator access to mechanical rooms shall be key-controlled only.
3. Standby power is required to operate elevators and shall follow Section 30 of the IBC.
4. Standby power of 110V is needed to feed alarm bell.

END OF SECTION 142000

SECTION 210000 – Section Index

211000 WATER BASED FIRE SUPPRESSION SYSTEMS

SECTION 211000 – WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Project Manager.
- 1.2 Adhere to current OH State Fire Code and NFPA.
- 1.3 Plan reviews by the state fire marshal shall be scheduled through Baldwin Wallace University Facilities Department.
- 1.4 Testing of sprinkler systems shall be conducted in the presence of Fire Control Personnel, (i.e. 2 inches main, inspector's tests, fire pump run, etc.)
- 1.5 Training shall be conducted for Fire Control Personnel on all Fire and Life Safety Systems.

1.6 OWNER INSTRUCTION

After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be sixteen (16) man hours. The instruction period shall be broken into segments at the discretion of the Owner.

1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
2. Forward to the Architect the signatures of all those present for the instruction periods.
3. Video tape all training and convert to DVD for Owner use.

1.7 SPECIAL TOOLS

Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.8 PRE-BID SITE VISIT

Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions. Schedule a site visit at least forty-eight (48) hours in advance of desired time of visit.

1.9 PRODUCTS AND SUBSTITUTIONS

Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where several manufacturers' products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, the Contractor shall pay additional costs related to submissions review, redesign, and system and/or structure modifications required by the use of that product.

It is the intent of these specifications that service organizations such as balancing agencies follow the above substitution procedures.

1.10 MAINTENANCE MANUAL

At the completion of the project, the Contractor shall provide to the Owner two (2) copies of an Operations and Maintenance Manual. The manuals shall be prepared in 3-ring binders with tabs depicting the following information:

1. Tab 1: Project information such as Owner, project address, applicable codes governing the project, Contractor name, address and phone numbers
2. Tab 2: Design information including water flow test report, and hydraulic parameters for each system
3. Tab 3: Certificates including welder certificates, material and test certificates
4. Tab 4: Products cut sheets for products used in the project including installation instructions, maintenance and lubrication instructions, and wiring diagrams
5. Tab 5: An original copy (not duplicated) of the current edition of NFPA 25 "Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems"

1.11 PLACARDS

Provide a framed placard encased in Plexiglass at each sprinkler supply connection to each standpipe, listing the design criteria for that standpipe and sprinkler zone. Also, provide a Plexiglass enclosed 8-½ inches by 11 inches plan at each sprinkler connection to each standpipe showing the area served from that standpipe connection.

1.12 GUARANTEES AND CERTIFICATES

Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.

Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing,

1.13 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.

Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of the Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.

Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.14 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 01.

The following shall be submitted by the Contractor for review:

1. Scale shop drawings showing system components with sizing indicated, including but not limited to:
 - a. Equipment
 - b. Piping
 - c. Hangers, anchors and guides
 - d. Expansion joints and loops
 - e. Access doors and panels

PART 2: PRODUCTS

2.1 All steel sprinkler piping 4 inches and smaller shall be coated on the interior surface with an antibacterial coating such as the “ABF” coating.

A. Manufacturer and Model (Only for special locations or projects, verify with Baldwin Wallace University staff)

1. Allied Tube and Conduit Company
2. Wheatland Tube Company – MIC-SHIELD

2.2 Seamless copper tube Type K or L shall only be used on limited area sprinklers only.

2.3 Schedule 10 pipe can only be used on stand pipe risers only.

2.4 The use of plain end pipe type fittings is prohibited.

2.5 U-bolt fittings similar to and including Victaulic 921 outlet tees are not permitted.

2.6 Provide three (3) acceptable manufactures for all systems unless otherwise specified.

2.7 Through wall penetrations of exterior non-fire-resistance walls shall be Link Seal only.

2.8 The Tyco manufacture will not be acceptable for any systems.

2.9 Special system equipment, confirm with Baldwin Wallace University staff for preferred specific manufactures.

PART 3: EXECUTION

3.1 Provide temporary fire protection required by NFPA and the City of Berea. Provide shop drawings for temporary fire protection prior to the shop drawing submittal for the remaining fire protection system.

1. Provide computer generated design drawings and hydraulic calculations as required by NFPA.
2. Design drawings and hydraulic calculations shall be reviewed and approved by the Owner's Insurance Underwriter, the City of Berea, and/or the authority having jurisdiction.

Install entire sprinkler system in strict accordance with NFPA 13: Standard for the Installation of Sprinkler Systems.

Submit copies of hydraulic and fluid delivery time calculations to the Owner's insurance carrier and the Engineer for review, prior to the start of system installation. Installation may only proceed with approved copies of calculations and drawings on site.

Provide forty-eight (48) hours' notice to the Owner's representative and Architect/Engineer prior to hydrostatic testing of fire protection and alarm systems.

Test the system for two hours at 50 pounds per inch (345 kilopascals) over the system working pressure or 200 pounds per inch (1,380 kilopascals,) whichever is greater. Record test data and submit for review and approval. Contractor shall make repairs and re- test as needed until system passes.

The minimum slope towards the main drain of the system branch lines shall be $\frac{1}{8}$ inches/feet (4 millimeter/m). The minimum slope toward the main drain of the system mains shall be $\frac{1}{16}$ inches/feet (2 millimeters/meter).

The maximum number of dry pendent or dry sidewall sprinklers shall be limited to twenty-five (25) sprinklers per system.

Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

With the exception of low point and auxiliary drains, all new system drains shall be hard piped to an approved exterior location, or to a safe location inside the building that shall accept full flow without causing property damage or a safety hazard.

Inspectors test valve assemblies shall be provided at the hydraulically most remote point in each system. These drains shall be piped as described above.

All sprinkler piping in the stairwells, storage rooms, mechanical rooms and utility rooms shall be painted red enamel. All other exposed sprinkler piping (outside of the stairwells) shall be painted to match the adjacent ceiling and/or walls. In addition, 4 inches wide red enamel bands shall be painted at (ten) 10-foot intervals along the length of all piping.

Contractor shall notify the Owner's Insurance Company and fire department and schedule a final inspection by their personnel. Alarm valves and signaling devices shall be tested.

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DIVISION 21 – FIRE SUPPRESSION

The Contractor shall complete the “Contractor’s Material and Test Certificate” found in NFPA 25 and submit as part of the system final acceptance.

Only certified welders are permitted to perform welding services for the sprinkler systems. Submit a copy of the welder’s certificate for review and maintain a copy at the job site.

Flushing connections consisting of 2 inches (50 millimeters) threaded nipple and cap shall be provided at the ends of all bulk and cross mains. Plugged tees shall be installed at the end of all branch lines.

Provide a pressure relief valve, with discharge piped to a building drain, at the Inspector’s test connection for all gridded systems to prevent over pressurization.

Auxiliary Drains

1. Provide an auxiliary drain for each location where piping pitch prevents complete drainage through the main drain valve. If the capacity of the trapped section exceeds five (5) gallons (19 liters), a valve must be provided and the outlet piped to a drain or convenient location acceptable to the Baldwin Wallace University staff.

Underground Pipe Flushing and Testing

1. Underground pipe shall be thoroughly flushed before connecting to the sprinkler system. Perform hydrostatic pressure test in accordance with NFPA 24-1992.

Contractor’s Inspection of System

1. The Contractor shall thoroughly inspect the completed system to assure compliance with this document, project plans, NFPA 25, and all applicable Codes and Standards.

IMPORTANT: This must include a test of each water flow alarm switch and all system supervisory devices, in coordination with the fire alarm system Contractor.

Project Closeout Documents

1. Provide Operations and Maintenance Manuals for all fire suppression equipment as required in Part 1 of Section 211000.

END OF SECTION 211000

SECTION 220000 – Section Index

220500	COMMON WORK RESULTS FOR PLUMBING
220523	GENERAL DUTY VALVES FOR PLUMBING PIPING
220593	TESTING, ADJUSTING, AND BALANCING
220700	PLUMBING INSULATION
221113	WATER DISTRIBUTION
221116	DOMESTIC WATER PIPING
221119	DOMESTIC WATER PIPING SPECIALTIES
221316	SANITARY WASTE AND VENT PIPING
221319	SANITARY WASTE AND VENT PIPING SPECIALTIES
221413	STORM DRAINAGE PIPING
221423	STORM DRAINAGE PIPING SPECIALTIES
224000	PLUMBING FIXTURES
224500	LABORATORY PLUMBING FIXTURES AND TRIM
226313	LABORATORY GAS PIPING
226319	LABORATORY GAS PIPING SPECIALTIES
226653	LABORATORY WASTE AND VENT PIPING
226683	LABORATORY WASTE AND VENT PIPING SPECIALTIES
226713	LABORATORY GRADE WATER PIPING
226718	LABORATORY WATER PIPING SPECIALTIES
226719	LABORATORY GRADE WATER PIPING SPECIALTIES
227013	NATURAL GAS PIPING

SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.
- 1.2 All utility interruptions and tie-ins shall be coordinated with Baldwin Wallace University Facilities Management. Please provide five (5) working days notification.

1.3 OWNER INSTRUCTION

After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be sixteen (16) man hours. The instruction period shall be broken into segments at the discretion of the Owner.

- A. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
- B. Forward to the Architect the signatures of all those present for the instruction periods.
- C. Video tape all training and convert to DVD for Owner use

1.4 SPECIAL TOOLS

Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.5 PRE-BID SITE VISIT

Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions. Schedule a site visit at least forty-eight (48) hours in advance of desired time of visit.

1.6 PRODUCTS AND SUBSTITUTIONS

Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where several manufacturers' products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, the Contractor shall pay additional costs related to submissions review, redesign, and system and/or structure modifications required by the use of that product.

It is the intent of these specifications that service organizations such as balancing agencies follow the above substitution procedures.

1.7 GUARANTEES AND CERTIFICATES

Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.

Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing.

1.8 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.

Submit to the Owner in writing for approval: proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.

Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.9 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 01. The following shall be submitted by the Contractor for review:

A. Scale shop drawings showing system components with sizing indicated, including but not limited to:

1. Equipment
2. Fixtures and trim
3. Piping
4. Hangers, anchors and guides
5. Expansion joints and loops
6. Access doors and panels

1.10 DEMOLITION

Review construction documents, to determine areas affected by demolition. Remove systems in the affected areas not to be reused including equipment, piping, hangers, supports, etc.

Schedule demolition work with Owner.

Demolition work involving electrical systems shall be coordinated prior to commencement of demolition work. All existing piping shall be saw-cut, not broken, at point where piping connects to existing.

Where demolition of existing systems, equipment, and associated appurtenances occurs, all such service shall be properly terminated in an approved manner to allow affected systems to remain in operation.

When demolishing existing equipment, all control wiring or pneumatic tubing serving that equipment shall be properly terminated in an approved manner to allow affected systems to remain in operation.

The Owner has the right-of-first-refusal for any items to be demolished, salvaged or removed. The Contractor and Owner shall jointly review the space where demolition is to occur and identify items the Owner elects to retain prior to demolition and removal. Remove items to be retained by the Owner and deliver them to the location directed by the Owner within a five (5) mile radius of the project. Promptly remove and properly dispose of materials, equipment, piping, debris, etc., which is not specified for reuse, storage, or retainage by Owner.

Provide support as required for any existing piping and equipment support affected by demolition.

Provide cutting and patching to match existing finish of roof, wall, floor, etc., associated with demolition of existing systems. Fire and smoke ratings compromised due to demolition shall be immediately restored. Repair or apply fire proofing to structural components that are exposed due to demolition.

Where existing systems serve areas adjacent to but not affected by demolition, reconnect existing systems serving unaffected areas to existing or new systems serving affected areas.

1.11 PAINTING

Painting requirements of this section shall conform to Division 01 – Painting.

Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.

Provide field painting of systems, equipment and miscellaneous metals located outdoors. Application shall be in strict accordance with manufacturer's recommendations.

Provide painting of plumbing piping and equipment exposed in mechanical equipment room and in occupied spaces.

A. Plumbing items to be painted are as follows:

1. Piping, pipe hangers, pipe insulation, and supports
2. Equipment and supports
3. Tanks
4. Accessory items

PART 2: PRODUCTS

- 2.1 Upon project completion, all as-built drawings will be delivered to the Owner in latest AutoCAD version on CD-ROM as well as hard copies.
- 2.2 Contractor shall mount 24 inches by 36 inches Xerox hard copy project drawings of mechanical room equipment in each mechanical room. Each drawing shall be mounted under plastic, framed, and rigidly affixed to the wall in a conspicuous location.
- 2.3 Design calculations shall be furnished at the 35 percent design stage. Calculations shall be detailed enough to give Baldwin Wallace University personnel a good understanding of how the designer arrived at their conclusions. Include projected energy use per year and projected peak flows.
- 2.4 Life cycle cost analysis shall use a 25-year period. Such analysis shall be performed to determine equipment selection.
- 2.5 Acceptable manufactures, provide at least three (3) acceptable manufactures for all equipment with a base design make and model unless specifically instructed on a no equal requirement.

PART 3: EXECUTION

- 3.1 Water piping containing glycol may be buried no less than 24 inches from top of pipe to grade level.
- 3.2 Non-metallic below grade piping shall be equipped with metallic tracer wire. All piping shall be marked by warning tape. Warning tape shall be 12 inches below the surface of the ground and at least 12 inches above the pipe. Metallic warning tape is an acceptable alternative to tracer wire.
- 3.3 All pipes shall be labeled showing full descriptive words and arrows indicating flow direction. Such labels shall be provided on straight runs, at valves, and where passing through walls and floors.

END OF SECTION 220500

SECTION 220523 – GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

PART 2: PRODUCTS

2.1 Use only flanged or threaded valves.

2.2 Use full port ball valves on pipes 2 inches diameter and smaller, and butterfly on pipes larger than 2 inches diameter.

2.3 Use full port ball valves only for shut offs.

PART 3: EXECUTION

3.1 Any branch line off of a main line requires an isolation valve. Install valves on all lines at locations such that each floor can be isolated independent of main building. Include isolation valves at all terminal equipment to allow service without shutting down a larger area.

A. Manufacturers:

1. Apollo Press and Sweat Ball Valves
2. Nibco Press and Sweat Ball Valves
3. Legend Press and Ball Valves

3.2 PIPE IDENTIFICATION

Interior

Pipe bands indicating contents and flow direction shall be flexible vinyl film with acrylic pressure sensitive adhesive suitable for pipe surface temperatures of minus 40 to 220 degrees Fahrenheit.

A. Manufacturer and Model:

1. Seton – Opticode
2. W.H. Brady
3. Bunting

Exterior

Pipe bands indicating contents and flow direction shall be snap-on markers consisting of a surface-printed and overcoat-protected vinyl base material suitable for pipe surface temperatures from minus 40 to 150 degrees Fahrenheit.

B. Manufacturer and Model

1. Seton – Weather-Code Style AA
2. W.H. Brady
3. Bunting

Below Grade

Metallic Pipe – Underground metallic pipe shall be identified by underground warning tape. Tape shall be

0.004 inch thick, 6 inch wide polyethylene tape, color coded, with continuous message stating “Caution” and stating which type of pipe is buried.

Nonmetallic Pipe – Underground nonmetallic pipe shall be identified by underground metallic warning tape. Tape shall be 0.004 inch thick, 6 inch wide polyethylene tape with metallic core, color coded, with continuous message stating “Caution” and stating the type of pipe buried.

Pipe marking shall comply with ANSI A13.1 Scheme for the Identification of Pipe Systems.

Markers shall be in compliance with respect to:

Marker length

Background color

Letter color

Letter size

3.3 VALVE TAGS

Brass with stamped numbers and letters (black-filled), 1-½ inches square with ½ inch numbers and ¼ inch letters.

Example for identifying letter for various systems shall be as follows:

Cold Water = CW

Hot Water = HW

Sanitary = SAN

Vent = V

Storm = ST

Fastening shall be by brass “S” hooks, brass jack chains, or brass ball chains.

A. Manufacturer and Model

1. Seton – Tag 2960-25
2. W.H. Brady
3. EMED Company
4. Bunting

3.4 VALVE CHARTS

8-½ inches by 11 inches (minimum or of sufficient size), wood or aluminum frames with plexiglass covers. Include valve numbers, sizes, functions, and locations. Coordinate location with the Owner. Chart shall have key plan denoting approximate valve location.

3.5 EQUIPMENT NAMEPLATES

Heavy gauge (.025) aluminum with four (4) mounting holes. Coloring in background, lettering, and pads in aluminum.

3.6 CEILING MARKERS FOR CONCEALED EQUIPMENT, VALVES, AND DEVICES

Install color-coded ceiling markers on ceiling at concealed valve locations. Markers shall be a minimum of 7/8 inch diameter, and shall include engraving to indicate service.

A. Manufacturer and Model:

1. Seton – Style ECM
2. Brady – Style ECM
3. EMED Company – Style ECM
4. Bunting – Style ECM

END OF SECTION 220523

SECTION 220593 – TESTING, ADJUSTING AND BALANCING

PART 1: GENERAL

1.1 RELATED DOCUMENTS

Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

1.2 QUALITY ASSURANCE

Provide water systems balancing and testing by an approved member of a Certified Water Testing, Adjusting, and Balancing agency. The balancers must submit to the Architect a resume of experience, a sample of the forms to be used for the final report, and an inventory of the instruments to be used. Types, serial numbers and dates of last calibration of instruments used shall be listed in final balance reports.

1.3 WARRANTY

Provide a guarantee on Testing and Balancing forms stating that testing and balancing will assist in completing requirements of the Contract Documents.

Guarantee includes the following provisions:

- A. The certified Testing and Balancing firm has tested and balanced systems according to the Contract Documents.
- B. Systems are balanced to optimum performance capabilities within design and installation limits.

1.4 SUMMARY

This section includes the following:

- Examination
- General requirements for testing and balancing
- Tolerances
- Final Report
- Final Inspection
- Additional Adjustment

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

3.1 EXAMINATION

Examine the Contract Documents to become familiar with the Project requirements and to discover conditions in systems' designs that may preclude proper testing and balancing of systems and equipment.

It shall be the Testing and Balancing firm's responsibility to review the drawings and to notify the Engineer if additional valves, test plugs, components, and associated appurtenances are required to properly balance the various systems prior to the installation of those systems. If the Testing and Balancing firm reviews the drawings and does not notify the Engineer that additional valves, test plugs, components, and associated appurtenances are required, then the Testing and Balancing firm shall be responsible to provide additional components, and associated appurtenances as required to properly balance the various systems at no additional cost to the Owner.

Examine approved submittal data of systems and equipment.

Examine system and equipment installations to verify that they are complete. Systems shall be cleaned, pressure tests completed and approved, and in continuous operation before balancing begins. Minimum continuous operation shall be twenty-four (24) hours.

Report deficiencies discovered before and during performance of testing and balancing procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 GENERAL REQUIREMENTS FOR TESTING AND BALANCING

Provide complete testing and balancing of each and every water system and equipment that requires testing and balancing.

Cut insulation, pipes, and associated appurtenances for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed.

Neatly mark equipment and balancing device settings with paint or other suitable, permanent identification material, including valve position indicators, and similar controls and devices, to show final settings.

Coordinate with the General Contractor to ensure proper balancing above inaccessible ceilings before the ceilings are completed.

Final tests and adjustments necessary to demonstrate compliance with specified performance requirements for major items of equipment shall be directly supervised by the manufacturer's representatives.

The Architect shall be notified in writing of the date and time of final balancing and testing activities. Notification must be received at least forty-eight (48) hours in advance so that the Architect can be present if he so wishes.

3.3 TOLERANCES

Set water flow rates within the following tolerances:

Hot Water Return Flow Rate: Minus 5 to plus 5 percent of design values.

The domestic hot water system balancing valves shall be set with equal flow through each device to begin the overall process. Adjust each valve accordingly to provide the desired hot water temperature to the farthest fixture on the branch line to deliver hot water within ten 10 seconds maximum. Adjust all balancing valves to be equal in delivery time and temperature plus or minus 5 percent at each of the farthest fixtures in the loop. Adjust the hot water re-circulating pump valves to suit.

Reverse Osmosis Water Return Flow Rate: Minus 5 to plus 5 percent of design values.

3.4 FINAL REPORT

The Contractor shall obtain copies of the final Water Flow Balance and Test Reports from the balancing agency. Submit same to the Architect in accordance with the shop drawing submittal requirements for the Architect's review.

The report shall be a typewritten or computer generated printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

Include a list of instruments used for procedures, their serial numbers, and proof of calibration.

3.5 ADDITIONAL ADJUSTMENT

Provide an additional twenty-five (25) hours for balancing after occupancy for additional adjustment.

END OF SECTION 220593

SECTION 220700 – PLUMBING INSULATION

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 GENERAL

Insulation shall have composite fire and smoke hazard ratings (including insulation, jacket or facing, PVC covers, and adhesives), as tested by ASTM E84, NFPA 255 or UL 723 procedures, not exceeding a flame spread rating of twenty-five (25) and smoke developed rating of fifty (50).

Piping tests and inspection of piping system shall be completed prior to installation of insulation. Asbestos shall not be used in the manufacture of or contained in any part of the insulation.

1.3 INSULATION

Piping systems, which includes existing piping that may need reinsulated, including flanges, fittings, valves, expansion joints, drains and appurtenances shall be insulated as specified herein.

Piping subject to freezing shall be insulated with a minimum of 2 inches insulation.

1.4 ADHESIVES AND COATINGS

Provide adhesives and coating as specified herein.

1.5 SUMMARY

This section includes the following:

- Domestic cold water piping insulation
- Laboratory water piping insulation
- Domestic hot water piping insulation
- Domestic hot water return system piping insulation
- Storm water piping insulation
- Horizontal sanitary/storm piping insulation associated with HVAC condensate

PART 2: PRODUCTS

2.1 PIPING SYSTEM INSULATION SCHEDULE (P-1)

Domestic cold water mains, risers, and branch piping	1 inch
Laboratory water mains, risers, and branches piping	1 inch
Domestic hot water mains, risers and branch piping	1 inch for pipes 1 ½ inches and smaller; 2 inches for pipes larger than 1 ½ inches

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Domestic hot water circulation mains, risers and branch piping	1 inch for pipes 1 ½ inches and smaller 2 inches for pipes larger than 1 ½ inches
Storm mains, risers, branch piping and drain bodies	1 inch
Exterior domestic water	2 inch
Sanitary piping and drain bodies utilized for HVAC condensate drainage:	1 inch insulation shall be provided from main building risers up to and including drain bodies
Storm piping and drain bodies utilized for HVAC condensate drainage:	1 inch insulation shall be provided from main building risers up to and including drain bodies.

2.2 TYPE P-1 GLASS FIBER

- A. Insulation, including fiberglass fitting inserts, shall be glass fiber with a maximum K factor of .24 at 75 degrees Fahrenheit mean temperature with factory applied all-service jacket with self-sealing lip. Exposed pipe insulation material must be the one piece type. Sectional type may be used for concealed piping.
- B. Seal butt joints with 3 inches wide butt stripe adhered neatly in place.
- C. Fittings and valves for all piping shall be insulated with preformed fiberglass inserts of the same density as the pipe insulation and finished with a PVC fitting cover. Provide one (1) fiberglass insert per fitting or valve for each 1 inch of piping insulation specified. Field cut or loose blanket insulation is not acceptable.
- D. Exposed exterior piping shall be finished with a factory attached all-service jacket, protected with two (2) 1/16 inch coats of Childers CP/10 or CP/11 weather barrier coating.
- E. Manufacturer and Model:
 - 1. Owens – Corning SSL-11
 - 2. Manville Micro – Lok
 - 3. Knauff – ASJ-SSL
 - 4. Certainteed – Alley-K

2.3 ADHESIVES AND COATINGS

- A. Manufacturer and Model:

	Insulcoustic	Foster	Childers
Vapor Barrier Adhesive	225	80-07	CP-54
Vapor Barrier Coating	501	30-35	CP-30
Lagging Adhesive	102	30-36	CP-52
Insulation Adhesive	225	85-20	CP-54
Glass Cloth Adhesive	225	85-20	CP-54
Weatherproofing Mastic	VI-AC	48-00	CP-10/11

PART 3: EXECUTION

3.1 GENERAL

- A. Insulation shall be applied on clean, dry surfaces.
- B. Insulation shall be continuous through hangers, construction openings, and sleeves.
- C. Insulation on cold surfaces where vapor barrier jackets are required shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors and similar devices that are secured directly to cold surfaces shall be adequately insulated and vapor sealed to prevent condensation.
- D. For pipe handling fluids below 70 degrees Fahrenheit, provide one of the following means of preventing contact between pipe insulation and hanger or support:
 - E. High density rigid fiberglass insulation insert, equal in thickness to pipe insulation, with factory applied jacket and metal protection shield. Protection shield shall be installed between provided between pipe and hanger or support.
 - F. For piping 5 inches in diameter and smaller protection shield width shall be eighteen (18) gauge and equal to ½ the outside insulation diameter and 12 inches in length.
 - G. For piping 6 inches in diameter and larger protection shield shall be sixteen (16) gauge and equal to ½ the outside diameter and a length of 18 inches.
 - H. For piping handling fluids 70 degrees Fahrenheit and above, rest pipe directly on hanger, insulate pipe and hanger.
- I. Apply insulation in accordance with manufacturer's recommendations.
- J. Piping located on roof shall have eighteen (18) gauge stainless steel shield a minimum of 36 inches in length the full circumference of pipe. Locate where insulation will be stepped on due to maintenance traffic.

END OF SECTION 220700

SECTION 221113 – WATER DISTRIBUTION

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 PERFORMANCE REQUIREMENTS

- A. All design and components shall comply with governing codes and regulations.
- B. Elements/products used in design shall have a demonstrated record of success. Each manufacturer shall have been in business for a minimum of three (3) years.

PART 2: PRODUCTS

2.1 PIPING AND SPECIALTIES

- A. All pipes and fixtures shall be sized to supply water to the structure in the quantities and at pressures required in this code. The minimum diameter of water service pipe shall be $\frac{3}{4}$ inch.
- B. RPZ backflow protection devices must be provided on both the domestic and fire service lines. They must meet ASSE 1013 standards. Bypasses are not allowed.
- C. Minimum static pressure for private or public water service shall be 40 pounds per inch. Maximum static pressure shall be 80 pounds per inch.
- D. Top of pipe shall be a minimum of 36 inches below grade.

PART 3: EXECUTION – NOT USED

END OF SECTION 221113

SECTION 221116 – DOMESTIC WATER PIPING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.
- 1.2 All design and components shall comply with governing codes and regulations.

PART 2: PRODUCTS

- 2.1 Water distribution piping below ground to the building shall be hard Class 52 Double Cement Lined Coated Ductile Iron Pipe.
- 2.2 Water distribution piping above ground shall be hard drawn Type L copper. Fittings shall be wrought copper or cast copper alloy (PEX pipe and fittings is acceptable with Baldwin Wallace University approval).
- 2.3 Reverse osmosis and distilled/de-ionized water piping shall be Schedule 40 CPVC plastic pipe and fittings. Connections shall be made with solvent.
- 2.4 Trap Primer piping below grade shall be Cross-Linked Polyethylene Tubing

PART 3: EXECUTION

3.1 GENERAL

- A. Dielectric unions will be installed at any change in pipe material.
- B. Copper crimping is an acceptable method of joining copper tubing and fittings.
- C. All joints on copper pipe 2-½ inches diameter and larger shall be brazed or crimped instead of soldered.
- D. Solder joints shall be made with no-lead solder.
- E. Piping connections to plumbing fixtures and equipment shall be provided with offsets, unions, and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- F. Pitch water piping up in direction of flow to ensure adequate flow without air binding and to prevent noise and water hammer. Branch connections to mains shall be made in such a manner as to prevent air trapping and prevent free passage of air.
- G. Converging or diverging Bullheaded Tee's are not permitted in piping systems.
- H. Provide hose drain connections on downstream of floor main shut-off valves.
- I. T-Drill type fittings are not permitted in piping systems.
- J. Pressed type fittings and valves are not permitted in piping systems. (Unless specifically approved by Baldwin Wallace University facilities staff)

3.2 INSTALLATION AND TESTING

- A. Installation Procedures

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1. Water piping shall be arranged to drain to low points and to provide for air elimination at high points.
2. Mains, risers and branch connections to same shall be arranged to permit expansion and contraction without strain by means of elbow swings and/or expansion joints.
3. Provide a riser control valve and drain valve for each riser. Drain valve shall be located downstream of riser control valve on up-feed risers.
4. Valves, check valves, reducing valves, shock absorbers, tempering valves, etc. shall be easily accessible for maintenance and/or removal.
5. Screwed joints shall be made with best quality approved pipe compound, carefully placed on male threads only and not on the fittings.
6. Cut and threaded pipe shall have the cutting burrs and sharp edges reamed out.
7. In erecting pipe, friction wrenches shall be used exclusively, and any pipe cut, dented or otherwise damaged shall be replaced.
8. Ferrous to non-ferrous pipe connections shall be made with dielectric pipe or flange union isolating joints to prevent any electrolytic action between dissimilar metals.
9. Copper pipe and tubing shall be cut square and reamed out to remove burrs. Outside and inside of the fittings and outside of the tubing at each end shall be well cleaned with steel wool before brazing to remove traces of oxidation regardless of how clean the surfaces of the pipe and fittings may appear.

B. System Pressure Test

1. Each water system shall be tested to a hydrostatic pressure equal to 1-1/2 times the system normal operating pressure.
2. The water used for the pressure test shall be supplied from a potable water source.
3. Take all due precautions to prevent damage to the building and its contents that may be incurred by such tests; repair or make good any damage caused by the tests.
4. Tests shall apply full test pressure to the piping for a minimum of fifteen (15) minutes to detect leaks and defects.
5. Tests shall be conducted prior to the installation of insulation. If delicate control mechanisms, not including control valves, are installed in the piping, they shall be removed to prevent shock damage.
6. The section of piping to be tested shall be brought up to the specified test pressure. If the test pressure falls more than the specified amount during the test period, the point of leakage shall be found, repaired and the test repeated. This procedure shall be repeated until the piping system has been proved absolutely tight.
7. Leaks shall be repaired by removing the valve, fitting, joint or section that is leaking and reinstalling new materials and joints as specified. Use of mastic or “no-leak” compounds or other temporary means of repairing leaks shall not be permitted.

C. Cleaning, Flushing and Disinfection

1. Before being placed in operation, the water piping systems shall be cleaned, flushed and disinfected in strict accordance with the requirements of the local health department or other authorities having jurisdiction.

2. The piping systems shall be sterilized with a solution containing not less than 50 parts per million of chlorine, which shall conform to the standards of the American Water Works Association, and the solution shall be introduced into the system in an approved manner. The solution shall be allowed to remain in the system for a minimum period of twenty-four (24) hours. During the sterilization period, valves and outlets shall be opened and closed several times. After the sterilization period, the solution shall be flushed from the system using clean water until the residual chlorine content is less than 0.2 parts per million, or as required by the local health department or other authority having jurisdiction.
3. Required water samples shall be taken and submitted to an approved laboratory for routine bacteriological examination. Copies of the test results shall be submitted to the Architect and the local health department or other authority having jurisdiction.
4. Provide the means for disposing the solution used to disinfect the system. The solution shall be disposed of in an approved manner that shall eliminate the possibility of damage to property or contamination of the water supply.

3.3 ADJUSTING AND BALANCING

- A. After completion of the installations and prior to acceptance by the Owner, water systems and appurtenances shall be adjusted and balanced to deliver the water quantities as specified, indicated on the drawings, or as directed. Modify pumps and/or controls to produce design flow.
- B. Pump capacities shall be determined by differential pressure measurements. Pump balancing valves shall be adjusted to provide the lowest discharge pressure possible while maintaining flow to all devices.
- C. Water circuits shall be adjusted by calibrated balancing valves provided as part of the installation, and calibrated balancing valves shall be permanently marked after final balance is complete so that they may be returned to their correct position if disturbed.
- D. The following data shall be recorded for each water system:
 1. Pump motor current and voltage
 2. Entering and leaving water flow rates, temperatures and pressures
 3. Differential pressure across pumps

END OF SECTION 221116

SECTION 221119 – DOMESTIC WATER PIPING SPECIALTIES

PART 1: GENERAL

1.1 WATER HAMMER ARRESTORS

- A. Provide water hammer arrestors on water supplies to solenoid valves, immediately adjacent to equipment wherein quick-closing valves are installed, and as indicated on the drawings. Provide water hammer arrestors as required whether shown or not, to eliminate any water hammer in the domestic water system.

1.2 BACKFLOW PREVENTERS

- A. Provide backflow preventers as required by local codes and authorities, as indicated on drawings, and as specified herein.

1.3 TRAP SEAL PRIMER VALVES

- A. Provide trap seal primer valves as indicated on drawings and as specified herein.

1.4 WATER PRESSURE REDUCING VALVE

- A. Provide water pressure reducing valve as indicated on drawings and as specified herein.

1.5 STRAINERS

- A. Provide strainer as required by local codes and authorities, as indicated on drawings, and as specified herein.

1.6 WATER PRESSURE BOOSTER SYSTEM

- A. Provide water pressure booster pump as indicated on drawings and as specified herein.

1.7 SUMMARY

This section includes the following:

- Water Hammer Arrestors
- Backflow Preventers
- Trap Seal Primer Valves
- Strainers
- Water Pressure Reducing Valves
- Water Pressure Booster System

PART 2: PRODUCTS

2.1 WATER HAMMER ARRESTORS

- A. Water hammer arrestors for general use shall be nested stainless steel bellows type contained within a sealed stainless steel chamber. Water hammer arrestors shall be sized in accordance with the manufacturer's recommendations.

2.2 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: For piping 2-½ to 10 inches, ASSE 1013, suitable for continuous application. Provide shut-off valves on inlet and outlet; test cocks; and pressure-differential relief valve with air-gap fitting located between two positive-seating check valves. Provide with non-rising stem resilient seated gate valve shut off.
- B. Dual Check Backflow Preventers for piping ½ inch to ¾ inch: ASSE 1012, suitable for continuous pressure application. Provide with inlet screen, two independent check valves, and atmospheric vent.
- C. Anti-siphon Vacuum Breakers for piping ¼ to 3 inches: ASSE 1001, with floating disk and atmospheric vent.

2.3 TRAP SEAL PRIMER VALVES

- A. Floor drains or traps not subject to water seal on a daily basis shall be provided with a trap primer valve and associated appurtenances.
- B. Electronic Trap Primer Manifold
 - 1. Electronic trap primer manifold shall provide a minimum of 2 ounces of water per trap every twenty-four (24) hours. Manifold shall be capable of equally priming from 4 to 30 individual traps at one time.
 - 2. The manifold shall be factory assembled, pre-piped, and shall include a bronze ¾ inch female WOG rated ball valve, electronic brass body ¾ inch solenoid valve, and Type “L” copper manifold with ½ inch compression fitting and orifice opening for water distribution to each floor drain trap.
 - 3. Electronic components shall include single point power connection at 120 volts, single phase, manual override switch, minimum 5 amps breaker, 24 hours geared timer with relay, and 5 seconds dwell function.
 - 4. All components shall be factory assembled, tested, and supplied in a 16 gauge steel enclosure suitable for surface or recess mounting.
- C. Pressure differential trap priming valve
 - 1. Pressure differential trap priming valve shall be automatically activated when trap primer valve senses a cold water pressure drop of 5 to 10 pounds per square inch gauge. Trap primer valve shall be provided with a distribution unit when required to supply more than one floor drain trap.

2.4 STRAINER (Domestic Water)

- A. For piping 2 inches to 10 inches: Class 125 flanged cast iron “Y” strainer, ASTM A-126 Class B cast iron with blow-off connections and self-aligning cylindrical screens, and FDA approved epoxy coated inside and out.
- B. Strainers shall be installed such that they are accessible for maintenance and inspection.
- C. Strainers shall be arranged so as to permit the blowing out of accumulated dirt, and to facilitate removal and replacement of strainer screen without disconnecting from piping system.
- D. Valved dirt blow-out connections for strainers shall be installed such that the valve is located 6 to 12 inches below the strainer. Blow-out connections shall be terminated in an approved manner, at a point where there shall be no risk of flooding or damage.

- E. After the piping systems have been flushed and prior to releasing the system to the Owner, strainers shall be removed, cleaned, and reassembled.

2.5 WATER PRESSURE REDUCING VALVE

- A. Provide pressure reducing valve with strainer conforming to ASSE 1003. Pressure reducing valve shall be capable of reducing water pressure within building to 80 pounds per inch static or less. Pressure reducing valve shall provide constant downstream pressure regardless of flow rate or inlet pressure.
- B. Water pressure reducing valves shall be full size of water pipe to which it connects
 - 1. Pipe sizes ½ inch through ¾ inch shall be provided with integral strainer and have an adjustable pressure range from 25 to 75 pounds per inch.
 - 2. Pipe sizes 1-¼ inch through 12 inches shall be pressure reducing valve with low flow bypass, pilot operated diaphragm valve designed to automatically reduce fluctuating high stream pressure to a constant lower downstream pressure. Flow requirements below normal range of main line pressure reducing control valve shall be handled by a valve mounted, direct actuating low flow by-pass valve.
 - 3. The main valve body and cover shall be ductile iron ASTM A536, and all internal cast components shall be CF8M 316 stainless steel. All ductile iron components, including body and cover shall be lined and coated with an NSF61 certified epoxy coating. All main valve throttling components including valve seat and disc guide shall be stainless steel.

2.6 WATER PRESSURE BOOSTER SYSTEM

- A. Provide Boost System 240 volts, single phase, 60 hertz, with pump, controller, pressure switch, mounting brackets, and diaphragm tank and flex connectors. System shall be capable of boosting the pressure to 60 pounds per inch at a flow rate of 20 gallons per minute.

PART 3: EXECUTION

3.1 WATER HAMMER ARRESTORS

- A. Provide shutoff valves between each water hammer arrestors and the piping served to permit removal of water hammer arrestor while the system is under pressure.

3.2 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers shall be provided at building water supply pipe after the water meter, and all cross-connections subject to back pressure or back siphonage.
- B. Dual Check Backflow Preventer shall be provided at supply pipe to beverage machines and at cross-connections subject to back pressure or back siphonage.
- C. Anti-siphon Vacuum Breakers shall be installed at supply pipe to dishwashers, washing machines, and at all cross-connections not subject to back pressure or continuous pressure. Install at least 6 inches above fixture rim.

END OF SECTION 221119

SECTION 221316 – SANITARY WASTE AND VENT PIPING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.
- 1.2 All design and components shall comply with governing codes and regulations.

PART 2: PRODUCTS

- 2.1 For laboratories use acid resistant piping with mechanical joints.
- 2.2 Use cast iron hub piping or PVC schedule 80 for lines under concrete floor slabs or if under other inaccessible floor construction (where necessary).
- 2.3 Horizontal DWV piping and roof drains above grade may be PVC schedule 40 (Non-plenum ceilings) or hub less cast iron.

PART 3: EXECUTION

3.1 GENERAL

- A. All roof drains shall be insulated and covered with a vapor barrier. Starting at the interior side of the roof, at least 10 feet of insulation shall be installed in a continuous manner.
- B. All vertical roof drains and sanitary drain lines shall be cast iron to minimize noise.
- C. PVC plumbing vents that are exposed to sunlight shall be painted with two (2) coats of water based latex paint.
- D. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.
- E. Piping passing through roof construction shall be arranged to provide a minimum of 12 inches clearance from walls or other obstructions so as to permit proper flashing. Set pipe flashing fittings at a suitable level above the roof to permit proper termination of flashing.

3.2 INSTALLATION AND TESTING

- A. Installation Procedures
 1. Slope of horizontal piping
 - a. Sanitary piping 2-½ inches and smaller shall be sloped at a minimum pitch of ¼ inch per foot.
 - b. Sanitary piping 3 to 6 inches shall be sloped at a minimum pitch of ⅛ inch per foot.
 - c. Sanitary piping 8 inches or larger shall be sloped at a minimum pitch of 1/16 inch per foot.
 2. Connections to stacks or main drains shall be made in a manner that shall not permit backflow.
 3. Vent piping shall be arranged to drain any condensate back to drainage piping.
 4. Provide test tees in vertical risers as required to permit testing in sections.
 5. Pipe shall have the cutting burrs and sharp edges reamed out.

6. When connecting to existing sanitary piping system, clean out piping from tie-in to next downstream cleanout.

B. System Testing

1. The entire sanitary and vent piping system shall be subjected to testing in accordance with applicable codes. Plumbing Contractor shall provide all equipment, material, labor and associated appurtenances necessary for drainage system testing.
2. The sanitary and vent piping systems shall be provided with two separate tests. The first test shall occur during the installation and the final test shall occur after the plumbing fixtures have been set and their traps filled with water. The entire sanitary and vent piping system shall be submitted to the final test.
3. Sanitary and vent piping systems testing during construction shall be provided by utilizing either water or air.

C. Water Test

1. A water test shall be applied to the sanitary and vent piping system either in its entirety or in sections. If applied to the entire system, all openings in the piping system shall be tightly closed, except the highest opening, and the system shall be filled to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test. The section shall be filled with no less than a 10 feet head of water.
2. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building, except for the uppermost 10 feet of the system, shall have been submitted to a test of not less than a 10 feet head of water.
3. The water shall be kept in the system, or in a portion under test, for at least fifteen (15) minutes before inspection starts.

D. Air Test

1. An air test shall be applied to the sanitary and vent piping system either in its entirety or in sections. All openings in the piping system shall be tightly closed and the system shall be filled with air until there is a uniform gauge pressure of 5 pounds per square inch or a pressure sufficient to balance a 10 inches column of mercury.
2. This pressure shall be held for a period of at least fifteen (15) minutes. Any adjustment to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

E. Final Test.

1. The final test of the completed drainage and vent system shall be visual and in detail to determine compliance with the provisions of the Plumbing Code except that the systems shall be subject to a smoke test where necessary for cause.
2. Where a smoke test is utilized, it shall be made by filling all traps with water and then introducing into the entire drainage system a pungent, thick smoke produced by one or more smoke machines.
3. When smoke appears at the stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1 inch water column shall be held for a test period of not less than fifteen (15) minutes.

SECTION 221319 – SANITARY WASTE AND VENT PIPING SPECIALTIES

PART 1: GENERAL

1.1 GENERAL

- A. Provide sanitary and vent piping specialties as shown on drawings and as specified herein.

1.2 CLEANOUTS

- A. Provide cleanouts as required by local codes and authorities, as shown on drawings, and as specified herein.

1.3 BACKWATER VALVES

- A. Provide backwater valves as shown on drawings and as specified herein.

1.4 ELEVATOR PIT SUMP PUMP

- A. Provide elevator pit sump pump as shown on drawings and as specified herein.

1.5 OIL INTERCEPTOR

- A. Provide oil interceptor as shown on drawings and as specified herein.

1.6 SUMMARY

- A. This section includes the following:
 - 1. Cleanouts
 - 2. Backwater valves
 - 3. Elevator pit sump pump
 - 4. Oil Interceptor

PART 2: PRODUCTS

2.1 CLEANOUTS

- A. Cleanouts shall be full size of pipe up to 4 inches, and shall be 4 inches for larger sizes. Cleanouts on piping 6 inches and smaller shall be provided with a clearance of not less than 18 inches for rodding. Cleanouts on piping 8 inches and larger shall be provided with a clearance of not less than 36 inches for rodding.
- B. Cleanouts on concealed piping, piping under a floor slab, piping in a crawl space of less than 24 inches in height, or piping in a plenum shall be extended through and terminated flush with finished wall, floor, or ground surface.
- C. Horizontal drains within a building shall be provided with cleanouts located not more than 100 feet apart. Cleanouts shall also be provided at every change of direction greater than 45 degrees. Where more than one change of direction occurs in a run of piping, only one cleanout shall be provided for every 40 feet of developed length of piping.

- D. Building sanitary sewers shall be provided with cleanout located not more than 100 feet apart measured from the upstream entrance of the cleanout. For building sewers 8 inches and larger, manholes shall be provided and located at each change of direction and at intervals of not more than 400 feet.
- E. Access doors and frames for cleanouts located behind walls shall be furnished by plumbing Contractor and installed by others. A complete list of wall cleanout locations and associated access panels shall be prepared by the plumbing Contractor prior to the erection of walls.

2.2 BACKWATER VALVES

- A. Backwater valves shall be flapper type cast iron body, with hub inlet and offset spigot outlet, and bronze threaded cover.
- B. Provide extension as required.

2.3 ELEVATOR PIT SUMP PUMP

- A. Provide simplex submersible elevator pipe sump pump, valves, piping, oil minder controls, and associated appurtenances. Pump shall function automatically and shall provide an alarm and separate LED lights for:
 - 1. Presence of oil in the sump
 - 2. High liquid in the sump
 - 3. High amps or locked rotor condition
 - 4. Power
 - 5. Pump run function
 - 6. High amps or locked rotor condition
- B. Pump construction shall be ceramic face with heat resistant stainless steel and Buna-N components. Case shall be heavy duty close grain, high density cast iron with stainless steel strainer.
- C. Pump shall be ½ horsepower, 3600 revolutions per minute, 120 volts, single phase, approved to UL 778 standards, hermetically sealed starter motor with built in overload protection, Class F insulation, air filled submersible pump. Pump end bell motor and shell shall be cast iron, with stainless steel shaft, factory sealed grease lubricated ball bearings, mechanical seal, and perforated stainless steel plated strainer.
- D. The main control shall be approved to UL 508 standards and housed in a gasketed National Electrical Manufacturers Association (NEMA) 4X enclosure with see through window for observation of functions. The control shall be equipped with an 8-pin twist lock receptacle, dual solid state, Oil-Minder relays with variable sensitivity settings, an over current relay, self-cleaning stainless steel sensor probe, high decibel warning horn with alarm silencing switch, dual floats, clearly marked terminal board and remote monitoring contact. The control unit, junction box, pump, floats and sensors shall be factory assembled and tested as a complete assembly. The main control shall be located outside of the elevator shaft to permit monitoring of all functions without having to enter the elevator shaft.

2.4 OIL INTERCEPTOR

- A. Provide coated steel oil interceptor with bronze cleanout plug, visible double wall trap seal, removable pressure equalizing/flow diffusing baffle and sediment bucket, adjustable oil draw-off and vent connections, gasketed secured cover and flow control fitting. Install in accordance with manufacturer's recommendations and all applicable codes.

PART 3: EXECUTION

3.1 BACKWATER VALVES

- A. Install backwater valves to allow complete accessibility. Provide corrugated pipe sections (minimum 36 inches diameter) for access to backwater valves when valve handle is greater than 1 foot below top of slab or grade.

END OF SECTION 221319

SECTION 221413 – STORM DRAINAGE PIPING

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Storm systems which are provided to serve HVAC equipment, components, and associated appurtenances shall be located within five feet of equipment drain point. Plumbing Contractor shall coordinate exact locations of HVAC drain points with Mechanical Contractor prior to rough-in of floor drains. HVAC equipment, components, and associated appurtenances shall be provided under the HVAC section.
- B. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- C. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.2 SUMMARY

- A. This section includes the following:
 1. Storm piping – Interior
 2. Storm piping – Below grade
 3. Installation and Testing

PART 2: PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL SCHEDULE

- A. Piping systems shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
 1. Storm (ST) Piping – Interior
 - Pipe: Service weight no-hub Cast Iron – ASTM A74, ASTM A888, CISPI 301 and be marked with the collective material trade mark of the Cast Iron Soil and Pipe Institute
 - Fittings: No-hub Cast Iron drainage – ASME B16.4, ASTM B16.12, ASTM A74, ASTM A888, CISPI 301
 - Joints: 4 inches and smaller – cast iron neoprene gasket with heavy duty stainless steel coupling and four (4) stainless steel bands
 - Joints: 5 to 10 inches – Cast Iron neoprene gasket with heavy duty stainless steel coupling and six (6) stainless steel bands pipe. Any portion of a storm piping system located above food service preparation areas or areas associated with food sales shall be provided with a secondary means of containment in the event of a leak. Provide in accordance with manufacturers requirements.
 2. Storm (ST) Piping System – Below Grade
 - Pipe:
 - Cast Iron hub and spigot – ASTM A74, ASTM A888, CISPI 301
 - Rubber compression gaskets – ASTM C564
 - PVC DWV Schedule 40 IPS pipe (solid) – ASTM D 2665, ASTM D 3311

Solvent Cement

- Joints shall be cleaned and free from moisture.
- A purple primer that conforms to ASTM F 656 shall be applied.
- Solvent cement, not purple in color conforming to ASTM 2564 shall be applied to all joint surfaces.
- Joint shall be made while cement is wet and shall be in accordance with ASTM 2855 and ASTM F 402.

B. Minimum 2 inches pipe size permitted below grade, provided in accordance with manufacturers requirements.

2.2 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

A. Piping, fittings, and components, for the storm and emergency storm piping systems shall be capable of withstanding the following:

1. Plumbing Piping System: Minimum Working Pressure Storm 10 feet head of water

PART 3: EXECUTION

3.1 GENERAL

A. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.

B. Piping passing through roof construction shall be arranged to provide a minimum of 12 inch clearance from walls or other obstructions so as to permit proper flashing. Set pipe flashing fittings at a suitable level above the roof to permit proper termination of flashing.

3.2 INSTALLATION AND TESTING

A. Installation Procedures

1. Slope of horizontal piping

- a. Storm piping 3 to 6 inches shall be sloped at a minimum pitch of $\frac{1}{8}$ inch per foot in direction of flow.
- b. Storm piping 8 inches or larger shall be sloped at a minimum pitch of $\frac{1}{16}$ inch per foot.

2. Branch drainage connections to stacks or main drains shall be made in a manner that shall not permit backflow.

3. Provide test tees in vertical risers as required to permit testing in sections.

4. Pipe shall have the cutting burrs and sharp edges reamed out.

5. When connecting to existing storm or emergency storm piping system, clean out piping from tie-in to next downstream cleanout.

B. System Testing

1. The entire storm system piping system shall be subjected to testing in accordance with applicable codes. Plumbing Contractor shall provide all equipment, material, labor and associated appurtenances necessary for drainage system testing.

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2. The storm piping systems shall be provided with two separate tests. The first test shall occur during the installation and the final test shall occur after the plumbing fixtures have been set and their traps filled with water. The entire drainage system shall be submitted to the final test.
3. Storm piping systems testing during construction shall be provided by utilizing either water or air.

C. Water Test

1. A water test shall be applied to storm piping system either in its entirety or in sections. If applied to the entire system, all openings in the piping system shall be tightly closed, except the highest opening, and the system shall be filled to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test. The section shall be filled with no less than a 10 feet head of water.
2. The water shall be kept in the system, or in a portion under test, for at least fifteen (15) minutes before inspection starts.
3. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building, except for the uppermost 10 feet of the system, shall have been submitted to a test of not less than a 10-foot head of water.

D. Air Test

1. An air test shall be applied to storm piping system either in its entirety or in sections. All openings in the piping system shall be tightly closed and the system shall be filled with air until there is a uniform gauge pressure of 5 pounds per square inch or a pressure sufficient to balance a 10 inches column of mercury.
2. This pressure shall be held for a period of at least fifteen (15) minutes. Any adjustment to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

E. Final Test

1. The final test of the completed drainage and vent system shall be visual and in detail to determine compliance with the provisions of the Plumbing Code except that the systems shall be subject to a smoke test where necessary for cause.

END OF SECTION 221413

SECTION 221423 – STORM DRAINAGE PIPING SPECIALTIES

PART 1: GENERAL

1.1 GENERAL

- A. Provide storm piping specialties as shown on drawings and as specified herein.

1.2 CLEANOUTS

- A. Provide cleanouts as required by local codes and authorities, as shown on the drawings, and as specified herein.

1.3 SUMMARY

- A. This section includes the following:
 - 1. Cleanouts

PART 2: PRODUCTS

2.1 CLEANOUTS

- A. Cleanouts shall be full size of pipe up to 4 inches, and shall be 4 inches for larger sizes. Cleanouts on piping 6 inches and smaller shall be provided with a clearance of not less than 18 inches for rodding. Cleanouts on piping 8 inches and larger shall be provided with a clearance of not less than 36 inches for rodding.
- B. Cleanouts on concealed piping, piping under a floor slab, piping in a crawl space of less than 24 inches in height, or piping in a plenum shall be extended through and terminated flush with finished wall, floor, or ground surface.
- C. Horizontal drains within a building shall be provided with cleanouts located not more than 100 feet apart. Cleanouts shall also be provided at every change of direction greater than 45 degrees. Where more than one change of direction occurs in a run of piping, only one cleanout shall be provided for every 40 feet of developed length of piping.
- D. Building storm sewers shall be provided with cleanout located not more than 100 feet apart measured from the upstream entrance of the cleanout. For building sewers 8 inches and larger, manholes shall be provided and located at each change of direction and at intervals of not more than 400 feet.
- E. Access doors and frames for cleanouts located behind walls shall be furnished by plumbing Contractor and installed by others. A complete list of wall cleanout locations and associated access panels shall be prepared by the plumbing Contractor prior to the erection of walls.

PART 3: EXECUTION – NOT USED

END OF SECTION 221423

SECTION 224000 – PLUMBING FIXTURES

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 Ball valves shall be installed at each fixture.
- 1.3 All sinks and lavatories shall include a mixing valve piped below the sink or behind a Contractor provided access panel in the pipe chase. Valve shall be ½ inch
- 1.4 Hydro-pneumatic water hammer arresters shall be installed on any piping where flush valves or any quick-acting automatic valves are used.
- 1.5 All restrooms, mechanical rooms, and laundry rooms floors shall be waterproof and have a floor drain installed.

1.6 SUMMARY

A. This section includes the following:

1. Traps
2. Supply Pipes
3. Plumbing Fixtures
4. Floor Drains
5. Roof Drains
6. Floor Sinks
7. Supply and Drain Box

PART 2: PRODUCTS

2.1 TRAPS

A. For sinks with 1-¼ inch drain openings that are not provided with traps, provide an adjustable chrome-plated P-trap. P-Traps shall be 1-¼ inch by 1-½ inches, 17 gauge tubing outlet with cleanout plug, wall flange, and slip joint inlet.

1. Manufacturer and Model:
 - a. Zurn Z8700-8B-PC

B. Exposed piping, fittings, escutcheons, valves, etc. shall be chrome-plated brass.

2.2 SUPPLY PIPES

A. Supply pipes for sinks shall be ½ inch IPS by ¾ inch O.D. angle valve with loose key handle, flexible tubing, and cast brass escutcheon with set screw.

1. Manufacturer and Model:
 - a. Zurn Z8855WLLK-PC

2.3 PLUMBING FIXTURES

A. Plumbing Fixtures

1. Water Closet, WC-1 (Wall Mounted): Water closet shall be vitreous china with elongated bowl, high efficiency toilet system with Z600EV battery powered flushometer, 1.28 gpf, 1-½ inches inlet spud. Mounting height shall be 15 inches from toilet rim to floor.
 - a. Manufacturer and Model (Water Closet):
 - 1) American Standard – Dorm/Residence/Academic
 - 2) Kohler – Dorm/Residence/Academic
 - 3) Zurn Model Z5615 EcoVantage (See Baldwin Wallace University for approval)
 - b. Manufacturer (Flushometer):
 - 1) Sloan – Dorm/Residence/Academic
 - 2) Zurn – Dorm/Residence/Academic
 - 3) Zurn Low Flow – Dorm/Residence/Academic
 - c. Manufacturer and Model (Toilet Seat):
 - 1) Church – Model 9500SSC
 - 2) Beneke
 - 3) Olsonite
2. Handicapped Water Closet, WC-2 (Wall Mounted): Water closet shall be vitreous china with elongated bowl, high efficiency toilet system with Z600EV battery powered flushometer, 1.28 gpf, 1-½ inches inlet spud. Mounting height shall be 17 inches from toilet rim to floor.
 - a. Manufacturer and Model (Water Closet):
 - 1) American Standard – Dorm/Residence/Academic
 - 2) Kohler – Dorm/Residence/Academic
 - 3) Zurn Model Z5615 EcoVantage (See Baldwin Wallace University for approval)
 - b. Manufacturer (Flushometer):
 - 1) Sloan – Dorm/Residence/Academic
 - 2) Zurn – Dorm/Residence/Academic
 - 3) Zurn Low Flow – Dorm/Residence/Academic
 - c. Manufacturer and Model (Toilet Seat):
 - 1) Church – Model 9500SSC
 - 2) Beneke
 - 3) Olsonite

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3. Urinal U-1 (Wall Mounted): Urinal shall be vitreous china, high efficiency system with ZEG6003AV battery powered flushometer, 1/8 gpf, 3/4 inch inlet spud. Mounting height shall be 24 inches from rim to floor.
 - a. Manufacturer and Model (Urinal): Zurn Z5798 EcoVantage
4. Handicapped Urinal U-2 (Wall Mounted): Urinal shall be vitreous china, high efficiency system with ZEG6003AV battery powered flushometer, 1/8 gpf, 3/4 inch inlet spud. Mounting height shall be 17 inches from rim to floor.
 - a. Manufacturer and Model (Urinal): Zurn Z5798 EcoVantage
5. Mop Basin, MB-1 (Floor Mounted): Durastone mop basin, 36 inches by 24 inches by 10 inches with integral drain 3 inches drain and strainer, mop hanger, hose and hose holder, and bumper guards.
 - a. Manufacturer and Model (Mop Basin):
 - 1) Mustee – Dorm/Residence/Academic
 - b. Manufacturer and Model (Faucet):
 - 1) Zurn Z841M1
6. Lavatory, L-1 (Wall Mounted): Vitreous china, with front over flow, self-draining deck area with contoured back and side splash shields and faucet ledge.
 - a. Manufacturer and Model (Sink):
 - 1) American Standard – Dorm/Residence/Academic
 - 2) Kohler – Dorm/Residence/Academic
 - 3) Zurn Z5334 (See Baldwin Wallace University for approval)
 - b. Manufacturer and Model (Faucet – Sensor Operated – Battery):
 - 1) Moen Commercial Grade
 - 2) Chicago – Dorm/Residence/Academic
 - c. Manufacturer and Model (Drain):
 - 1) Zurn Z8746
7. Handicapped Lavatory, L-2 (Wall Mounted): Vitreous china, with front over flow, self-draining deck area with contoured back and side splash shields and faucet ledge.
 - a. Manufacturer and Model (Sink):
 - 1) American Standard – Dorm/Residence/Academic
 - 2) Kohler – Dorm/Residence/Academic
 - 3) Zurn Z5334 (See Baldwin Wallace University for approval)

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- b. Manufacturer and Model (Faucet – Sensor Operated – Battery):
 - 1) Moen Commercial Grade
 - 2) Chicago – Dorm/Residence/Academic
 - c. Manufacturer and Model (Drain):
 - 1) Zurn Z8746
8. Handicapped Sink, S-1 (Countertop): Stainless Steel, 18 gauge, type 304, satin finish, fully coated underside, 3-½ inches drain opening off-centered rear, 19-½ inches by 22 inches by 6 inches deep, three (3) faucet holes.
- a. Manufacturer and Model (Sink):
 - 1) Elkay LRAD2219
 - b. Manufacturer and Model (Faucet – manual – blade handles):
 - 1) Elkay LKD2445BH
 - c. Manufacturer and Model (Drain):
 - 1) Elkay LK99
 - d. Manufacturer and Model (Garbage Disposal):
 - 1) In-Sink-Erator Evolution Essential, 120 volts
9. Sink, S-2: Sink provided under another division. Under this division provide: P-Trap, supply pipes, rough-in and final connection. Install all faucets, strainers, tailpieces, etc. and leave in operating condition.
10. Sink, S-3: Sink and garbage disposal provided under another division. Under this division provide: P-Trap, supply pipes, rough-in and final connection. Install all faucets, strainers, tailpieces, etc. and leave in operating condition.
11. Sink, S-4 (Countertop): Stainless Steel, 18 gauge, type 304, satin finish, fully coated underside, 3-½ inches drain opening off-centered rear, 15 inches by 15 inches by 7 inches deep, one (1) faucet hole.
- a. Manufacturer and Model (Sink):
 - 1) Elkay BLR15
 - b. Manufacturer and Model (Faucet – manual- blade handles):
 - 1) Elkay LKD2223
 - c. Manufacturer and Model (Drain):
 - 1) Elkay LK36
12. Electric Water Cooler, EWC-1 (Bi-Level – Wall Mounted): Self-contained, dual bi-level wall hung electric refrigerated water cooler with self-closing push bars on front, provided with stainless steel finish and stainless steel bubbler and bottle fill

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- a. Manufacturer and Model (Water Cooler):
 - 1) Elkay – Dorm/Residence/Academic – Model LZS8WSADA with Bottle Filler
 - 2) Halsey Taylor – Dorm/Residence/Academic – Model HAC8SSADA with Bottle Filler
 - b. Manufacturer and Model (Drain):
 - 1) Zurn Z8746
13. Electric Water Cooler, EWC-2 (Wall Mounted): Self-contained, wall hung electric refrigerated water cooler with self-closing push bars on front, provided with stainless steel finish and stainless steel bubbler and bottle fill
- a. Manufacturer and Model (Water Cooler):
 - 1) Elkay – Dorm/Residence/Academic – Model LZS8WSADA with Bottle Filler
 - 2) Halsey Taylor – Dorm/Residence/Academic – Model HAC8SSADA with Bottle Filler
 - b. Manufacturer and Model (Drain):
 - 1) Zurn Z8746
14. Hose Bibb, HB-1 – (Exposed – Interior): Exposed, interior anti-siphon, wall hydrant with vacuum breaker spout. Mount piping and hose bibb on brick wall of greenhouse.
- a. Manufacturer and Model:
 - 1) Woodford – Model 46-VB
 - 2) Nibco
 - 3) Watts
15. Hose Bibb, HB-2 – (Recessed – Interior): Recessed, interior with vacuum breaker spout. Stainless steel recessed box with hinged lockable door, wall flange, hot and cold water supplies. Mount 24 inches above finished floor.
- a. Manufacturer and Model:
 - 1) Acorn – Model 8156
16. Glassware Washer – GW-1: Glassware Washer provided under another Division. Under this division, provide: Solid brass, chrome plated air gap fitting with full $\frac{3}{8}$ inch pathway, $\frac{1}{2}$ inch hose barb inlet and $\frac{3}{4}$ inch hose barb outlet.
- a. Manufacturer and Model (Air Gap):
 - 1) Sioux Chief – Model 249
17. Dish Washer – DW-1: Dish Washer provided under another Division. Under this division, provide: Solid brass, chrome plated air gap fitting with full $\frac{3}{8}$ inch pathway, $\frac{1}{2}$ inch hose barb inlet and $\frac{3}{4}$ inch hose barb outlet.

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a. Manufacturer and Model (Air Gap):

- 1) Sioux Chief – Model 249

18. Domestic Water Heaters and Boilers

- 1) Rheem – SPIDERfire
- 2) Lochinvar – Shield

19. Pumps:

- 1) Bell and Gossett – Sealed Bearing Recirculating Pumps
- 2) Grundfoss Sealed – Bearing Recirculating Pumps ONLY

20. Showers:

a. Manufacturer (Shower Stall):

- 1) Mustee Fiberglass Shower Stalls – Dorm/Residence/Academic
– 3 Piece Wall Kit with Base (* Not one piece) – Base set in mortar

b. Manufacturer (Shower Faucet):

- 1) Moen Commercial Grade PosiTemp
- 2) Symmons Temptrol

21. Utility Sinks:

b. Manufacturer:

- 1) Mustee Fiberglass Utility Sinks – Dorm/Residence/Academic

B. Fixture Supports

1. Wall-Mounted Water Closet Supports: Shall be adjustable siphon jet complete with cast iron right hand, left hand, or double main fitting, with adjustable gasketed face plate, universal floor mounted foot supports, corrosion resistant adjustable ABS coupling with integral test cap, fixture bolts, trim, and stud protectors.

a. Manufacturer and Model (Single – Horizontal):

- 1) Zurn – Model Z-1203-N Series
- 2) Josam
- 3) J.R. Smith

b. Manufacturer and Model (Back-to-Back – Horizontal):

- 1) Zurn – Model Z-1203-ND Series
- 2) Josam
- 3) J.R. Smith

- c. Manufacturer and Model (Single – Vertical):
 - 1) Zurn – Model Z-1204-N Series
 - 2) Josam
 - 3) J.R. Smith
- d. Manufacturer and Model (Back-to-Back – Vertical):
 - 1) Zurn – Model Z-1204-ND Series
 - 2) Josam
 - 3) J.R. Smith
- 2. Wall-Mounted Urinal: Shall be rectangular steel uprights with welded feet, adjustable face plate, upper support plate, adjustable corrosion resistant coupling, fixture bolts, trim, and bonded gasket.
 - a. Manufacturer and Model:
 - 1) Zurn – Model Z1222
 - 2) Josam
 - 3) J.R. Smith
- 3. Wall-Mounted Lavatories: Shall be rectangular steel uprights with welded feet cast iron adjustable headers, concealed arms, steel sleeves, alignment truss, and mounting fasteners.
 - a. Manufacturer and Model (Single):
 - 1) Zurn – Model Z1231
 - 2) Josam
 - 3) J.R. Smith
 - b. Manufacturer and Model (Back-to-Back):
 - 1) Zurn – Model Z1231-D
 - 2) Josam
 - 3) J.R. Smith

C. Handicapped Plumbing Fixtures

- 1. Provide P-trap, hot water angle valves and supply tubing, and cold water angle valves and supply tubing, with insulation in accordance with the American with Disabilities Act (ADA). Trap Wrap Z81104-3M

2.4 FLOOR DRAINS

- A. Floor Drain FD-1: Cast iron body with bottom outlet, trap primer connection, combination membrane clamp and adjustable collar with strainer.

- a. Manufacturer and Model:
 - 1) Zurn – Model Z415-P with Type “B” Strainer
 - 2) Josam
 - 3) J.R. Smith
- B. Floor Drain FD-2: Cast iron body with bottom outlet, trap primer connection, combination membrane clamp and adjustable collar with strainer and raised flange.
 - a. Manufacturer and Model:
 - 1) Zurn – Model Z415-P with Type “I” Strainer
 - 2) Josam
 - 3) J.R. Smith
- C. Floor Drain FD-3: Cast iron body with bottom outlet, trap primer connection, combination membrane clamp and adjustable collar with strainer and solid hinged cover.
 - a. Manufacturer and Model:
 - 1) Zurn – Model Z415-P with Type “D” Strainer
 - 2) Josam
 - 3) J.R. Smith

2.5 ROOF DRAINS

- A. Roof Drain RD-1: 15 inches diameter with cast iron body, roof sump receiver, under deck clamp, adjustable extension, and combination membrane flashing clamp/gravel guard.
 - a. Manufacturer and Model:
 - 1) Zurn – Model ZC-100-C-AE
 - 2) Josam
 - 3) J.R. Smith

2.6 FLOOR SINK

- A. Floor Sink FS-1: Cast iron body with bottom outlet, trap primer connection, 8 inches deep, slotted grate, anti-splash bottom dome strainer.
 - a. Manufacturer and Model:
 - 1) Zurn – Model Z1901
 - 2) Josam
 - 3) J.R. Smith

2.7 SUPPLY AND DRAIN BOX

- A. Supply and Drain Box SD-1: White powder coated metal supply and drain box with ¼ turn lever handle ball valves with ¾ inch threaded vacuum breaker hose connections and threaded 2 inches centered drain outlet; hot and cold water to be supplied from the top (Burt Hill Project 08082.00 – June 26, 2009, Baldwin Wallace University, Thomas Family Science and Innovation Renovation and Addition)
 - a. Manufacturer:
 - 1) Guy-Gray

PART 3: EXECUTION

3.1 GENERAL

- A. Provide plumbing fixtures in a secure, true, plumb and symmetrical manner. Thoroughly clean each fixture after installation and leave in proper working order, absolutely solid in their respective positions. For sinks and lavatories, verify clockwise rotation for cold water stem and counterclockwise rotation for hot water stem while facing respective stems.
- B. Water supply piping serving flush valves for water closets, urinals and associated accessories shall be securely anchored within the construction at each exit point to ensure that flush valves, equipment and accessories shall be absolutely rigid with no movement in supply pipes.
- C. When fixture trim is completed, adjust stops to provide proper flow through each valve or faucet.
- D. Each fixture shall be filled with water and checked for leaks and retarded drainage.
- E. Flush valves, loose key or wheel handle stops, valves and similar devices shall be adjusted and balanced to provide first class operation of the various systems.
- F. Floor-mounted fixtures shall not be installed until finished floor is in place.
- G. Where any plumbing fixture comes in contact with the wall, seal with a non-shrink, mildew-resistant caulking.
- H. Provide waterproofing of floor drains as required by local codes. Flashing material shall extend a minimum of 18 inches from the center of the floor drain in all directions.
- I. Installation of handicapped plumbing fixtures shall meet requirements of ADA.
- J. Provide final connection and install fixtures and equipment furnished by others.

END OF SECTION 224000

SECTION 224500 – LABORATORY PLUMBING FIXTURES AND TRIM

PART 1: GENERAL

- 1.1 Provided sink trap as indicated on drawings and as specified herein.
- 1.2 Provide sink supply pipes as indicated on drawings and as specified herein.
- 1.3 Provide laboratory plumbing fixtures as indicated on the drawings and specified herein.
- 1.4 All lab sinks shall include an ASSE 1070 mixing valve piped below the sink or behind a Contractor provided access panel in the pipe chase. Valve shall be ½ inch, Honeywell Series Am or equal.

1.5 SUMMARY

A. This section includes the following:

1. Traps
2. Supply Pipes
3. Laboratory Stations
4. Laboratory Fume Hoods
5. Emergency Showers
6. Emergency Eye/Face Wash

PART 2: PRODUCTS

2.1 TRAPS

- A. For laboratory sinks not provided with traps, provide an adjustable P-trap of the same size as fixture tailpiece or 1-½ inches whichever is greater. P-traps shall be chemical resistant tubing outlet with cleanout plug, wall flange, and slip joint inlet.**
 - 1. Manufacturer and Model (Polypropylene – Mechanical Joint):**
 - a. Orion – Model RBP
 - b. Zurn
 - c. Enfield
 - 2. Manufacturer and Model (Polypropylene – Fused Joint):**
 - a. Orion – Model RBP
 - b. Zurn
 - c. Enfield

3. Manufacturer and Model (PVDF – Mechanical Joint):

- a. Orion – Model RBP
- b. Zurn
- c. Enfield

4. Manufacturer and Model (PVDF – Fused Joint):

- a. Orion – Model RBP
- b. Zurn
- c. Enfield

B. Exposed piping, fittings, escutcheons, valves, etc. shall be chrome-plated brass.

2.2 SUPPLY PIPES

A. Supply pipes for sinks shall be ½ inch IPS by ¾ inch OD angle valve with loose key handle, flexible tubing, and cast brass escutcheon with set screw.

1. Manufacturer and Model:

- a. Zurn Z8855WLLK-PC

2.3 PLUMBING FIXTURES

A. Laboratory Stations

1. Laboratory Station, LS-1, LS-2 and LS-3: Laboratory stations provided under another division. Under this Division provide: P-Trap, supply pipes, rough-in and final connection.

B. Laboratory Fume Hoods

1. Laboratory Fume Hood, FH-1, FH-2 and FH-3: Laboratory fume hood provided under another division. Under this division provide: P-trap, supply pipes, vacuum breakers, rough-in and final connection.

C. Emergency Fixtures

- 1. Emergency Shower ES-1: Emergency showers provided under another division. Under this division provide: supply pipes, rough-in and final connection.
- 2. Emergency Eye/Face Wash, EW 1: Emergency eye/face wash provided under another division. Under this division provide: supply pipes, rough-in and final connection.

D. Gas Outlets

1. Gas Outlets G-1: Gas outlets provided under another division. Under this division provide: supply pipes, rough-in and final connection.

PART 3: EXECUTION

3.1 GENERAL

- A. Thoroughly clean each fixture after installation and leave in proper working order, absolutely solid in their respective positions. For sinks, verify clockwise rotation for cold water stem and counterclockwise rotation for hot water stem while facing respective stems.
- B. When fixture trim is completed, adjust stops to provide proper flow through each valve or faucet.
- C. Stops, valves and similar devices shall be adjusted and balanced to provide first class operation of the various systems.
- D. Provide final connection and install fixtures and equipment furnished by others

END OF SECTION 224500

SECTION 226313 – LABORATORY GAS PIPING

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- 1.2 Laboratory gas piping which connect to plumbing fixtures, equipment, components and associated appurtenances as indicated under another division's drawings or specifications shall be provided with rough-in and final connection.
- 1.3 Plumbing Contractor shall coordinated exact location of rough – in and final connection prior to installation.
- 1.4 Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- 1.5 Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.
- 1.6 Provide laboratory compressed air piping, specialties, and equipment as shown on the drawings and specified herein.

1.7 SUMMARY

A. This section includes the following:

1. Laboratory natural gas piping – Interior
2. Laboratory Air piping – Interior

PART 2: PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL SCHEDULE

A. Laboratory Gas and Air Systems: Shall be constructed of the following materials, subject to approval by authorities having jurisdiction.

1. Natural Gas (G) Piping and Air (A) Piping:
 - a. Interior Pipe: Schedule 40 black steel – ASTM A53, ASTM A106, ASME B36.10
 - b. Fittings: Schedule 40 black steel – ANSI B16.3
 - c. Joints: Interior piping 2 inches and smaller, threaded cast iron – ASME B1.20.1
 - d. Interior piping larger than 2 inches, welded cast iron – ANSI B16.3
 - e. Manufacturer:
 - 1) Anvil, Tyco
2. Air (A) Piping:
 - a. Interior Pipe: Copper Tubing – Interior piping 2 inches and smaller

Remarks: Welding shall be performed by a certified welder, provided in accordance with manufacturer's requirements. All pipe fittings and valves in this system shall be factory cleaned, purged and sealed and labeled "for clean service piping systems", provided in accordance with manufacturers requirements.

2.2 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, components, and equipment for the various plumbing piping systems shall meet the following pressure requirements:

	Maximum Operating Component Pressure	Plumbing Piping System Operating Pressure
Laboratory Air	50	125
Natural Gas	14"	125

PART 3: EXECUTION

3.1 GENERAL

- A. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.
- B. Piping connections to plumbing fixtures and equipment shall be provided with offsets, unions, and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- C. Converging or diverging Bullheaded Tee's are not permitted in piping systems.
- D. Where connection to existing systems occurs, do not make connection until tests are complete.
- E. Provide a gas verification for each outlet as per NFPA 99. Verification shall include verification of proper gas for each outlet. All outlets shall be flowed at 100 liters per minute to check for dirt.
- F. Outlet locations shall be field checked by the Architect before actual installation begins.
- G. Gas systems shall be installed and tested in strict accordance with NFPA 99.
- H. Refer to architectural drawings for manifold locations.

3.2 INSTALLATION AND TESTING

A. Installation Procedures

- 1. Piping, fittings, and other components for gas supply shall be prepared at a facility equipped to clean the material in accordance with provisions of CGA Pamphlet G-4.1 titled "Cleaning Equipment for Oxygen Service". Materials shall be delivered, capped, or plugged to the job site. Materials shall be uncapped just prior to installation and inspected. If required, material shall be re-cleaned in accordance with NFPA 99, Chapter 4.
 - a. Prior to installation, remove any burrs or loose material encountered from removing caps or plugs.
 - b. While being brazed, the interior of pipe and joints shall be continuously purged with dry nitrogen to prevent scaling. After brazing, system shall be charged with nitrogen until testing.

B. Testing Procedures

- 1. Take all due precautions to prevent damage to the building and its contents that may be incurred by such tests; repair or make good any damage caused by the tests.

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2. Tests shall apply full test pressure to the piping for a sufficient period of time to detect leaks and defects.
3. If delicate control mechanisms, not including control valves, are installed in the piping, they shall be removed to prevent shock damage.
4. The section of piping to be tested shall be brought up to the specified test pressure. If the test pressure falls more than the specified amount during the test period, the point of leakage shall be found, repaired and the test repeated. This procedure shall be repeated until the piping system has been proved absolutely tight.
5. Leaks shall be repaired by removing the valve, fitting, joint or section that is leaking and reinstalling new materials and joints as specified. Use of mastic or “no-leak” compounds or other temporary means of repairing leaks shall not be permitted.
6. Test piping with dry nitrogen. Source of nitrogen shall be removed during test.
7. Maintain pressure for twenty-four (24) hours or until testing is complete. Apply soap suds to fittings and connections to check for leaks. Soap suds is the only acceptable test solution. Other types of solutions are not acceptable.
8. Complete connection of all system components. Pressurize systems to 20 percent above working pressure. Maintain pressure for twenty-four (24) hours. System shall remain leak-free without pressure drop for the entire period. If pressure drops, find and repair leak(s) and retest.
9. Systems shall be purged and analyzed in accordance with NFPA 99. Provide the services of an independent laboratory for system testing and analyzing.

END OF SECTION 226313

SECTION 226319 – LABORATORY GAS PIPING SPECIALTIES

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Plumbing Contractor shall coordinated exact location of rough – in and final connection with architectural drawings prior to installation.
- B. Provide laboratory gas, specialties, and equipment as shown on the drawings and specified herein.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Laboratory outlets
 - 2. Installation and Testing

PART 2: PRODUCTS

2.1 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Components, and equipment for the various plumbing piping systems shall meet the following pressure requirements:

	Maximum Operating Component Pressure	Plumbing Piping System Operating Pressure
Natural Gas	4 – 14”	125
Laboratory Air	50	125

2.2 LABORATORY OUTLETS

- A. Deck or Wall Mounted – G-1:
 - 1. Outlets for natural gas provided in another division
 - 2. Provide piping, valves etc. as required, install and make final connections

PART 3: EXECUTION

3.1 GENERAL

- A. Provide a gas verification for each outlet as per NFPA 99. Verification shall include verification of proper gas for each outlet. All outlets shall be flowed at 100 liters per minute to check for dirt.
- B. Gas systems shall be installed and tested in strict accordance with NFPA 99.

3.2 INSTALLATION AND TESTING

A. Installation Procedures

1. Laboratory outlets, regulators, and equipment shall be installed in accordance with NFPA 99, Standards for Health Care Facilities and NFPA 50, Standards for Bulk Oxygen Systems at Consumer Sites.
2. Provide regulators as required to suit system requirements. Vent regulators to the atmosphere.

B. Testing Procedures

1. Take all due precautions to prevent damage to the building and its contents that may be incurred by such tests; repair or make good any damage caused by the tests
2. Tests shall apply full test pressure to the piping for a sufficient period of time to detect leaks and defects.
3. Leaks shall be repaired by removing the valve, fitting, joint or section that is leaking and reinstalling new materials and joints as specified. Use of mastic or “no-leak” compounds or other temporary means of repairing leaks shall not be permitted.
4. Apply soap suds to fittings and connections to check for leaks. Soap suds is the only acceptable test solution. Other types of solutions are not acceptable.
5. Systems shall be purged and analyzed in accordance with NFPA 99. Provide the services of an independent laboratory for system testing and analyzing.

END OF SECTION 226319

SECTION 226653 – LABORATORY WASTE AND LABORATORY VENT PIPING

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Laboratory waste and laboratory vent systems which are provided to serve laboratory equipment, components, and associated appurtenances shall be located within 5 feet of equipment drain point.
- B. Laboratory waste and laboratory vent systems which connect to plumbing fixtures, equipment, components and associated appurtenances as indicated under another divisions drawings or specifications shall be provided with rough-in and final connection. Plumbing Contractor shall coordinated exact location of connection prior to installation.
- C. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- D. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Laboratory Waste Piping – Below Grade
 - 2. Laboratory Vent Piping – Below Grade
 - 3. Laboratory Waste Piping – Interior
 - 4. Laboratory Vent Piping – Interior
 - 5. Installation and Testing

PART 2: PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL SCHEDULE

- A. Laboratory waste and laboratory vent systems shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
 - 1. Laboratory Waste (LW) Piping – Below Grade
 - a. Pipe: Schedule 40 Polypropylene – ASTM F1412
 - b. Fittings: Polypropylene drainage style – ASTM F1412
 - c. Joints: Socket fusion
 - d. Manufacturer:
 - 1) Enfield
 - 2) George Fisher
 - 3) Zurn
 - 4) Orion

Remark: Provide in accordance with manufacturers requirements.

2. Laboratory Waste (LW) Piping – Interior Piping
 - a. System located above food service preparation areas or areas associated with food sales shall be provided with a secondary means of containment in the event of a leak. Provide in accordance with manufacturers requirements.
3. Laboratory Vent (LWV) Piping – Below Grade
 - a. Pipe: Schedule 40 Polypropylene – ASTM F1412
 - b. Fittings: Polypropylene drainage style – ASTM F1412
 - c. Joints: Socket fusion
 - d. Manufacturer:
 - 1) Enfield
 - 2) George Fisher; Zurn
 - 3) Orion

Remark: Provide in accordance with manufacturers requirements

4. Laboratory Vent (LWV) Piping – Interior Piping
 - a. Pipe: Schedule 40 Polypropylene – ASTM-F1412
 - b. Fittings: Polypropylene drainage style – ASTM-F1412
 - c. Joints: Mechanical threaded or electric fusion
 - d. Manufacturer:
 - 1) Enfield:
 - 2) George Fisher
 - 3) Zurn
 - 4) Orion

Remarks: Provide in accordance with manufacturers requirements

2.2 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, and components, for the laboratory waste and laboratory vent piping systems shall be capable of withstanding the following:

Plumbing Piping System Minimum Working Pressure	
Laboratory Waste	10 feet head of water
Laboratory Vent	10 feet head of water

PART 3: EXECUTION

3.1 GENERAL

- A. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.
- B. Piping passing through roof construction shall be arranged to provide a minimum of 12 inches clearance from walls or other obstructions so as to permit proper flashing. Set pipe flashing fittings at a suitable level above the roof to permit proper termination of flashing.

3.2 INSTALLATION AND TESTING

A. Installation Procedures

1. Laboratory waste piping 2-½ inches and smaller shall be sloped at a minimum pitch of ¼ inch per foot.
Laboratory piping 3 to 6 inches shall be sloped at a minimum pitch of ⅛ inch per foot in direction of flow.
Laboratory piping 8 inches or larger shall be sloped at a minimum pitch of 1/16 inch per foot.
Connections to stacks or main drains shall be made in a manner that shall not permit backflow.
2. Laboratory vent piping shall be arranged to drain any condensate back to drainage piping.
3. Provide test tees in vertical risers as required to permit testing in sections.
4. Cut and threaded pipe shall have the cutting burrs and sharp edges reamed out.
5. When connecting to existing laboratory waste system, clean out piping from tie-in to next downstream cleanout.

B. System Testing

1. The entire laboratory waste system and laboratory vent piping system shall be subjected to testing hydrostatic testing in accordance with applicable codes. Plumbing Contractor shall provide all equipment, material, labor and associated appurtenances necessary for drainage system testing.
2. The laboratory waste and laboratory vent piping systems shall be provided with two separate tests. The first test shall occur during the installation and the final test shall occur after the plumbing fixtures have been set and their traps filled with water. The entire laboratory waste and laboratory vent system shall be submitted to the final test.
3. Laboratory waste and laboratory vent piping systems testing during construction shall be provided by utilizing either water or air.

C. Water Test

1. A water test shall be applied to the laboratory waste and laboratory vent system either in its entirety or in sections. If applied to the entire system, all openings in the piping system shall be tightly closed, except the highest opening, and the system shall be filled to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test. The section shall be filled with no less than a 10 feet head of water.

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2. The water shall be kept in the system, or in a portion under test, for at least fifteen (15) minutes before inspection starts.
3. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building, except for the uppermost 10 feet of the system, shall have been submitted to a test of not less than a 10 feet head of water.

D. Air Test

1. An air test shall be applied to the laboratory waste and laboratory vent piping system either in its entirety or in sections. All openings in the piping system shall be tightly closed and the system shall be filled with air until there is a uniform gauge pressure of 5 pounds per square inch or a pressure sufficient to balance a 10 inch column of mercury. This pressure shall be held for a period of at least fifteen (15) minutes. Any adjustment to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

E. Final Test

1. The final test of the completed drainage and vent system shall be visual and in detail to determine compliance with the provisions of the Plumbing Code except that the systems shall be subject to a smoke test where necessary for cause.
2. Where a smoke test is utilized, it shall be made by filling all traps with water and then introducing into the entire drainage system a pungent, thick smoke produced by one or more smoke machines.
3. When smoke appears at the stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1 inch water column shall be held for a test period of not less than fifteen (15) minutes.

END OF SECTION 226653

SECTION 226683 – LABORATORY WASTE AND LABORATORY VENT SPECIALTIES

PART 1: GENERAL

1.1 LABORATORY WASTE NEUTRALIZATION SYSTEMS

- A. Provide laboratory neutralization system, laboratory waste specialties, and associated appurtenances as shown on drawings and as specified herein.

1.2 CLEANOUTS

- A. Provide cleanouts as required by local codes and authorities, as shown on the drawings, and as specified herein.

1.3 SUMMARY

- A. This section includes the following:
 - 1. Cleanouts
 - 2. Passive laboratory waste neutralization systems

PART 2: PRODUCTS

2.1 CLEANOUTS

- A. Cleanouts shall be full size of pipe up to 4 inches, and shall be 4 inches for larger sizes. Cleanouts on piping 6 inches and smaller shall be provided with a clearance of not less than 18 inches for rodding. Cleanouts on piping 8 inches and larger shall be provided with a clearance of not less than 36 inches for rodding.
- B. Cleanouts on concealed piping, piping under a floor slab, piping in a crawl space of less than 24 inches in height, or piping in a plenum shall be extended through and terminated flush with finished wall, floor, or ground surface.
- C. Horizontal laboratory waste piping within a building shall be provided with cleanouts located not more than 100 feet apart. Cleanouts shall also be provided at every change of direction greater than 45 degrees. Where more than one change of direction occurs in a run of piping, only one cleanout shall be provided for every 40 feet of developed length of piping.
- D. Building laboratory waste sewers shall be provided with cleanout located not more than 100 feet apart measured from the upstream entrance of the cleanout.
- E. Access doors and frames for cleanouts located behind walls shall be furnished by plumbing Contractor and installed by others. A complete list of wall cleanout locations and associated access panels shall be prepared by the plumbing Contractor prior to the erection of walls.
- F. Laboratory waste cleanouts shall be compatible with and provided by laboratory waste pipe manufacturer.

2.2 PASSIVE LABORATORY WASTE NEUTRALIZATION SYSTEM

- A. Neutralization Tank – NT-1

1. Provide tank constructed of high density, rigid polyethylene conforming to ASTM D1248 for polyolefin materials. Tank shall be provided with a removable cover and flat bottom. Tank shall have a 1-½ inches FIP inlet and outlet connection.
2. Tank shall have a minimum capacity of 1-½ gallons.
3. Tank to be installed in accordance with manufacturer's recommendations.
4. Manufacturer:
 - a. Orion Style 8 – 1-½ gallons
 - b. Enfield

B. Neutralization Tank – NT-2

1. Provide tank constructed of high density, rigid polyethylene conforming to ASTM D1248 for polyolefin materials. Tank shall be provided with a removable cover, built-in removable 3 inches diameter flanged inspection/sample port, and flat bottom. Tank shall be completely drainable from side bottom outlet connection.
2. Tank shall have a minimum capacity of 180 gallons.
3. Tank to be installed in accordance with manufacturer's recommendations.
4. Manufacturer:
 - a. Orion
 - b. Enfield.

C. Neutralization System Operation

1. Laboratory waste shall flow through neutralization tanks by gravity.
2. Neutralization system shall be capable of maintaining a pH level greater than five (5) and less than ten (10).
3. Each laboratory neutralization tank shall be provided with limestone chips for neutralization.

PART 3: EXECUTION

3.1 GENERAL

- A. All components of the laboratory waste system, including tanks, mounting assemblies, valves, piping, etc., shall be tested at the site under the supervision of the manufacturer's technical representative prior to startup.
- B. Neutralization tanks shall be interconnected with all drain and supply piping and control valves provided. All piping, valves, and other wetted components shall be of polypropylene construction. Components shall be mechanical joints.
- C. Install all products in accordance with manufacturer's instructions and the referenced sections of the specifications.
- D. Install neutralization tank level, with continuous support over the entire bottom.

SECTION 226713 – LABORATORY GRADE WATER PIPING

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Laboratory grade water systems which connect to plumbing fixtures, equipment, components and associated appurtenances as indicated under another division's drawings or specifications shall be provided with rough-in and final connection. Plumbing Contractor shall coordinate exact location of rough-in and final connection.
- B. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- C. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Reverse osmosis Water Piping Supply
 - 2. Reverse Osmosis Water Piping Return
 - 3. Installation and Testing
 - 4. Adjusting and Balancing

PART 2: PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL SCHEDULE

- A. Laboratory grade water systems shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
 - 1. Reverse Osmosis Water and Digital Input Water
 - a. Piping Pipe: Polyvinylidene Fluoride (PVDF) purity grade – ASTM E84, ASTM D2447
 - b. Fittings: Polyvinylidene Fluoride (PVDF) purity grade – ASTM E84, ASTM D2447
 - c. Joints: Socket fusion
 - d. Manufacturer:
 - 1) Enfield
 - 2) George Fisher
 - 3) Orion

Remarks: Provide in accordance with manufacturers requirements.

OR

2. Pipe: Schedule 40 natural polypropylene – ASTM D4101
 - a. Fittings: Schedule 40 natural polypropylene – ASTM D4101
 - b. Joints: Socket fusion
 - c. Manufacturer:
 - 1) Enfield
 - 2) George Fisher
 - 3) Zurn
 - 4) Chemtrol

Remarks: Do not provide in return air ceiling plenums. Provide in accordance with manufacturers requirements.

2.2 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, components, and equipment for the various plumbing piping systems shall meet the Manufacturer's pressure requirements.

PART 3: EXECUTION

3.1 GENERAL

- A. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.
- B. Piping connections to plumbing fixtures and equipment shall be provided with offsets, unions, and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- C. Pitch laboratory grade water piping up in direction of flow to ensure adequate flow without air binding and to prevent noise and water hammer. Branch connections to mains shall be made in such a manner as to prevent air trapping and prevent free passage of air.
- D. Converging or diverging bullheaded tees are not permitted in piping systems.
- E. Provide hose drain connections on downstream of floor main shut-off valves.

3.2 INSTALLATION AND TESTING

A. Installation Procedures

1. Laboratory grade water piping shall be arranged to drain to low points and to provide for air elimination at high points.
2. Mains, risers and branch connections to same shall be arranged to permit expansion and contraction without strain by means of elbow swings and/or expansion joints.
3. A riser control valve and drain valve shall be provided on each riser. Drain valve shall be located downstream of riser control valve on up feed risers.

4. Cut pipe shall have the cutting burrs and sharp edges reamed out.
5. In erecting pipe, friction wrenches shall be used exclusively and pipe cut, dented, or otherwise damaged, shall be replaced.

B. System Pressure Tests

1. The entire laboratory grade water system shall be tested to a hydrostatic pressure equal to 1-½ times the system normal operating pressure.
2. The water used for the pressure test shall be supplied from an independent water source. Water must be compatible with purified water system.
3. Take all due precautions to prevent damage to the building and its contents that may be incurred by such tests; repair or make good any damage caused by the tests
4. Tests shall apply full test pressure to the piping for a sufficient period of time to detect leaks and defects.
5. If delicate control mechanisms, not including control valves, are installed in the piping, they shall be removed to prevent shock damage.
6. The section of piping to be tested shall be brought up to the specified test pressure. If the test pressure falls more than the specified amount during the test period, the point of leakage shall be found, repaired and the test repeated. This procedure shall be repeated until the piping system has been proved absolutely tight.
7. Leaks shall be repaired by removing the valve, fitting, joint or section that is leaking and reinstalling new materials and joints as specified. Use of mastic or “no-leak” compounds or other temporary means of repairing leaks shall not be permitted.

C. Cleaning, Flushing, and Disinfections

1. Before being placed in operation, the water piping systems shall be cleaned, flushed and disinfected in strict accordance with system requirements.
2. Based on the volume of water in the storage tank and piping system, provide 50 percent hydrogen peroxide dilution to a 3 percent solution for disinfection.
3. Drain a sufficient amount of water from the storage tank to allow for the addition of the hydrogen peroxide. By-pass any equipment in the piping system that is not compatible with hydrogen peroxide (i.e. filters, carbon, and resin tank, etc.)
4. Using a suitable chemical transfer pump, add 50 percent hydrogen peroxide solution to the storage tank. Fill the remaining volume of the storage tanks with reverse osmosis water.
5. Turn on the distribution pump and allow a minimum thirty (30) minutes for the hydrogen peroxide concentration to equalize.
6. Starting on upper floors, open each faucet for several minutes to draw the hydrogen peroxide through the piping system and faucet. Using a hydrogen peroxide kit, test random faucets for the presence of hydrogen peroxide. If hydrogen peroxide is not present, continue drawing water from the faucets until peroxide is detected. Do not use more than 10 percent of the water from the storage tank.

7. Let the hydrogen peroxide solution from the piping system and the storage tank for at least two (2) hours.
8. Drain hydrogen peroxide solution from the piping system and storage tank.
9. Refill the piping system and storage tank with reverse osmosis water and start flushing the system by opening all faucets in piping system.
10. Using a hydrogen peroxide kit, check random faucets for the presence of hydrogen peroxide. Continue to flush faucets until no hydrogen peroxide residual is present.

3.3 ADJUSTING AND BALANCING

- A. After completion of the installations and prior to acceptance by the Owner, laboratory grade water systems and appurtenances shall be adjusted and balanced to deliver the water quantities as specified, indicated on the drawings, or as directed. Modify pumps and/or controls to produce design flow.
- B. Pump capacities shall be determined by differential pressure measurements. Pump balancing valves shall be adjusted to provide the lowest discharge pressure possible while maintaining flow to all devices.
- C. Laboratory grade water circuits shall be adjusted by calibrated balancing valves provided as part of the installation, and calibrated balancing valves shall be permanently marked after final balance is complete so that they may be returned to their correct position if disturbed.
- D. The following data shall be recorded for each laboratory water system:
 1. Pump motor current and voltage
 2. Entering and leaving water flow rates, temperatures and pressures
 3. Differential pressure across pumps

END OF SECTION 226713

SECTION 226718 – LABORATORY WATER PIPING SPECIALTIES

PART 1: GENERAL

1.1 LABORATORY BACKFLOW PREVENTERS

- A. Provide backflow preventers as required by local codes and authorities, as shown on the drawings, and as specified herein.

1.2 LABORATORY WATER PRESSURE REDUCING

- A. Provide water pressure reducing valve as indicated on drawings and as specified herein.

1.3 EMERGENCY TEPID WATER MIXING VALVE

- A. Provide laboratory emergency water mixing valve as indicated on drawings and as specified herein.

1.4 SUMMARY

- A. This section includes the following:
 - 1. Laboratory Backflow Preventers
 - 2. Laboratory Water Pressure Reducing Valves
 - 3. Emergency Tepid Water Mixing Valves

PART 2: PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers for piping 2 ½ to 10 inches: ASSE 1013, suitable for continuous application. Provide shut off valves on inlet and outlet; test cocks; and pressure-differential relief valve with air-gap fitting located between two positive-seating check valves. Provide with non-rising stem resilient. Seated gate valve shut off.
 - 1. Manufacturer and Model:
 - a. Wilkins
 - b. Apollo
- B. Dual Check Backflow Preventers for piping ½ inch to ¾ inch: ASSE 1012, suitable for continuous pressure application. Provide with inlet screen, two independent check valves, and atmospheric vent.
 - 1. Manufacturer and Model:
 - a. Wilkins
 - b. Apollo

- C. Anti-siphon Vacuum Breakers for piping ¼ inch to 3 inches: ASSE 1001, with floating disk and atmospheric vent.
 - 1. Manufacturer and Model:
 - a. Wilkins
 - b. Apollo

2.2 LABORATORY WATER PRESSURE REDUCING VALVE

- A. Laboratory water pressure reducing valves shall be full size unless otherwise indicated.
- B. Provide pressure reducing valve with strainer conforming to ASSE 1003. Pressure reducing valve shall be capable of reducing water pressure within building to 80 pounds per inch static or less. Pressure reducing valve shall provide constant downstream pressure regardless of flow rate or inlet pressure.
- C. Laboratory water pressure reducing valves shall be full size of water pipe to which it connects
 - 1. Pipe sizes ½ inch through ¾ inch shall be provided with integral strainer and have an adjustable pressure range from 25 to 75 pounds per inch.
 - a. Manufacturer and Model:
 - 1) Wilkins
 - 2) Apollo
 - 2. Pipe sizes 1-¼ inches through 12 inches shall be automatic diaphragm actuated, pilot controlled, hydraulically operated.
 - a. Manufacturer and Model:
 - 1) Wilkins
 - 2) Apollo

2.3 EMERGENCY TEPID WATER MIXING VALVE – TWV-1

- A. Emergency tepid water mixing valve shall employ two (2) fully independent control mechanisms which split the water flow in half, blend each half to the design temperature and then integrates each stream at the outlet. The valve shall control outlet temperature over a wide range of flow and shall be suitable for deluge emergency showers and/or emergency eyewashes applications.
- B. Emergency tepid water mixing valve shall include three thermometers to measure the temperature of each stream and the merged flow. Temperature adjustment shall be vandal resistant.
- C. Each independent control mechanism shall employ a liquid-filled thermostatic motor to drive the valve. Each control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass.
- D. In the event of interruption of the cold water supply, each control mechanism shall close off the hot water port, stopping all flow.

- E. In the event of interruption of the hot water supply, each control mechanism shall allow cold flow through both the fixed and variable by-pass.
- F. In the event that one liquid motor fails, the control mechanism shall close off the hot water port with the reverse seat and shall fully open the internal variable bypass to allow cold water flow. The other control mechanism shall be unaffected by the failure and shall maintain design temperature.
- G. Tepid emergency water mixing valve shall meet ANSI Standard Z358.1 – 1998. It shall be capable of providing 38 GPM of water at 65 to 95 degrees Fahrenheit at 15 pounds per inch pressure drop.
 - 1. Manufacturer and Model:
 - a. Guardian – G3802
 - b. Lawler
 - c. Speakman

PART 3: EXECUTION

3.1 LABORATORY BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow: Preventers shall be provided at building water supply pipe after the water meter, at boiler make-up water line, at cooling tower connections, at chemical feed makeup systems, and all cross-connections subject to back pressure or back siphonage.
- B. Dual Check Backflow: Preventers shall be provided at supply pipe to beverage machines and at cross-connections subject to back pressure or back siphonage.
- C. Anti-siphon Vacuum Breakers: Breakers shall be installed at supply pipe to glassware washers, laboratory fume hoods, and at all cross-connections not subject to back pressure or continuous pressure. Install at least 6 inches above fixture rim.

END OF SECTION 226718

SECTION 226719 – LABORATORY GRADE WATER PIPING SPECIALTIES

PART 1: GENERAL

1.1 REVERSE OSMOSIS WATER SYSTEM

- A. Provide reverse osmosis water system as indicated on drawings and as specified herein.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Reverse Osmosis water systems

PART 2: PRODUCTS

2.1 REVERSE OSMOSIS WATER SYSTEM – RO-1

- A. Reverse Osmosis Water System shall be a packaged system with all components provided by one water system manufacturer. The water system manufacturer shall provide all controls, equipment, pumps, piping, valves, wiring, devices, controller, and associated appurtenances required to complete the system. The water system manufacturer shall also provide complete installation drawings and diagrams defining all required piping, wiring, and control work by the plumbing Contractor.
- B. Upon successful installation and start-up of the reverse osmosis water system, the manufacturer shall provide documentation demonstrating that the reverse osmosis water system meets the following criteria.
 - 1. Resistivity: Reverse osmosis quality
 - 2. Bacteria: Less than 10 colony-forming units per milliliter (cfu/ml)
- C. The central reverse osmosis water treatment system shall consist of a pre-treatment water softener, a reverse osmosis unit with integral storage tank, a building loop distribution variable speed pump and all associated pipe and fittings with a capacity of 225 gallons per 10 hours at 50 degrees Fahrenheit feed water.
- D. The water softener system shall remove particulates, suspended solids, organics, and colloids and have the capacity of 350 gallons per day at a minimum flow rate of 25 gallons per minute with regeneration on a seven day cycle. Culligan Soft-Minder Twin Model SMF-185 digital demand or equal.
- E. Piping, valves, and fitting shall be manufactured of pressure rated pigmented polypropylene with socket type joints with an interface fit. Ball valves shall be provided with true unions and ultraviolet inhibitors shall be provided in the piping to prevent UV destruction.
- F. System
 - 1. Reverse Osmosis Unit
 - a. The reverse osmosis unit shall be capable of producing 225 gallons per day of reverse osmosis grade water at 50 degrees Fahrenheit feed water temperature.
 - b. The reverse osmosis system shall be a completely self-contained water treatment system, pre-wired and pre-plumbed.

- c. The reverse osmosis unit shall have an integral 115 gallons tank, a loop flow rate of up to 10 gallons per minute, 70 gallons per hour reverse osmosis membrane and inlet boost pump with pre-filter pump protection, 0.2 um filter to maintain water quality in loop, composite vent filter, system monitoring control panel with contacts for connection to the building monitoring system, UV photo oxidation and a variable speed loop building distribution pump.
 - d. The RO unit shall be UL listed.
- 2. Interconnecting Piping and Valves
 - a. Pipe, valves, and fittings shall be manufactured of pressure rated pigmented polypropylene with ultraviolet inhibitors.
 - b. Polypropylene pipe shall be manufactured from a Group 1, Class 2 beta nucleated homopolymer material meeting the requirements of ASTM D 4101.
 - c. Polypropylene materials shall comply with FDA guidelines and shall be suitable for contact with foodstuff and pharmaceutical use.
 - d. Polypropylene ball valves shall be true union type.
- 3. Startup and Commissioning
 - a. Startup shall include:
 - 1) One (1) eight (8)-hour training course to instruct the Owner as to the operation and required maintenance of the system.
 - 2) Fill brine tank with enough salt for nine (9) regenerations.
 - 3) Run pre-treatment through all regeneration and backwash cycles.
 - 4) Run RO through all level scenarios. Demonstrate that all alarms are operational and programmable controller is accurately displaying and storing all operating parameters.
 - 5) Run post-treatment equipment and demonstrate that post-treatment equipment is fully operational.
 - b. Disinfect integral piping assemblies, distribution piping system, and storage.
 - c. Manufacturer shall provide documentation to demonstrate that the system was installed, operates, and performs to the design specifications. An O&M manual describing the various operation and maintenance of all components of the water system will be provided as well. The manual shall be in binder form with major sections divided appropriately for easy use.
- 4. Manufacturer:
 - a. Siemens
 - b. Western Reserve
 - c. Hydro Service and Supplies

PART 3: EXECUTION – NOT USED

END OF SECTION 226719

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SECTION 227013 – NATURAL GAS PIPING

PART 1: GENERAL

1.1 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Natural gas piping which connects to plumbing fixtures, equipment, components and associated appurtenances as indicated under another division's drawings or specifications shall be provided with rough-in and final connection. Plumbing Contractor shall coordinated exact location of rough – in and final connection.
- B. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- C. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Natural gas Piping – Interior
 - 2. Installation and Testing

PART 2: PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL SCHEDULE

- A. Natural gas piping shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
 - 1. Natural Gas (G) Distribution Piping – Interior
 - a. Pipe: Schedule 40 black steel – ASTM A53, ASTM A106, ASME B36.10
 - b. Fittings: Schedule 40 black steel – ANSI B16.3
 - c. Joints: Interior piping 2 inches and smaller, threaded – ASME B1.20.1
Interior piping larger than 2 inches, welded – ANSI B16.3
 - d. Manufacturer:
 - 1) Anvil International
 - 2) Wheatland Tube
 - 3) Grinnell

Remarks: Welding to be performed by a certified welder. Provide in accordance with manufacturers requirements. Gas Trac piping is acceptable.

2.2 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, components, and equipment for the various plumbing piping systems shall meet the following pressure requirements:

Operating Pressure Component Pressure	Plumbing Piping System Range (wc)	Rating (psi)
Natural Gas (Downstream of gas meter/regulator)	4 – 14 inches water	125 column

PART 3: EXECUTION

3.1 GENERAL

- A. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points, and connected equipment.
- B. Piping connections to plumbing fixtures and equipment shall be provided with offsets, unions, and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- C. Converging or diverging bullheaded tees are not permitted in piping systems.

3.2 INSTALLATION AND TESTING

A. Installation Procedure

- 1. Piping shall be installed without pockets, with drips at low points and with valves at each outlet.
- 2. Final connections shall be made to pieces of equipment.
- 3. Right and left nipples shall not be used in lieu of unions.
- 4. Complete gas service connections to gas utility mains with service extensions into buildings, piping, valves, metering and pressure regulation in accordance with utility company requirements.
- 5. Provide plug valves at gas piping risers and main control points.
- 6. Provide gas cocks at gas equipment and appliances.

B. System Inspection

- 1. Every third weld in the gas riser piping shall be x-ray inspected in accordance with the gas company requirements. The results of the tests shall be forward to the gas company and to the Architect.

C. System Testing

- 1. Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the test period. The source of pressure shall be isolated before the pressure test is made.
- 2. Test pressure shall not be less than 1 ½ times the working pressure, but no less than 3 pounds per square inch gauge, irrespective of design pressure. Testing duration shall not be less than ½ hour for each 500 cubic feet of pipe volume or fraction thereof.

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DIVISION 22 – PLUMBING

3. Final tests shall be conducted in the presence of and to the satisfaction of the Architect and inspectors of any and all authorities having jurisdiction, including the gas company, who shall be notified a minimum of forty-eight (48) hours in advance of same. Preliminary testing shall be completed prior to such notification.
4. While subjected to the test pressure, the piping system shall be visually examined for signs of leakage or other defects. Exposed joints shall be checked by means of a soap bubble test or other foaming agent test. Any reduction to test pressure measured by the gauge during the testing period shall be deemed to indicate the presence of a leak unless such reduction can be readily attributable to some other cause.
5. Test records shall be maintained during the testing and shall confirm that piping has been pressure tested as specified above.
6. Purging of piping shall be accomplished in accordance with the provisions contained in USAS-Z-83.

END OF SECTION 227013

SECTION 230000 – Section Index

230000	GENERAL HVAC PROVISIONS
230500	COMMON WORK FOR HVAC
230513	COMMON MOTOR REQUIREMENTS FOR HVAC
230516	EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING
230519	METERS AND GAGES
230523	GENERAL DUTY VALVES FOR HVAC
230529	HANGERS AND SUPPORTS FOR HVAC
230530	ADJUSTABLE FREQUENCY DRIVES
230531	MOTOR CONTROLLERS
230533	ELECTRIC HEAT TRACE
230548	VIBRATION CONTROLS
230553	IDENTIFICATION FOR HVAC
230593	TESTING, ADJUSTING, AND BALANCING
230700	HVAC INSULATION
230900	INTEGRATED AUTOMATION CONTROL SYSTEM
230901	CONTROL SEQUENCES OF OPERATION
231123	NATURAL GAS PIPING
232113	HVAC PIPING
232123	HYDRONIC PUMPS
232213	STEAM AND CONDENSATE PIPING
232223	STEAM CONDENSATE PUMPS
232233	STEAM SPECIALTIES
232243	STEAM PIPING INSULATION
232253	STEAM VAULTS
232300	REFRIGERANT PIPING
232301	REFRIGERANT
232500	HVAC WATER TREATMENT
233113	HVAC DUCTS
233300	DUCT ACCESSORIES
233416	HVAC FANS
233600	AIR TERMINAL UNITS
233713	DIFFUSERS, REGISTERS, AND GRILLES
234100	PARTICULATE AIR FILTRATION
236416	CHILLERS
236500	CLOSED CIRCUIT COOLING TOWERS
237313	MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS
238146	WATER SOURCE UNITARY HEAT PUMPS
238147	ENERGY RECOVERY HEAT PUMPS
238239	ELECTRIC HEATERS
238413	HUMIDIFIERS

SECTION 230000 – GENERAL HVAC PROVISIONS

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1, Specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following:
 1. Scope of Work
 2. Intent of Drawings
 3. Definitions
 4. General Standards of Materials
 5. Products and Substitutions
 6. Applicable Codes
 7. Guarantees and Certificates
 8. Quiet Operation and Vibration Control
 9. Temporary Shutdown of Existing Systems
 10. Coordination
 11. Shop Drawings, Product Data, and Samples
 12. Owner Instruction
 13. Class I and Class II Substances

1.3 SCOPE OF WORK

- A. The scope of the work included under Division 23 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid, except where there is specific reference to exclusion and incorporation in other quotations.
- B. A brief written Scope of Work appears in Division 1.

1.4 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform to accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this Contractors work.

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DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

- B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, valves, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the Owner.
- C. These documents may not explicitly disclose final details required for a complete systems installation; however, Contractors shall possess the expertise to include the necessary appointments of complete operating systems.
- D. Contractors shall be “Experienced” (as defined in Division 1) in this type of construction and realize the extent of the work required.

1.5 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. Finished Space: Space other than mechanical rooms, electrical rooms, pipe chases, unheated spaces immediately below roof, space above finish ceilings, crawl spaces, utility service tunnels, and interstitial spaces.
 - 2. Conditioned Space: Space directly provided with heating and cooling.
 - 3. Unconditioned Space: Space without heating or cooling including ceiling plenums.
 - 4. Indoors: Space located inside the exterior walls and roof of the building.
 - 5. Outdoors: Space located outside the exterior walls and roof of the building.
 - 6. Atmosphere: The same as outdoors.

1.6 GENERAL STANDARDS OF MATERIALS

- A. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years.
- B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.7 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the contract sum shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

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DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

- B. Where several manufacturers' products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.
- C. Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are submitted, the Contractor shall agree to accept a unilateral change order that includes additional costs incurred by the Owner for the Architect's and other Contractors review of submissions, redesign, and system and/or structure modifications required by the use of that product.
- D. It is the intent of these specifications that service organizations such as balancing agencies follow the above substitution procedures.

1.8 APPLICABLE CODES

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 1, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

1.9 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.
 - 1. Unless specifically indicated otherwise, the duration of the guarantee period shall be in accordance with the provisions of Division 1, however temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered beneficial use and thus not part of the warranty period.

1.10 QUIET OPERATION AND VIBRATION CONTROL

- A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.
- B. The sound pressure levels around mechanical and electrical equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 decibels A-weighting at any point 3 feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.11 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.

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- B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.
- C. Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.12 COORDINATION

- A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Coordination drawings shall be prepared as defined in Division 1. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.
- C. Coordination drawings shall be developed from individual system shop drawings and Contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.
- E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2) percent of this Contract Amount.

1.13 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 1.
- B. The following shall be submitted by the Contractor for review:
 - 1. To-scale shop drawings showing system components with sizing indicated, including but not limited to:
 - a. Equipment locations and service clearance requirements; include weights at each hanger or support
 - b. Piping and ductwork, including accessories and appurtenances
 - c. Insert and sleeve locations
 - d. Hangers, anchors and guides
 - e. Expansion joints and loops
 - f. Access doors

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2. Product data for system components and materials (including construction standards).
 3. Samples of finishes and trim exposed to view, such as finishes on diffusers, grille, registers, exposed ductwork and equipment in finished spaces, and similar items.
- C. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of these items shall be a minimum of one (1) percent of this Contract Amount.

1.14 OWNER INSTRUCTION

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 40 hours. This duration shall be considered in addition to the training periods separately specified by Division 23, Section 230530: Adjustable Frequency Drives and Section 230900 – Integrated Automation Control System. The instruction periods for each training topic shall be broken into segments at the discretion of the Owner.
1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one week prior to conducting same.
 2. Forward to the Architect the signatures of all those present for the instruction periods.

1.15 CLASS I AND CLASS II SUBSTANCES

- A. All equipment containing Class I or Class II substances as identified by the Clean Air Act of 1990 shall be manufactured in strict accordance with that act and its amendments.
- B. All work involving Class I or Class II substances as identified by the Clean Air Act of 1990 shall be performed in strict accordance with that act and its amendments.

PART 2: PRODUCTS

1. York is not a preferred manufacturer of Baldwin Wallace University.

PART 3: EXECUTION – NOT USED

END OF SECTION 230000

SECTION 230500 – COMMON WORK FOR HVAC

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Excavating and Backfilling
 - 2. Waterproofing
 - 3. Air Plenums
 - 4. Electrical Connections
 - 5. Accessibility
 - 6. Painting
 - 7. Equipment Foundations, Supports, Piers, and Attachments
 - 8. Equipment Guards and Rails
 - 9. Cleaning, Protection and Adjustment
 - 10. Special Tools
 - 11. Welding
 - 12. Enclosed Switches (Disconnect Switches)

1.3 EXCAVATING AND BACKFILLING

- A. Excavate and backfill as required for the installation of underground work under this division. Comply with all applicable Division 31 requirements.
- B. No backfilling shall be done on any mechanical system requiring testing or inspection until such testing or inspection has been completed satisfactorily.
- C. Remove from the site surplus excavated materials resulting from work. Surplus excavated materials include materials not suitable for use as backfill.
- D. Notify utility companies and state “one-call” system for verification of underground utilities before any excavation takes place.

1.4 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

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DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

1.5 AIR PLENUMS

- A. In plenums which are used as part of an air distribution system as defined by NFPA, materials must be of the type rated for air plenum use. The Contractor shall be responsible to utilize the correct materials in ceiling space used for environmental air purposes.

1.6 ELECTRICAL/MECHANICAL COORDINATION

- A. Regardless of voltage, provide control wiring, interlock wiring, and equipment control wiring for the equipment provided under Division 23.
- B. Division 23 shall furnish electrical disconnect switches, variable frequency drives (VFDs/VSDs), contactors and relays, manual starters, magnetic starters and combination starter disconnects required for equipment operation and control for equipment provided under this division of the specifications. Circuit breakers furnished shall be rated for motor protection.
- C. Unless specifically noted otherwise, field-provided power wiring not used for control functions, complete from power source to motor, equipment junction box or disconnect switch, including power wiring through starters, shall be provided under Division 26.
- D. The Division 23 Contractor shall coordinate with the Division 26 Contractor to ensure that electrical devices furnished or provided are compatible with the electrical systems used.
- E. Unless otherwise indicated, automatic controls shall be furnished, installed, and wired under Division 23.
- F. Note that the intent of the following schedule is to have Division 23 responsible for coordinating and providing all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications.
- G. Work under Division 23 shall comply with the applicable requirements of Division 26 for wiring, conduit, etc., which is not otherwise specified.
- H. The Division 26 Contractor shall refer to the Division 23 drawings and specifications for HVAC equipment requiring power from the electrical systems provided under Division 26 and shall advise the Architect/Engineer of any discrepancies prior to bidding.
- I. Schedule of Division of Responsibilities:

Item	Furnished By	Installed By	Power Wiring Provided By	Control/ Signal Wiring Provided By
ATC Control Valve and Damper Motors <i>(See Note 7)</i>	DIV. 23	DIV. 23	DIV. 23	DIV. 23
Smoke Dampers and Combination Fire/Smoke Dampers	DIV. 23	DIV. 23	DIV. 26	DIV. 26
Duct Smoke Detection <i>(See Note 6)</i>	DIV. 26	DIV. 23	N/A	DIV. 26
Pilot Lights and Manually Operated Switches Not Carrying Load Currents <i>(See Note 3)</i>	DIV. 23	DIV. 23	N/A	DIV. 23

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Item	Furnished By	Installed By	Power Wiring Provided By	Control/Signal Wiring Provided By
Temporary Heating	DIV. 23	DIV. 23	DIV. 23	DIV. 23
Equipment Motors (<i>See Note 9</i>)	DIV. 23	DIV. 23	DIV. 26	N/A
Motor Starters (Magnetic, Manual, and Variable Speed Drives) and Overload Heaters (<i>See Notes 1, 5, 8, and 9</i>)	DIV. 23	DIV. 26	DIV. 26	DIV. 23
Fused and Unfused Disconnect Switches, Thermal Overload Heaters (<i>See Notes 5 and 9</i>)	DIV. 23	DIV. 26	DIV. 26	DIV. 23 (<i>See Note 8</i>)
Manual Operating switches, speed switches, and similar devices carrying load currents (<i>See Notes 3, 4, and 10</i>)	DIV. 23	DIV. 26	DIV. 26	N/A
Low Voltage Control Relays, Thermostats, and similar control devices. and Control Transformers (<i>See Note 2</i>)	DIV. 23	DIV. 23	DIV. 23	DIV. 23
Low Voltage Control Transformers (<i>See Note 2</i>)	DIV. 23	DIV. 23	DIV. 23	DIV. 23
Line Voltage Thermostats, Relays, Aquastats, and similar line voltage devices (<i>See Notes 3 and 4</i>)	DIV. 23	DIV. 23	DIV. 26	N/A
DDC System Controllers/Control Panels	DIV. 23	DIV. 23	DIV. 26	DIV. 23
Building Fire Alarm System interface Modules and Relays for Fan Shutdown and Override	DIV. 26	DIV. 26	DIV. 26	DIV. 26
Interlock Wiring, Remote Manual Start/Stop Pushbuttons connected to 3- phase starters	DIV. 23	DIV. 23	N/A	DIV. 23

N/A = Not applicable for this entry.

Footnotes for the above schedule:

1. All starters and variable frequency drives, other than those noted on the Division 26 drawings, shall be furnished under Division 23.
2. Low Voltage control devices (thermostats, relays, etc.) and control transformers shall be provided under Division 23, including associated wiring work.
3. Switches and relays carrying full load current shall be wired under Division 26 of the work.
4. Electrical circuits, feeders, and connections to motors and other HVAC equipment requiring power shall be provided under Division 26, except as noted otherwise.

Disconnects switches for all equipment furnished under Division 23 shall be provided under Division 23. Disconnect switches may be integral to VSDs and across the line magnetic starters, however the HVAC Contractor shall furnish disconnect switches to the Division 26 Contractor for installation at the equipment if the equipment is not in line of sight of the motor starter/VFD with the integral disconnect switch. Field applied/mounted disconnect switches shall comply with the Division 26.

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5. Control wiring to fire alarm panel and from fire alarm panel to mechanical equipment shall be provided under Division 26.
6. Valve and damper actuators for HVAC systems and equipment shall be powered from a DDC panel or electrical panel board circuit set aside for ATC. Control and power wiring and conduit, control transformers, etc. required for full function of the DDC system shall be the responsibility of the DDC system provider under the scope of Division 23, this includes both 24 volts and 120 volts power wiring. The DDC system provider shall utilize spare circuit breakers in the electrical panels provided on the project.
7. “Run Permit” and other interlock wiring between local disconnect switches and remote VSDs shall be provided under Division 23.
8. The Division 26 Contractor shall refer to the Division 23 drawings for the locations of Division 23 equipment requiring power, motor starters, and variable speed drives. Power wiring on both the line and load sides of the field applied starters, VSDs and disconnect switches shall be Division 26 work.
9. Where fans are switched with lights or controlled by a separate wall switch, a two-pole toggle switch shall be provided under Division 26. Where fans are interlocked with other mechanical equipment, the interlock wiring shall be furnished by the mechanical Contractor under Division 23.

1.7 ACCESSIBILITY

- A. Provide Portable Pipe Hangers (PPH) ‘PHP Crossovers’ to permit maintenance access to all portions of the Energy Recovery Unit (ERU) on the roof. The crossovers shall be constructed of hot dipped galvanized materials (including fasteners), and shall meet all Federal and State OSHA and Ohio Building and Mechanical Code requirements for safe access to equipment requiring maintenance.
- B. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- C. Locate equipment which must be serviced, operated, maintained or removed for replacement in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, etc. Equipment requiring access shall include, but is not necessarily limited to, valves, traps, clean-outs, motors, fire dampers, controllers, switchgear, drain points, etc.
- D. Furnish ceiling, shaft, wall, and chase access panels and doors under this division for installation by other Prime Contractor(s). Panels and doors shall comply with the architectural specifications for this project.
- E. Indicate the locations of access doors for each concealed piece of equipment, valve, control, damper, or other device concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall be also be indicated on the coordination drawings. Refer to the architectural drawings for locations of non-accessible ceilings.

1.8 PAINTING

- A. Painting requirements of this section shall conform to Division 9, Section 099100: Painting.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.

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- C. Provide field painting of all piping, ductwork, hangers, supports, equipment platforms, railings, and miscellaneous metals located outdoors (including galvanized jacketed piping, galvanized jacketed ductwork, insulated ductwork, and insulated piping). Piping over 200 degrees Fahrenheit shall be finished with high temperature epoxy paint. Application shall be in strict accordance with manufacturer's recommendations.
- D. Touch up painted finishes damaged during construction, storage, or transport.
- E. Painting work is also specified elsewhere in Division 23 sections.

1.9 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal Requirements prior to the purchase, fabrication or construction of same.
- B. Provide 4 inches thick concrete pads for chillers, base-mounted pumps, rotating equipment, and floor-mounted equipment located in equipment rooms and as indicated on drawings. Pads shall be extended 6 inches beyond machine base in each direction with top edge chamfered. Anchor equipment pads to the floor.
- C. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.
- D. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, deemed insufficient shall be replaced as directed, with no additional cost to the Owner.

1.10 EQUIPMENT GUARDS AND RAILS

- A. Provide readily removable guards or railings for belt drives and rotating machinery. Guards shall consist of heavy angle iron frames, hinged and latched, with heavy galvanized iron crimped mesh wire securely fastened to frames. Railing shall be 1-½ inches pipe and railing fittings.
- B. Multiple V-belt drives shall have band belts to minimize vibration.

1.11 CLEANING, PROTECTION AND ADJUSTMENT

A. Cleaning

1. General cleaning requirements are specified in Division 1.
2. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.

B. Protection of Surfaces

1. Protect surfaces from damage during the construction period.
2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.
3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.

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C. Protection of Services

1. Protect new and existing services from damage during the construction period.
2. Repair, replace and maintain in service any new or existing utilities, facilities or services (underground, over ground, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction.
3. Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing or maintaining the services shall be approved by the Owner and Architect.

D. Protection of Equipment and Materials

1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground and out of standing water by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
3. During the construction period, protect ductwork, piping and equipment from damage and dirt. Properly cap ductwork and piping. Each system of piping shall be flushed to remove grit, dirt, sand, and other foreign matter for as long a time as required to thoroughly clean the systems.
4. Provide two (2) complete sets of filters. One set shall be installed just prior to balancing but after cleaning of duct and air handling systems. The second set of filters shall be turned over to Owner for future use.
5. Air systems shall not be used for temporary heating during construction. And alternate source of temporary heat required by this and other divisions is the sole responsibility of the Division 23 Contractor.

E. Adjustment

1. After the entire installation has been completed, make required adjustments to balancing valves, air vents, automatic controls, circulators, pressure reducing valves and similar devices until performance requirements are met.
2. Provide factory-lubricated bearings for mechanical equipment. Before initial startup of mechanical equipment, inspect and verify bearings for proper amounts of lubricant. If required, provide proper amounts of lubricant in accordance with manufacturer's recommendations.

1.12 SPECIAL TOOLS

- A.** Provide the Owner's Representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.13 WELDING

A. General Requirements

1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off the site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.
2. Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:
 - a. Submit copies of welder certification test records in accordance with this Division and Division 1 requirements.
 - b. Testing was performed by an independent testing laboratory.
 - c. The welding procedures and welders are certified in accordance with the “ASME Boiler and Pressure Vessel Code,” and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
 - d. Certification has been within a one (1) year period from the start of the project.
3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
5. Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 feet intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

TELE/DATA Room Requirements

The temperature of each room should be able to be controlled at 72 to 76 degrees Fahrenheit with 50 to 60 percent humidity.

Each room should have the ability to have an independent thermostat.

Each room should have the ability to exhaust hot air.

The heat (BTU) produced by the electronics will determine load size of heating and cooling.

PART 2: PRODUCTS

2.1 WALL ACCESS DOORS

- A. Each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
- B. Access doors and frames shall be of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
- C. Frames shall be fabricated from 16-gauge steel.
 - 1. Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
 - a. Exposed Masonry
 - 2. For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4. For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame
- D. Flush Panel Doors shall be fabricated from not less than 14 gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees Fahrenheit. Finish with manufacturer's factory-applied prime paint.
 - 1. For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
- E. Locking devices shall be flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.
- F. Manufacturers:
 - 1. Bar-Co., Inc.
 - 2. J. L. Industries
 - 3. Karp Associates, Inc.
 - 4. Nystrom, Inc.

2.2 ENCLOSED SWITCHES (Disconnects)

- A. Furnish Enclosed Switches for equipment and apparatus specified in this division, as indicated on the contract documents, and as specified herein.
- B. Enclosed Switches used with variable-frequency motor controllers shall have auxiliary contacts to interface with controller shutdown.
- C. Furnish Enclosed Switches as specified in Division 26 sections, Enclosed Switches and Circuit Breakers.

2.3 PIPING WELDING

- A. Welding materials shall comply with the ASME Boiler and Pressure Vessel Code. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a certified welder using qualified welding procedures.

PART 3: EXECUTION

3.1 ACCESS DOORS

- A. Coordinate installation of access doors with the installing Prime Contractor(s). Locations of access shall be submitted and doors furnished in sufficient time to allow installation in the normal course of the work.

3.2 WELDING

- A. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.
- B. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.
- C. Replace and inspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.
- D. Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

3.3 SPECIAL REQUIREMENTS

- A. Plastic HVAC Lines: No plastic is permitted unless specifically approved by Baldwin Wallace University Facilities. If specifically required any change from the plastic to another material must be accomplished through the use of flanges with rubber or other appropriate material as a gasket. Flanges must be provided on both sides.
- B. All base mounted pumps must be secured to the floor or pad through the use of vibration isolation mounts or pre-manufactured bases.
- C. All pumps and equipment must be located near (approximately 5 feet or less) a floor drain if condensate or leakage is possible. All floors shall be sealed and painted. (Curbing system may be required, verify with Baldwin Wallace University Facilities.)
- D. All equipment serving classrooms shall be accessible from hallways or equipment rooms as to not interfere with classes. (This is recommended but not required.)
- E. All equipment requiring condensate lines shall have traps installed.
- F. All equipment shall have full flow valves. (This will allow the equipment to be isolated for maintenance.)
- G. Floor control valves shall be installed in all systems to isolate floors for maintenance. (This will allow a floor to be isolated without having to drain the entire system.)

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- H. All equipment having filters shall have adequate space to maintain filters and change filters, filters shall be of standard size and available through any supplier.
- I. Outside condensing units shall have coil guards to protect from damage.
- J. No rector seal shall be used on heating and air conditioning systems.
- K. Pumps larger than 1 horsepower must be installed on the floor.
- L. Heat Recovery Units and Energy Recovery Ventilation Units must be floor mounted.
- M. Geothermal Systems:
 - 1. Two (2) pumps for the well field
 - 2. Two (2) pumps for the building loop
 - 3. Glycol injection system (with level alarms to BMS system)
 - 4. Fifteen (15 percent) Glycol
 - 5. HRU/ERV units
 - 6. Heat Pumps
 - 7. Fluoride Heat Pumps
 - 8. Water Furnace Heat Pump
 - 9. Vaults shall have accessible lids.
 - 10. Vaults shall have water level alarms.
 - 11. Vaults incoming lines shall have pressure gauges.
- N. Room temperature sensors shall be provided for each room being controlled by one thermostat. (One thermostat controls three or more rooms.)
- O. Rooms with intermittent use shall have occupancy or motion sensors controlling HVAC systems.

END OF SECTION 230500

SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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.
- B. Division 23, Section 230531: Motor Controllers and Section 230530: Adjustable Frequency Drives” for motor starters and variable speed drives.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 volts and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers
 - 2. Torque, speed, and horsepower requirements of the load
 - 3. Ratings and characteristics of supply circuit and required control sequence
 - 4. Ambient and environmental conditions of installation location

PART 2: PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this section except when stricter requirements are specified in HVAC equipment schedules or sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Provide motors for equipment specified in this division.
- D. Motors for equipment shall be supplied by the equipment manufacturer. Motors shall be furnished with enclosed controllers, except motors with controllers in a motor control center. Refer to electrical drawings for motors with controllers in a motor control center.
- E. Motors shall comply with the following general requirements:
 - 1. Motors shall be built in accordance with the latest standards of NEMA and applicable IEEE standards and as specified. Motors shall be tested in accordance with ASA C50 and conform thereto with respect to insulation resistance and dielectric strength.
 - 2. Each motor shall be provided with conduit terminal box and adequate starting and protective equipment as specified or required. The capacity shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and shall be at least the horsepower indicated or specified. Each motor shall be selected for quiet operation.

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3. Provide motors rated for 200 volts for 208 volts service. Provide 230 volts and 460 volts rated motors for 240 volts and 480 volts service. For hermetic refrigeration and elevator applications, motor voltage must match service voltage.
4. Brake horsepower load requirements at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors. For motors with 1.25, 1.35, and 1.4 service factors, maximum load percentage shall be 78 percent, 72 percent, and 70 percent, respectively. Brake horsepower load requirements do not apply for water-cooled or refrigerant-cooled motors.
5. Starting (locked rotor) currents shall not exceed NEMA Design B maximum values for the specified ratings.
6. Where motors operate in an ambient temperature above 40 degrees Celsius, the motors shall be suitably designed for the ambient temperature indicated.
7. Outdoor, Exposed Motors: Totally enclosed fan-cooled construction, stator windings totally encapsulated having non-hygroscopic insulation approved for outdoor use and double shielded bearings.
8. Provide power factor correction as follows:
 - a. Individual single speed, non-reversing motors, 15 horsepower and larger, having a full load power factor of less than 90 percent, shall be supplied by the equipment supplier with power factor correcting capacitors which shall correct the full load power factor of the circuit to a minimum of 90 percent and the no load power factor to a maximum of unity. Where the power factor of the motor combined with a variable speed controller exceeds 90 percent at full load, power factor correction capacitors are not required.
 - b. These capacitors shall be sized by the motor manufacturer. The shop drawings for the equipment shall list the capacitor reactive power (kvar), and full load current of the motor-capacitor combination to enable proper sizing of the overload protection and the correct power factor at no load and full load.
 - c. Capacitors will: be 3-phase, rated for the applied circuit voltage, fused at 5 kilovars and above; employ non-PCB impregnated paper or film dielectric and insulation; be in indoor dust-proof or NEMA Type 3R enclosure, depending on location; not contain more than 3 gallons of a combustible insulating liquid; be equipped with integral discharge resistors to reduce voltage to a maximum of 50 volts in three (3) minutes.
 - d. Package or unitized equipment on which motors and controls are factory wired up to a point or points of power connection shall have the capacitors, as specified above, installed and connected to the motor circuits between the starters and the motors, as part of the factory supplied assembly.
 - e. Do not apply power factor correction to motors with variable frequency drives.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 degrees Celsius and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

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2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Rotor: Random-wound, squirrel cage.
- E. Motors of open drip proof construction shall be NEMA Class B for operation for 40 degrees Celsius ambient. Except: Motors used in conjunction with variable frequency speed drive controllers shall be as elsewhere specified.
- F. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Code Letter Designation:
 - 1. Motors 15 horsepower and larger: NEMA starting Code F or Code G.
 - 2. Motors smaller than 15 horsepower: Manufacturer's standard starting characteristic.
- H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- I. Bearings, Drives, and Efficiency: Lifetime ball bearing through 2 horsepower, anti-friction bearing with a L-10 life of 200,000 hours under belt load conditions. Bearings shall be in re-greasable race. Belt drive motors shall have steel adjustable slide base with slide rails and adjustment screws. Minimum efficiency and power factor shall be as follows:

MOTOR HORSEPOWER %	NOMINAL FULL-LOAD EFFICIENCY								POWER FACTOR AT 1800 RPM
	OPEN MOTOR				ENCLOSED MOTOR				
	900 RPM 8 POLE	1200 RPM 6 POLE	1800 RPM 4 POLE	3600 RPM 2 POLE	900 RPM 8 POLE	1200 RPM 6 POLE	1800 RPM 4 POLE	3600 RPM 2 POLE	
	%	%	%	%	%	%	%	%	
1	74.0	80.0	82.5		74.0	80.0	92.5	75.5	75
1.5	75.5	84.0	84.0	82.5	75.5	85.5	84.0	82.5	78
2	85.5	85.5	84.0	84.0	85.5	86.5	84.0	84.0	78
3	86.5	86.5	86.5	84.0	86.5	87.5	87.5	85.5	80
5	87.5	87.5	87.5	85.5	87.5	87.5	87.5	87.5	80
7.5	88.5	88.5	88.5	87.5	88.5	89.5	89.5	88.5	85
10	89.5	90.2	89.5	88.5	89.5	89.5	89.5	89.5	85
15	89.5	90.2	91.0	89.5	89.5	90.2	91.0	90.2	85
20	90.2	91.0	91.0	90.2	90.2	90.2	91.0	90.2	85
25	90.2	91.7	91.7	91.0	90.2	91.7	92.4	91.0	85
30	91.0	92.4	92.4	91.0	91.0	91.7	92.4	91.0	85
40	91.0	93.0	93.0	91.7	91.0	93.0	93.0	91.7	85
50	91.7	93.0	93.0	92.4	91.7	93.0	93.0	92.4	85

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MOTOR HORSEPOWER %	NOMINAL FULL-LOAD EFFICIENCY								POWER FACTOR AT 1800 RPM
	OPEN MOTOR				ENCLOSED MOTOR				
	900 RPM 8 POLE %	1200 RPM 6 POLE %	1800 RPM 4 POLE %	3600 RPM 2 POLE %	900 RPM 8 POLE %	1200 RPM 6 POLE %	1800 RPM 4 POLE %	3600 RPM 2 POLE %	
	60	92.4	93.6	93.6	93.0	92.4	93.6	93.6	
75	93.6	93.6	94.1	93.0	93.6	93.6	94.1	93.0	85
100	93.6	94.1	94.1	93.0	93.6	94.1	94.5	93.6	85
125	93.6	94.1	94.5	93.6	93.6	94.1	94.5	94.5	85
150	93.6	94.5	95.0	93.6	93.6	95.0	95.0	94.5	85
200	93.6	94.5	95.0	94.5	93.6	95.0	95.0	95.0	85

J. Motor efficiencies shall be in accordance with IEEE standards.

K. Manufacturers:

1. Baldor
2. Lincoln
3. General Electric
4. Electric Machinery Company
5. Reliance
6. Approved Equal
7. York is not acceptable

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Designed for use with these Controllers and shall be tested with the specific Controller supplied for this project.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 Part 31, Definite Purpose Inverter-Fed Motors.
4. Bearings: Motors larger than 20 horsepower shall have insulated bearings or shaft grounding brushes (EST 'Aegis' or approved equal).

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 horsepower shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor
 - 2. Split phase
 - 3. Capacitor start, inductor run
 - 4. Capacitor start, capacitor run
- B. Motors 1/20 horsepower and Smaller: Shaded-pole type.
- C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- D. Bearings: Lifetime sealed ball bearing or oilable ball bearing type suitable for radial and thrust loading.
- E. Efficiency: Minimum efficiency 70 percent, minimum power factor 75 percent.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3: EXECUTION – NOT USED

END OF SECTION 230513

SECTION 230516 – EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1: GENERAL

1.1 RELATED SECTIONS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. Division 23, Section 230529: Hangers and Supports for HVAC.

1.2 SUMMARY

- A. This section includes pipe expansion fittings and loops for HVAC piping systems, and the following:
 - 1. Flexible Hose Expansion Loops
 - 2. Pipe Bends and Swing Joints
 - 3. Guides and Anchors

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Absorb 200 percent of maximum piping expansion between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of pipe expansion loop and alignment guide indicated.
- B. Shop drawings indicating where each loop is proposed.
- C. Operation and Maintenance Data: For pipe expansion loops to include in operation and maintenance manuals.

PART 2: PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers
 - 1. Flexible Hose Expansion Loops:
 - a. Metraflex, Inc. (Metraloop or V-Loop)
 - b. Flex-Hose Co. Inc. (Tri-Flex Loop)
 - c. Flexicraft Industries. (ML Loop)
 - d. Mason Industries (60E Vee Flexible Hose)

2. Guides:
 - a. Metraflex, Inc.
 - b. Adscos Manufacturing, LLC.
 - c. Flex-Hose Co. Inc.
 - d. Grinnell Corp.
 - e. Mason Industries

2.2 FLEXIBLE HOSE EXPANSION LOOPS

- A. Manufactured assembly with two or three flexible-metal-hose legs joined by long-radius return bend(s); with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths. Loop shall be suitable for up to 4 inches of in-plane expansion compensation unless otherwise noted on the drawings.
 1. End Connections: Flanged, screwed or solder ends to match piping system.
 2. Flexible loops shall have a factory supplied support nuts/clips located on the return elbow(s), and a ½ inch NPT drain/air release plug.
 3. Suitable for a working temperature of no less than 170 pounds per square inch gauge at 250 degrees Fahrenheit.

2.3 GUIDES

- A. Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

2.4 MISCELLANEOUS ANCHOR MATERIALS

- A. Structural Steel: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
 1. Stud: Threaded, zinc-coated carbon steel
 2. Expansion Plug: Zinc-coated steel
 3. Washer and Nut: Zinc-coated steel

PART 3: EXECUTION

3.1 EXPANSION – LOOP INSTALLATION

- A. Install expansion loops of sizes matching size of piping in which they are installed.
- B. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five (5) pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four (4) pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four (4) pipe fittings, including tee in main.

3.3 GUIDE INSTALLATION

- A. Install guides on piping adjoining expansion loops.
- B. Attach guides to pipe and secure to building structure.

3.4 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.

3.5 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09, Section 099100: Painting and Division 09, Section 099100A: Coatings and Paint Systems.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230516

SECTION 230519 – METERS AND GAGES

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.
- B. Division 23, Section 230900: Integrated Automation Control System for flow meters and temperature sensors connected to the DDC system.
- C. Division 23, Section 232113: HVAC Piping including piping system component and equipment pressure ratings applies to this section.

1.2 SUMMARY

- A. Section includes:
 - 1. Thermometers
 - 2. Pressure Gages
 - 3. Pressure and Temperature Test Plugs
 - 4. Sight Flow Indicators
 - 5. Thermowells

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gauge, from manufacturer.
- C. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2: PRODUCTS

2.1 THERMOMETERS

- A. For Hydronic Systems: Thermometers shall be 9 inch scale, red-reading organic liquid thermometers with cast aluminum case and clear glass window, and shall read degrees Fahrenheit. Thermometers shall be adjustable angle type, with 6 inch stem and 2-½ inches brass extension neck separable socket.
 - 1. Scale Ranges: 0 to 120 degrees Fahrenheit with 1 degrees Fahrenheit scale divisions.
 - 2. Manufacturers:
 - a. Weiss Instruments Inc.
 - b. Terice, H.O. Co.

- c. Weksler
- d. Palmer Wahl Instrumentation Group

2.2 PRESSURE GAGES

- A. Provide pressure gauges at suction and discharge connections to pumps and as indicated on the drawings.
- B. For Hydronic Systems: Pressure gauges shall have 4-½ inches diameter stainless steel cases, no back flange, and removable stainless slip ring. Gauge dial shall be white coated with black figures, gradations, and micro adjustable. Accuracy: within 1 percent of scale.
 - 1. Provide pressure gauges with the following accessories:
 - a. Valves: ¼ inch brass or stainless-steel needle type.
 - b. Snubbers: ASME B 40.5, ¼ inch brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.
 - 2. Manufacturers:
 - a. Weiss Instruments Inc.
 - b. Trerice, H.O. Co.
 - c. Weksler
- C. Temperature Ratings: 250 degrees Fahrenheit
- D. Scale ranges: 0 to 100 pounds per inch with 1 pound per inch scale divisions.

2.3 PRESSURE AND TEMPERATURE TEST PLUGS

- A. Provide pressure and temperature test plugs as shown on the drawings and specified herein.
- B. Test plugs shall be a ¼ inch MPT fittings to receive either a temperature or pressure probe with a ⅛ inch OD. Fittings shall be solid brass with two valve cores of Nordel (maximum 275 degrees Fahrenheit), fitted with a color coded and marked cap with gasket and shall be rated at 1,000 pounds per square inch gauge. Fittings shall be Peterson Equipment Company, Incorporated, Pete's Plug, or approved equal.
- C. Manufacturers:
 - 1. Flow Design, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Trerice, H.O. Co.
- D. Provide two (2) test kits with pressure gauge and thermometer. Pressure gauges shall have 0-50 pounds per inch dial range, and shall have adaptor with ⅛ inch probe of 304 stainless steel and union nut for use with pressure and temperature test plug. Thermometers shall have 0 to 220 degrees Fahrenheit range. Test kits shall be Peterson Equipment Company, Incorporated, Series 1500 Test Kit, or approved equal.

2.4 SIGHT FLOW INDICATORS

A. Manufacturers:

1. Dwyer Instruments, Inc.
2. Emerson Process Management; Brooks Instrument
3. Ernst Co., John C., Inc.
4. Ernst Flow Industries
5. OPW Engineered Systems; a Dover company
6. Penberthy; a brand of Tyco Valves & Controls – Prophetstown

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 pounds per square inch gauge.

E. Minimum Temperature Rating: 200 degrees Fahrenheit.

F. End Connections for NPS 2 and Smaller: Threaded.

G. Install flow indicators in piping systems in accessible positions for easy viewing.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: ASME B1.20.1 pipe threads.
7. Internal Threads: ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting the size of the thermowells internal screw thread to the size of the thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

PART 3: EXECUTION

3.1 THERMOMETERS

- A. Install thermometers in a thermowell installed in an oversize pipe tee.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Thermometers shall be installed such that they are easily read from a normal observation point. The Contractor shall select the proper stem orientation necessary to render the thermometer easily readable from the operating position.

3.2 PRESSURE GAUGES

- A. Gauges shall be installed such that they are easily read from the normal observation point.
- B. Install needle-valve and snubber fitting in piping for each pressure gauge.

3.3 PRESSURE AND TEMPERATURE TEST PLUGS

- A. Provide pressure and temperature test plugs where indicated on the drawings and one pair at every main to riser connection point. For this project, provide a minimum of two pair of pressure and temperature test plugs and main to riser connection points.

3.4 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION 230519

SECTION 230523 – GENERAL-DUTY VALVES 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.
- B. Division 23, Section 232113: HVAC Piping including piping system component and equipment pressure ratings applies to this section.

1.2 SUMMARY

A. Section includes:

- 1. Bronze Ball Valves
- 2. Butterfly Valves
- 3. Bronze Swing Check Valves
- 4. Iron Swing Check Valves
- 5. Manual Calibrated Balancing Valves
- 6. Automatic Balancing Valves
- 7. Chain Wheels

B. Related sections:

- 1. Other Division 23 sections for specialty valves applicable to those sections only.
- 2. Division 23, Section 230553: Identification for HVAC for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold Working Pressure
- B. EPDM: Ethylene Propylene Copolymer Rubber
- C. NBR: Acrylonitrile-Butadiene, Buna-N, or Nitrile Rubber
- D. NRS: Non-Rising Stem
- E. OS&Y: Outside Screw and Yoke
- F. RS: Rising Stem
- G. SWP: Steam Working Pressure

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer. All valves shall be new; remanufactured valves are not acceptable.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2: PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Valve Pressure and Temperature Ratings: Refer to Division 23, Section 232113: HVAC Piping for component and equipment ratings. Components, fittings, equipment, coils, specialties, etc., shall meet the component's pressure rating listed, and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves larger than NPS 4 with position indicator
2. Handwheel: For valves other than quarter-turn types
3. Handlever: For quarter-turn valves NPS 4 and smaller
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the “Valve Installation” article

D. Valves in Insulated Piping:

1. Extended Necks and Stems: Where insulation is indicated or specified, provide extended necks (butterfly valves) or stems (ball valves) arranged to receive insulation. Contractor will be required to remove any valves installed without extended stems/necks at his own cost.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck

E. Valve-End Connections:

1. Flanged: ASME B16.1
2. Threaded: ASME B1.20.1
3. Lug-Wafer: Butterfly valves only.

2.2 BUTTERFLY VALVES

- A. Butterfly valves greater than 2 inches: MSS SP-67. Lug type with carbon steel body, 316 stainless steel disc, and gear operated hand wheel for sizes larger than 4 inches. Liner shall be 317 stainless steel with PTFE woven fabric. Class 150 body, with extended neck. 285 pounds per inch bubble tight shut-off in either direction. High performance design with all metal to metal contact (no resilient seats).
- B. In lieu of the above, provide Victaulic Series 300 (Master Seal Only), stainless disc, EPDM seal.

2.3 BALL VALVES

- A. Ball valves 2 inches and below: MSS-SP-110. Two or three piece body, full port, 600 WOG, stainless steel ball and stem, TFE seats, blow-out proof stem, and threaded ends.

2.4 SWING CHECK VALVES

- A. NPS 2 and smaller: MSS SP-80; Class 200, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 61 cast-bronze body and cap, rotating bronze disc with renewable rubber seat or composition seat, threaded or soldered end connections.
- B. NPS 2 ½ and larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged end connections.

2.5 MANUAL CALIBRATED BALANCING VALVES

- A. 175 pounds per inch working pressure at 250 degrees Fahrenheit maximum operating temperature. Valves shall have differential pressure readout ports with integral check valve and seals, ¼ inch tapped drain/purge port, memory stop, calibrated nameplate.
 - 1. Bronze body/brass ball under 2-½ inches, threaded connections
 - 2. Cast iron body/brass ball with threaded or flanged connections for 2 ½ inches and 3 inches sizes
 - 3. Globe style cast iron body/brass plug with EPDM seal ring for valves 4 inches and larger, flanged connections

2.6 AUTOMATIC FLOW CONTROL BALANCING VALVES

- A. Automatic flow control valves: Automatically control flow to plus/minus 5 percent accuracy within a range of 3 to 80 pounds per inch differential pressure. Threaded or flanged ends as required. Test plugs for temperature and pressure readout. Pressure drop for automatic control valve shall be no higher than 5 pounds per square inch gauge at scheduled (required) flowrates.
- B. Hose Kits: For connections to heat pumps sized 2 inches and smaller, provide a valve package incorporating flexible hoses, an automatic balancing valve, a temperature control valve, P/T ports as described below, a strainer, and a pair of isolation shut-off ball valves.
 - 1. Shut-off ball valves shall be have two piece bronze body, full port design, chrome plated brass ball, teflon packing, brass packing nut, and blowout proof stem.
 - 2. Temperature control valves shall be characterized ball valves for equal percentage characteristics. Construction shall be as described for shut off valves.
 - 3. Hoses shall have an EPDM inner core, stainless steel braid, with threaded ends.
 - 4. P/T ports on either side of the unit connection, P/T ports on either side of both the control valve and the automatic flow control balancing valve, P/T ports ¼ inch size
 - 5. Strainers shall be on the supply side of the unit and shall be bronze body with threaded ends, stainless steel strainer, and ball-type drain valve with ¾ inch threaded hose connection and cap.

2.7 APPROVED MANUFACTURERS

- A. Butterfly Valves:
 - 1. Victaulic Series 300
 - 2. DeZurik HP Class 150
 - 3. Bray Series 40
 - 4. Cooper Cameron WKM
 - 5. Jamesbury Series 815W Model C Class 150
- B. Ball Valves:
 - 1. Apollo
 - 2. Watts

3. Legend
4. Nibco
5. Milwaukee
6. Stockham

C. Swing Check Valves:

1. Watts
2. Lunkenheimer
3. Cincinnati Valve Company
4. Apollo
5. Mueller
6. Metraflex

D. Calibrated Balancing Valves:

1. Bell & Gossett Circuit Setter Plus
2. DeZurik
3. Rockwell
4. TA Hydronics

E. Automatic Flow Control Balancing Valves and Hose Kits:

1. Griswold
2. Flow Design (FDI)
3. Belimo

PART 3: EXECUTION

3.1 APPLICATIONS

A. Unless otherwise indicated, use the following valve types:

1. Shut-off Duty: Ball or Butterfly
2. Throttling Duty: Calibrated Balancing Valves
3. Balancing Duty: Automatic Flow Control Balancing Valves

B. Provide shut-off valves at inlet and outlet of each item of HVAC equipment, including, but not limited to, heat pumps, ERUs, and other similar equipment.

3.2 VALVE INSTALLATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully opened to fully closed. Examine guides and seats made accessible by such operations.

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- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- G. Install valves so that the tops of the valve stems are above the horizontal.
- H. Install valves in accessible locations.
- I. Valves for equipment shutoff shall be size of pipe indicated on the drawings before reducing to equipment inlet/outlet size.
- J. Locate valves for easy access and provide separate support where necessary.
- K. Install valves in position to allow full stem movement.
- L. Install chainwheels on operators for valves 4 inches and larger in mechanical rooms and more than 7 feet above floor. Extend chains to 76 inches above finished floor.
- M. Install check valves for proper direction of flow and install swing check valves in a horizontal position with hinge pin level.

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. Division 23, Section 230516: Expansion Loops for HVAC Piping.
- C. See Division 23, Section 233113: HVAC Ducts for indoor hangers and supports of HVAC ducts.

1.2 SUMMARY

- A. This section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Pipe Hangers and Supports
 - 2. Equipment Supports
 - 3. Roof Support Rails for Equipment, Ductwork, and Piping
 - 4. Roof Curbs for Piping and Ductwork Penetrations of the Roof

1.3 SUBMITTALS

- A. Provide product data for the following:
 - 1. Pipe hangers and supports
- B. Shop Drawings: Provide fabrication and installation drawings for piping systems.

PART 2: PRODUCTS

2.1 PIPE HANGER AND SUPPORT MANUFACTURERS

- A. Provide supports and hangers for the items included in the work. Hanger design and spacing shall conform to ANSI Code B 31.1.0 for Pressure Piping and the Manufacturers' Standardization Society of the Valve and Fitting Industry (MSS) SP-58 and SP-69, unless supplemented or modified herein.
- B. Manufacturers:
 - 1. F&S.
 - 2. F&M
 - 3. Grinnell Corp.
 - 4. Central Iron Mfg.

2.2 PIPE HANGERS AND SUPPORTS – GENERAL

- A. Submit for approval product bulletins with figure numbers of supports, hangers and inserts proposed for the various conditions and services.
- B. Supports shall secure pipes in place, prevent swaying and vibrations, maintain required pitch by proper adjustment, and provide free expansion and contraction. Design supports to suit the loading and service, and not over stress the building structure.
- C. Hanger rods shall be threaded 1-½ inches on each end or all-threaded cadmium plated or galvanized steel. Hangers, rollers, and supports that are not plated shall be factory painted with a red oxide primer and black enamel finish.
- D. Specified bracket clamp and rod sizes are minimum size. Support and hanger design shall include a safety factor of 5.
- E. Where several pipes 4 inches in diameter and smaller can be installed in parallel at the same level, approved type trapeze hangers may be used in lieu of separate clevis hangers, with suspension rods having double nuts and securely attached to the building structure in an approved manner. Brace trapeze hangers to prevent motion due to expansion and contraction of pipe. Support individual pipes on trapeze by saddles and rollers. For trapeze hanger spacing, use the maximum support spacing listed for the smallest pipe on the trapeze.
- F. Plastic coated hangers and clamps shall be provided for uninsulated brass or copper pipes, unless shields are provided between hangers or clamps and uninsulated brass or copper pipes.
- G. Provide supplemental steel required for support of pipes other than steel shown on the structural drawings.
- H. Do not hang one pipe from another pipe, conduit, or ductwork.
- I. Do not use perforated band iron, wire, or chains as pipe hangers.
- J. Support piping as close as practical to heavy load concentrations such as vertical runs, branch connections, valves, and other pipe accessories such as air separators and strainers.
- K. Locate supports adjacent to both sides of control valves or pipe sections shown to be removable.
- L. Locate supports adjacent to branch shutoff valves to permit removal of branch piping without the installation of temporary supports.
- M. Support piping on at least one side and adjacent to each change in direction.
- N. Provide additional supports as specified elsewhere when grooved pipe construction is employed.
- O. Hangers for insulated pipes shall be sized to clear the outside diameter of the insulation, unless otherwise noted.
- P. Supports and hangers for horizontal piping shall be provided with a means of vertical adjustment after erection. Turnbuckles shall be provided with one (1) lock nut. Rod connections to hangers and attachment devices shall be provided with two (2) nuts.
- Q. Inserts for pipe hangers shall be of a type that does not interfere with structural reinforcing and does not displace excessive amounts of concrete.

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- R. Piping located near floors which can be supported from floor or walls shall be provided with approved floor stands, wall brackets, roller supports, masonry piers or similar items.
- S. Resilient hangers and isolation devices shall be provided on piping connected to rotating equipment including pumps and air handling units and on other piping which may vibrate and create audible noise. Refer to Division 23, Section 230548: Vibration Controls for additional requirements concerning vibration isolation at pipe supports.
- T. Additional hangers or supports shall be provided, as required, to stabilize and re-support any existing piping that is to remain and be reused in areas affected by demolition.
- U. Vertical piping shall utilize riser clamps specifically designed for piping.
- V. Pipe Hanger Schedule – Manufacturer’s Model Numbers:

Hanger Type	F&S	F&M	Grinnell	Central Iron
360 Shield	981	–	–	548
Beam Clamp	55	282	218	39
Multi-J Hood Blade	120	–	–	208
Clevis Hanger	86	239	260	10
180 Degree Shield	980	80	167	550
Rigid Trapeze	710	–	Std. 46	551
U-Bolt	37	176	137, 137C	98H
Adj. Steel Pipe Stanchion	421	291	259	71
Welded Steel Bracket	800, 801	151, 155	195, 199	195, 199
Riser Clamp	91, 93, 94	241	261, 261C	37, 261
Pipe Rest	92, 925	–	–	552
Base Elbow Support	720, 721	–	–	67, 68
Double Bolt Pipe Clamp	89	261	295	
Welded Beam Attachment	966	–	66	
Insert	180A, 180B	178	280 Series	100, 101
Cont. Slotted Insert	150A, 150B	190	–	50
Underground Pipe Hanger	275	–	–	600A

2.3 PIPE HANGERS AND SUPPORTS – PIPING 6 INCHES AND SMALLER

- A. Piping 6 inches and smaller shall be supported by hangers and supports referred to in MSS-SP69.
- B. High temperature hot water piping shall be supported on Type 43 adjustable pipe roller hangers or Type 46 adjustable pipe roller and base supports and Type 39 saddles.
- C. Chilled water and other piping operating at temperatures below ambient shall be supported with Type 40 protection shields and Type 1 clevis hangers.
- D. All other piping shall be supported by Type 1 adjustable steel clevis hangers.

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- E. Hangers for piping with insulation shall be equipped with insulation inserts and protection shields. Support piping in accordance with the insert manufacturer's recommendations.
- F. Hangers for piping 4 inches and smaller with insulation shall be equipped with Type 40 protection shields. Hot service piping shall be equipped with calcium silicate insulation inserts.
- G. 6 inch cold service piping shall be provided with insulation inserts or oak blocking of square dimension equal to the insulation thickness specified and 12 inches long. In addition, Type 40 protection saddles shall be provided.
- H. 6 inch hot service piping shall be supported on Type 39 protection saddles. Pipe saddles may not be used on piping with insulation requiring a vapor barrier.
- I. Support plastic piping in accordance with the piping system manufacturer's recommendations for the intended service based on the expected fluid temperatures.
- J. Copper piping shall be supported by copper or plastic clad hangers or shall be protected by plastic non-conducting spacers to prevent dielectric corrosion.
- K. Vertical piping shall be supported at floor levels with Type 8 riser clamps. Piping 2-½ inches and larger shall be provided with a minimum of two (2) shear lugs installed in accordance with PFI Standard ES-26. Support locations shall be selected to permit uniform loading, provision for expansion, or to suit space limitations. The riser clamps at exposed locations shall be of such design as to avoid creating a hazardous or unsightly condition and staying within the space limitations.
- L. Pipe guides shall be provided whenever piping has insufficient physical strength to maintain alignment with the force of lineal expansion applied.
- M. The base of piping at circulating pumps shall be Type 52 variable spring base supports or with stanchions. Pipe stanchions shall be a minimum of ⅓ to ½ the nominal pipe diameter of the pipe being supported and 1 inch minimum. The base plate shall be a minimum ¼ inch thick and its size shall be selected for fastening to the floor with a minimum of two (2) ⅜ inch bolts.
- N. Piping 4 inches and smaller supported from the steel structure shall be supported by Type 23 beam clamps or by inserts and/or expansion bolts in the floor structure above.
- O. 6 inch piping and trapeze hangers where loads in excess of 200 pounds are anticipated shall be supported by Type 22 welded beam attachments.
- P. Piping along walls shall be supported by Type 33 brackets with drilled horizontal legs for fastening standard hangers and hanger rods, and vertical legs shall be fastened to the wall with at least two (2) fasteners.
- Q. Where several pipes can be installed in parallel at the same level, provide trapeze hangers constructed of unistrut or steel angle suspended by hanger rods. Brace trapeze hangers to prevent motion due to expansion and contraction of the pipe. Support individual pipes by hangers or rollers.

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- R. Support spacing for horizontal steel piping: The support spacing listed below is the maximum normal spacing, and does not reduce the need for additional hangers and supports when specified elsewhere.

Steel Pipe Size	Minimum Rod Size	Maximum Support Spacing
1-¼ inches and smaller	¾ inch diameter	7 feet – 0 inches
1-½ inches	¾ inch diameter	9 feet – 0 inches
2 inches	¾ inch diameter	10 feet – 0 inches
2-½ inches	½ inch diameter	11 feet – 0 inches
3 inches	½ inch diameter	12 feet – 0 inches
4 inches	⅝ inch diameter	12 feet – 0 inches
5 inches	⅝ inch diameter	12 feet – 0 inches
6 inches	⅝ inch diameter	12 feet – 0 inches

- S. Support spacing for horizontal copper piping: The support spacing listed below is the maximum normal spacing, and does not reduce the need for additional hangers and supports when specified elsewhere.

Copper Pipe Size	Minimum Rod Size	Maximum Support Spacing
¾ inch and smaller	¾ inch diameter	5 feet – 0 inches
1 inch	¾ inch diameter	6 feet – 0 inches
1-¼ inches	¾ inch diameter	6 feet – 0 inches
1-½ inches	¾ inch diameter	8 feet – 0 inches
2 inches	¾ inch diameter	8 feet – 0 inches
2-½ inches	½ inch diameter	9 feet – 0 inches
3 inches	½ inch diameter	10 feet – 0 inches
4 inches	½ inch diameter	10 feet – 0 inches

- T. Support spacing for horizontal PVC piping: Support spacing listed below is the maximum normal spacing, and does not reduce the need for additional hangers and supports when specified elsewhere. Additionally, provide support at every pipe joint.

PVC Pipe Size	Minimum Rod Size	Maximum Support Spacing
¾ inch and smaller	¾ inch diameter	4 feet – 0 inches
1 inch	¾ inch diameter	4 feet – 0 inches
1-¼ inches	¾ inch diameter	4 feet – 0 inches
1-½ inches	¾ inch diameter	4 feet – 0 inches
2 inches	¾ inch diameter	4 feet – 0 inches
2-½ inches	½ inch diameter	4 feet – 0 inches
3 inches	½ inch diameter	4 feet – 0 inches
6 inches	⅝ inch diameter	4 feet – 0 inches

2.4 PIPE HANGERS AND SUPPORTS – PIPING 8 INCHES AND LARGER

- A. Where specified, pipe supports located in Mechanical Equipment Rooms shall be provided with spring vibration isolation hangers. Additionally, vibration isolation type supports and hangers shall be provided in all vertical mechanical shafts. Refer to Division 23, Section 230548: Vibration Controls, for additional requirements.
- B. All high temperature hot water supply and return piping shall be supported on Type 46 adjustable pipe roller and base supports or Types 41 or 43 roller hangers complete with Type 39 protection saddles.
- C. Medium temperature hot water, glycol hot water, and dual temperature hot/chilled water supply and return piping with horizontal movements exceeding ½ inch shall be supported with Type 39 protection saddles or with Type 40 protection shields on Type 46 adjustable pipe roller and base supports or Types 41 or 43 roller hangers. Where horizontal movements are less than ½ inch use Type 1 clevis hangers or Type 3 pipe clamps.
- D. Chilled water piping shall be supported with Type 40 protection shields and Type 41, 43 or 44 roller hangers where horizontal movements exceed ½ inch. Where horizontal movements are less than ½ inch, use oak blocking with oversized Type 1 clevis hangers. Insulation inserts or oak blocking shall be of square dimension equal to the insulation thickness specified and 12 inches long. In addition, Type 40 protection saddles shall be provided.
- E. Refrigerant piping shall be supported with Type 44 roller hangers, Type 1 clevis hangers or Type 4 pipe clamps.
- F. Pipe guides shall be provided whenever piping has insufficient physical strength to maintain alignment with the force of lineal expansion applied.
- G. Piping supported from the steel structure shall be supported by suitable type beam welding attachments.
- H. The base of piping at circulating pumps shall be supported by pipe stanchions. Pipe stanchions shall be a minimum of 30 percent of the nominal pipe size of the pipe being supported. The base plate shall be a minimum ½ inch thick and its size shall be selected for fastening to the floor with a minimum of four (4) ½ inch bolts.
- I. Piping connections to pressure vessels, chillers, heat exchangers, air separators, and basket strainers shall be supported from overhead in such a manner that no pipe load is exerted on the vessel nozzles.
- J. Vertical piping 8 inches and larger shall be supported at its lowest level by pipe stanchions. Pipe stanchions shall be a minimum of 30 percent of the nominal pipe size of the pipe being supported. It shall be provided with a base plate limiting loading on the structure to 2000 pounds per square feet. The riser shall be supported on higher levels by riser clamps. Clamps shall be restricted from movement along the pipe by welding a minimum of four (4) shear lugs to the pipe. Refer to PFI Standard ES-26 for the shear lug requirements. Support locations shall be selected to permit uniform loading, provision for expansion or to suit space limitations. The riser clamps at exposed locations shall be of such design as to avoid creating a hazardous or unsightly condition and staying within space limitations.

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- K. Support spacing for horizontal steel piping: Support spacing listed below is the maximum normal spacing, and does not reduce the need for additional hangers and supports when specified elsewhere.

Steel Pipe Size	Minimum Rod Size	Maximum Support Spacing
8 inches	7/8 inch diameter	12 feet – 0 inches
10 inches	7/8 inch diameter	12 feet – 0 inches
12 inches	7/8 inch diameter	12 feet – 0 inches
14 inches	1 inch diameter	12 feet – 0 inches
16 inches	1 inch diameter	12 feet – 0 inches
18 inches	1 inch diameter	12 feet – 0 inches (<i>See Note Below</i>)
20 inches	1-1/4 inch diameter	12 feet – 0 inches (<i>See Note Below</i>)
24 inches	1-1/4 inch diameter	12 feet – 0 inches (<i>See Note Below</i>)
30 inches	1-1/2 inches diameter	12 feet – 0 inches (<i>See Note Below</i>)

NOTE: For pipe sizes 18 through 30 inches, the support load requirements exceed the capacity requirements of standard manufactured supports. Therefore, use of larger support spacing is permitted only when custom designed supports are provided.

- L. Support spacing for horizontal PVC piping: Support spacing listed below is the maximum normal spacing, and does not reduce the need for additional hangers and supports when specified elsewhere. Additionally, provide support at every pipe joint.

PVC Pipe Size	Minimum Rod Size	Maximum Support Spacing
8 inches	3/4 inch diameter	4 feet – 0 inches
10 inches	3/4 inch diameter	4 feet – 0 inches
12 inches	3/4 inch diameter	4 feet – 0 inches

2.5 EQUIPMENT SUPPORTS

- A. Provide welded, shop-fabricated or field-fabricated equipment supports made from structural-steel shapes as required by the contract documents.
- B. Equipment supports shall be capable of supporting the combined operating weight of supported equipment and the connected systems and components.
- C. Provide the services of a Professional Engineer who is registered in the State of Ohio to perform analyses for equipment supports provided.

2.6 PREFABRICATED ROOF SUPPORT RAILS, CURBS, AND PIPE PORTALS

- A. General: Provide prefabricated equipment mounting rails for installation of roof mounted equipment, duct curbs, duct mounting rails, and prefabricated pipe portal systems for pipe lines extended through the roof. Openings in the roof, setting of curbs and rails, and base flashing, etc. shall be provided by the Contractor performing the roofing work. Installation of equipment, piping, ductwork, counterflashing, supports, etc. shall be provided by the Division 23 Contractor.

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- B. Construction: Rails shall be 14 gauge galvanized steel of monolithic construction with integral base plate, continuous welded corner seams, factory-installed treated wood nailers, 1-½ inches thick 3 pounds per cubic foot density fiberglass insulation adhered to inside of curb walls and 24 gauge galvanized steel counterflashing. Heights and lengths shall be as required for installation of the equipment shown. Overall height of rails and curbs shall be 16 inches.
 - 1. Pipe portal curb bases, and duct support rails and curbs for ductwork extending through roof shall be as specified above except construction shall be eighteen (18) gauge galvanized steel.
- C. Pipe Portal Curb Covers: The pipe portals shall be furnished with a laminated acrylic coated ABS plastic curb cover with pre-punched holes and molded sealing ring on an 8 inches collared opening and an EPDM compression molded rubber cap and necessary stainless steel clamps.
 - 1. Curb covers shall be resistant to ozone and ultraviolet sun rays and shall have a serviceable temperature range of minus 40 to plus 160 degrees Fahrenheit. The molded sealing ring on the collared opening and the groove in the rubber cap shall be installed to assure a weathertight pressure and mechanical lock. The protective rubber caps shall have a serviceable temperature range of minus 60 to plus 250 degrees Fahrenheit and shall also be resistant to ozone and ultraviolet sun rays. The conical shaped steps of the nipple shall provide a taut waterproof seal around the pipe. The stainless steel clamps shall provide added protection to guarantee the seal.
- D. Provide sheet metal rain caps and counterflashing for large diameter piping and ductwork that extend through curbs. The rain cap and counterflashing shall be constructed of 24 gauge galvanized sheet steel with seams soldered or brazed. The exposed surface of the rain cap shall be bitumastic coated for a completely watertight installation. Counterflashing shall be securely clamped directly to the pipes and ducts by means of a flashing collar to form a watertight seal. Exterior insulation, aluminum pipe jacketing, and duct weatherproofing shall be installed over top of counter-flashing. Thoroughly seal where insulation terminates. Rain cap shall be insulated by adhering 2 inches thick, 3 pounds per cubic foot density glass fiberboard insulation to interior surface.
- E. Duct curb shall be equivalent to Roof Products Systems Corporation Model RC-3B (or 4B for raised cant if required. Coordinate Roof Type with General Contractor)
- F. Equipment rails shall be equivalent to Roof Products Systems Corporation Model ER-3B (or 4B for raised cant if required.
- G. Piping portal shall be equivalent to Roof Products Systems Corporation Model RC-3B (or 4B for raised cant if required. Coordinate Roof Type with General Contractor)

PART 3: EXECUTION

3.1 HANGERS AND SUPPORT SCHEDULE

Building Construction	Pipe Support Method
Poured concrete floor slabs	Galvanized steel inserts, and/or fishplates of sufficient area to support slabs twice the calculated dead load.
Building structural steel	Beam attachments and similar devices.
Precast concrete floor slabs	Fishplates of sufficient area to support twice the calculated dead load and approve type specialty hanger accessories manufactured for the specific purpose of attaching to precast floors.
Metal deck floor flabs with concrete fill	Galvanized steel inserts and/or fishplates of sufficient area to support twice the calculated dead load, and approved type specialty hanger accessories Manufactured for the specific purpose of attaching to metal deck floors.

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Building Construction	Pipe Support Method
Concrete slabs where piping revisions are required and approved after slabs are poured or existing concrete slabs	“Phillips” or “Hilti” expansion bolts and shields for piping 4 inches and smaller, with main supports welded to structural steel at maximum 20 feet on center 4 inches by 4 inches by $\frac{3}{8}$ inch thick clip knee angles with $\frac{3}{4}$ inch expansion bolt in shear (horizontal) and supporting rod at 90 degrees from anchor bolt for piping greater than 4 inches, attached to concrete beams or columns
Concrete floor slabs on grade with ground water condition	Drainage, waste and vent piping to be encased in slab construction.

3.2 CURB, RAIL, AND PIPE PORTAL INSTALLATION.

- A. Ductwork, piping, equipment, fans, etc., which are roof mounted shall be furnished with equipment rails.
- B. Curb and rail type shall be compatible with roof.
- C. Duct and pipe penetrations through roof shall be furnished with curb.
- D. Furnish roof curbs and rails for sloping roofs with adjustments as required to level top of rail or curb.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Provide hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, loops, and bends.
- C. Provide lateral bracing with pipe hangers and supports to prevent swaying.
- D. Provide building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install hangers and supports so piping loads and stresses from movement will not be transmitted to connected equipment.
- F. Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- G. Trim excess length of continuous-thread hanger and support rods to 1- $\frac{1}{2}$ inches.

END OF SECTION 230529

SECTION 230530 – ADJUSTABLE FREQUENCY DRIVES

PART 1: GENERAL

1.1 SCOPE

- H. This specification describes the electrical and mechanical requirements for three phase AC adjustable frequency drives (variable frequency drives) as specified herein and shown on the contract drawings. All drives furnished for this project shall be from a single manufacturer unless specifically indicated otherwise.
- I. The Adjustable Frequency Drive (AFD) Manufacturer shall supply the drive and all necessary controls specified herein. The manufacturer shall have been producing this type of equipment for a minimum of ten (10) years. The AFD shall be purchased through a local supplier located no further than forty (40) miles from the project site.
- J. Sizing: AFD shall be rated for the actual rated full load amps of the driven motor operating at the upper limit of its service factor.

1.2 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.
- B. Division 23, Section 230531: Motor Controllers for across the line motor starters.
- C. Division 23, Section 230900: Integrated Automation for Control System for the requirements of the automatic temperature control system.
- D. Division 23, Section 230500: Common Work for HVAC for electrical/mechanical coordination, including delineation of responsibilities for control and control power wiring.

1.3 REFERENCES

- A. IEEE – Institute of Electrical and Electronic Engineers
 - 1. Standard 519-1992, governing recommendations for harmonic content and control
- B. UL and cUL – Underwriters' Laboratory
 - 1. UL508C, governing adjustable frequency drives in the United States and Canada
- C. NEC – National Electric Code
 - 1. Governing both the base drive and all configurations thereof
- D. IEC – International Electro – Technical Commission
 - 1. IEC 16800, governing international standards for adjustable frequency drives
- E. NEMA – National Electrical Manufacturer's Association
 - 1. In accordance with the latest applicable standards

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1.4 SUBMITTALS

- A. The following shall be submitted to the Engineer for approval:
1. Scope of project, highlighting the bill-of-material for approval
 2. Terminal block and customer connection diagrams
 3. Electrical diagrams demonstrating power connections of key components
 4. Dimensional outline drawings, including approximate weight
 5. The AFD Manufacturer shall submit a complete harmonic analysis based on the system and utility data. The analysis shall clearly show the size and type of harmonic suppression equipment being provided to comply with IEEE 519, 1992, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
 6. The name and contact information for the factory authorized representative that shall assist with the initial start-up, testing, and programming of the drive.
- B. The following will be submitted to the Architect upon project completion:
1. Final as-built drawings
 2. Installation and Operation manuals and replacement parts lists
 3. Wiring diagrams depicting all control and power wiring and control devices

1.5 WARRANTY

- A. The Contractor's parts and labor warranty shall be twenty-four (24) months from the date of start-up. Warranty shall include all parts, labor, and the service technician's travel expenses for the entire 24-month period.

1.6 RESPONSIBILITIES

- A. The AFD Manufacturer shall furnish the following:
1. Complete AFD's ready for installation
 2. A complete set of submittals as described herein
 3. All engineering and installation services as described herein
 4. All startup services as described herein
 5. Instructions to the Owner as described herein
 6. Owner's manuals, complete operation instructions, and spare parts lists as described herein
 7. A minimum 1-year parts and labor warranty
- B. The work by the Division 23 Contractor shall include the following:
1. Provide the AFD Manufacturer with a complete set of approved shop drawings for each pump and fan that will be driven by the AFD's. Shop drawings will include pump and fan curves with operating points designated and will also include the motor shop drawings. (V belt drive losses will be assumed to be in accordance with AMCA Standards for fans.)
 2. Provide for deliver, handling and installation of the AFD's.

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3. Provide all installation and assembly work using appropriate tradesmen as required. In addition, if the AFD's require any assembly or are delivered in more than one piece per AFD, all assembly and wiring inside the cabinets shall be provided. This wiring shall not include wiring to external control devices that are provided by the building automation system supplier.
4. Provide level housekeeping pads in accordance with the AFD Manufacturer's shop drawings.
5. Provide all interconnecting control wiring between the AFD's and the building automation system.
NOTE: All control wiring shall be tagged near terminal strip connections and checked by the AFD Manufacturer to verify proper connection to individual terminal strips.
6. Provide the Electrical Contractor with shop drawings and locations of the AFD's for coordination of electrical rough-ins.
7. Provide fuses and overload heaters.
8. Provide the AFD Manufacturer with electrical single line drawings of the facility power distribution and other electrical data required for the AFD manufacturer's harmonic analysis.
9. Coordination with the automatic temperature controls supplier/sub-Contractor to make all operational and control parameter adjustments, including lock-out of any resonant speeds. The manufacturer's authorized representative shall be present for all drive commissioning and set-up procedures/adjustments.

C. The work by the Division 26 Contractor shall include the following:

1. Provide all power wiring between the power sources and the AFD's and between the AFD's and the motors.
2. Jog each motor and verify proper motor rotation.

PART 2: PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

A. Manufacturers:

1. Danfoss
2. Graham
3. MagneTek
4. Square D
5. Toshiba

B. Adjustable Frequency Drives

1. The AFD's shall be rated for 208 volts AC, 230 volts AC, or 480 volts AC input voltage as shown on the drawings. The AFD shall provide microprocessor-based control of three-phase induction motors.
2. The AFD shall be a solid-state design, utilizing buffered pulse-width modulation to convert utility input power to an adjustable frequency output.
3. The AFD shall utilize soft-switching Insulated Gate Bipolar Transistors (IGBT) and be capable of operating without damaging the insulation in a NEMA B induction motor with MG1-1998 Part 3, Section 4.4.21 type insulation and with a drive to motor lead length of 300 feet.
 - a. Provide minimum 5 percent impedance type load reactors installed in series with the AFD output terminals. The reactors shall be specifically designed to reduce voltage waveform dV/dT and shall be tolerant of all possible carrier frequency settings. No drives using SCRs in the output circuitry will be accepted.

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4. Drive Design: Minimum six (6) pulses.
5. The controllers' full load current ratings shall be based on a variable torque application, 110 percent overload for one (1) minute, in a maximum 40 degrees Celsius ambient environment.
6. The AFD's continuous full load amp rating shall meet or exceed the full load current values specified in NEC Table 430-150 for the driven motor after de-rating the AFD for the ambient temperature requirements of this specification and the AFD carrier frequency settings that have been made.
7. The AFD's carrier (IGBT switching) frequency shall be adjustable. AFD's with fixed carrier frequencies will not be accepted. The frequency shall be adjustable from a value as low as .75 kilohertz at intervals not exceeding 1 kilohertz.
 - a. The AFD's shall be able to operate with carrier frequency up to 15 kilohertz for drives below 30 horsepower at 460 volts, up to 10 kilohertz for drives greater than 30 horsepower up to 100 horsepower at 460 volts, and up to 6 kilohertz for all drives over 100 horsepower at 460 volts. Drive shall be capable of producing continuous full load motor current as specified in NEC Table 430-150 across the entire switching frequency range.
 - b. Carrier frequency settings shall be field adjusted to the lowest value that does not create objectionable noise in occupied spaces in order to minimize motor temperatures.
8. The maximum sound level at the motor and drive shall be 80 decibels, a scale at 5 feet with the highest carrier frequency setting.
9. The controller and all the options listed in this specification shall be housed in a self-contained NEMA 1 steel enclosure where indoors and a NEMA 3R enclosure with ventilation fan and openings shall be used where installed outdoors.
10. The AFD shall include, within the drive enclosure, all necessary components to meet the National Electric Code requirement for full branch circuit protection.
11. AFD shall incorporate a lockable exterior disconnect switch. Provide an input circuit breaker with handle interlocked with the enclosure door.
12. The AFD's shall have a minimum power factor of 0.95 and shall have a minimum operating speed control range of 6 hertz to 120 hertz.
13. The AFD's shall have efficiency at full load and speed no less than 97 percent. Efficiency shall exceed 90 percent at 50 percent speed and load.
14. The AFD's shall operate in humidity of 5 to 95 percent, non-condensing.
15. The AFD's shall operate without fault in altitudes up to 3300 feet (1000 meters) above sea level.
16. The AFD shall include the following features as standard:
 - a. Regardless of horsepower size, drives shall have a 3 percent impedance input line reactor and a DC link choke provided as an integral part of the AFD and it shall be mounted within the drive enclosure.
 - b. All printed circuit boards in the AFD shall be protected with a factory applied conformal coating.
 - c. All AFD's shall have the same operator interface/keypad regardless of horsepower rating. The keypad shall be removable, capable of remote monitoring and control, and provide a copy feature to copy parameter values from one drive to another.
 - d. The keypad shall offer an alphanumeric LCD display that uses plain English for set-up, programming, and monitoring. A four-digit LED display shall also be utilized.
 - e. The keypad shall use Hand-Off-Auto functionality to provide easy transfer from different operating modes. The keypad shall offer one-touch speed set when operating in Hand mode.
 - f. Minimum two (2) sets of auxiliary relay contacts (one NO and one NC).

- g. The AFD's shall provide the follow displays or meters:
 - 1) Output frequency (hertz)
 - 2) Motor speed (revolutions per minute)
 - 3) Motor speed (percent)
 - 4) Motor current (amps)
 - 5) Motor power (kilowatts)
 - 6) DC bus voltage (volts DC)
 - 7) Output voltage (volts)
- h. The AFD's shall operate continuously without fault with input voltagess of 480 volts AC -15 percent/+10 percent.
- i. The AFD's shall be suitable for use on circuits delivering up to 60,000 AIC RMS symmetrical, 480 volts maximum.
- j. The AFD's shall start into a spinning load, when required, without fault.
- k. The AFD shall be able to provide continuous full load motor current as specified in NEC Table 430-150 while operating in an ambient temperature range of from minus 10 to 40 degrees Celsius.
- l. The AFD's shall accept 0 to 10 volts DC or 4 to 20 milliamps input reference signals without the need for jumpers.
- m. The AFD's shall be protected against the following conditions:
 - 1) Over current (VFD shall tolerate 150 of rated current for one minute.)
 - 2) Over voltage (110 percent average)
 - 3) Under voltage (80 percent minimum)
 - 4) Input phase loss
 - 5) Incoming surge
 - 6) Output phase loss
 - 7) Inverter over temperature (heat sink over temperature)
 - 8) Motor stalled
 - 9) Motor overload (over temperature) sized to match motor's full load current
 - 10) Motor under load (broken belt/shaft)
 - 11) Ground fault
 - 12) Logic board failure
- 17. The AFD's shall have a flexible programming environment, with the following basic programmable features:
 - a. Separately adjustable acceleration and deceleration points, with two independent sets and a configurable range of .01-3600 seconds.
 - b. Instantaneous electronic trip when the current demands of the inverter exceed its intermittent rating.
 - c. In the event a speed follower signal is lost, the AFD's shall have the programmable option of having the drive stop and display a fault, running at a preset speed, or running at the least known speed of the good signal.

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- d. The AFD's shall offer PID control as standard with fully configurable proportional, integral, and derivative gains. The set point shall be adjustable from the keypad, analog input, or through communication protocols.
- e. The AFD's shall utilize 'bump less' transfer for HOA, allowing the AFD to switch between local and live remote speed settings without faulting and without the use of additional relays.
- f. Auto-Restart feature: Upon restoration of power following an outage or after the clearing of a fault condition, the drive shall be capable of automatically re-starting.
- g. The AFD shall have programmable inputs and outputs:
 - 1) Analog Inputs
 - 0 to 10 volts DC
 - 4 to 20 milliamps
 - 2) Outputs
 - Form C fault relay
 - Programmable form A relay
 - Two (2) open collector
- h. Manufacturer shall be capable with communicating with the building Direct Digital Control (DDC) system. The AFD's shall include RS-485 communications utilizing the ModBus RTU protocol. Coordinate requirements with the DDC system supplier/sub-Contractor.

18. Optional Features

- a. Drive shall be enclosed in a steel enclosure to reduce EMI/RFI and insure protection from access to energized components.
- b. Control Power Transformer to utilize 120 volts control.
- c. LED-type pilot lights (green – off; red – on).
- d. Contractor Manual Bypass:
 - 1) Drive input, drive output and bypass circuit contactors, sized per NEC and IEC ratings.
 - 2) Control of the bypass shall utilize a large mimic diagram utilizing indicator lights for status and a switch for Inverter-Off-Bypass selection.
 - 3) Bypass design must meet NEC Type II coordinated circuit configuration. No three phase power shall feed the line side of the inverter when the bypass is selected.
 - 4) Bypass-inverter-off switch and indicating pilot lights.

19. Spare Parts

- a. Provide one set of fuses or overloads that naturally fail due to faults within the power distribution system or at the motor for each AFD provided.

20. Labeling

- a. Provide labels on each AFD. Refer to Division 23, Section 230553: Identification for HVAC for additional requirements. Name tags shall include fan or pump name and tag number (e.g.: Supply Fan SF-3, Hot Water Pump P-6, etc.)

PART 3: EXECUTION

3.1 INSTALLATION

- A. The Division 23 Contractor shall furnish and install the AFD. Drives shall be installed in accordance with the manufacturer's recommendations as outlined in the instruction manual and in accordance with NEC Article 110-26 and all applicable articles of the NEC. The Division 26 Contractor shall complete power wiring. The Division 23 Contractor shall be responsible for startup, warranty, training, and spare parts.
- B. Threaded fasteners and compatible shields/inserts shall mechanically secure the drives to walls and floors. Tamper-proof and non-threaded fasteners (such as powder actuated fasteners) shall not be used.
- C. Drives shall be set such that the keypad and display are between 4 feet-8 inches and 5 feet-5 inches above the finished floor.
- D. All wiring, wiring terminations, conduits, and conduit supports shall be made in accordance with all applicable Division 26 provisions.

3.2 FIELD QUALITY CONTROL AND TRAINING.

- A. Commissioning of the AFD's shall be done by an authorized service representative to assist the Contractor with start-up of the equipment specified under this section.
- B. Inform the Owner a minimum of seven (7) days in advance of commissioning. An Owner's representative will be present for the commissioning effort and the training session shall occur at that time.
- C. The Contractor shall provide a training session for Owner's representatives. The training shall be conducted by the manufacturer's authorized representative and shall include:
 - 1. Instructions on the proper operation and maintenance of the equipment
 - 2. At the time of training, the Owner's representative shall be furnished with two complete copies of the VFD submittal and all operations and maintenance information in 3-ring binders.
 - 3. Instructions regarding the automatic re-start features.

3.3 PRODUCT SUPPORT

- A. The manufacturer of the AFD's shall have factory-trained application and service personnel that are thorough versed in the operation of the drive equipment, available by phone or email for immediate assistance.

3.4 START-UP SERVICE

- A. The AFD Manufacturer shall provide start-up service for each AFD on the project. In providing this service, it shall be expressly understood that the AFD Manufacturer's representative shall be present during initial equipment startup and shall sign a startup data sheet or checklist for each AFD. Do not initially energize any AFD except in the presence of the AFD Manufacturer's representative.
- B. The start-up service shall include the following:
 - 1. Verify all control and power wiring connections.
 - 2. Check power lugs on source and load sides and tighten as required.
 - 3. Jog each motor to verify proper rotation.

4. Start and operate the AFD including fan or pump.
 5. Operate each safety device. Repair each device as required.
 6. Physically check each fan and AFD at start-up and shut down to insure no abnormal or problem conditions exist.
 7. Following successful start-up of the AFD's, the manufacturer's representative shall provide a minimum of sixteen (16) hours instruction to the Owner's operators. Training will consist of one or two separate sessions, dates selected by the Owner.
- C. The start-up service by the AFD Manufacturer shall also include a one-week period for simultaneously monitoring the incoming power and the load side power to problem drives with Dranetz meters.
1. It shall be the AFD Manufacturer's responsibility to prove that the problems exist outside of the AFD itself, i.e., to prove the AFD itself is not at fault.
 2. Should this testing prove that the problems exist inside the AFD, this service shall be performed at no additional cost to the Owner.
 3. Should this testing prove that the problems exist outside of the AFD, i.e., problem is with electrical distribution system or with motor or with the fan/pump, the testing costs shall be borne by the responsible trades.

3.5 HARMONIC ANALYSIS AND CORRECTION

The AFD Manufacturer shall perform a harmonic analysis of the AFD's to be installed at the input of the utility distribution transformer before and after installation of AFD's to confirm that the system is in compliance with the recommendations for General System applications per IEEE-519-1992, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. The analysis shall include an electrical single line drawing defining the resistance and impedance of each wire run and transformer leading to each AFD. The analysis shall be computer generated and shall utilize a Fourier analysis of the system.

The results shall list the current and voltage amplitudes of all harmonics up to at least the 50th level of the defined point common coupling. For the purpose of this specification, the point common coupling shall be defined as the primary side of the main utility distribution transformer feed to the AFD equipment.

- D. The Electrical Contractor will provide electrical single line drawings and all other required data to the AFD Manufacturer to complete the harmonic analysis. The information shall include:
1. The utility transformer kilovolts-ampere and impedance
 2. Primary and secondary voltage
 3. Short circuit current available at the primary of the transformer
 4. Typical configuration of the electrical system
 5. The length, size, and number of wires per phase of all feeders to the AFD
 - a. To the panelboard, motor control center, or switchboard feeding the AFD
 - b. To the AFD's from the panelboard, motor control center, or switchboard
 - c. To the motors from the AFD

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- E. The AFD Manufacturer shall be responsible for the added cost of the addition of an active harmonic filter as required to meet IEEE 519, 1992, at no additional cost to the Owner. This obligation extends to all installation and wiring work required to install the active front end. The proposed solution shall be approved by the Architect/Engineer prior to implementation.
- F. The AFD Manufacturer shall provide a field harmonic test to confirm that the computer analysis is accurate. This test shall be provided after all AFD's are installed at the site. The test shall be for a period of 1 to 5 days depending on the quantity of AFD's provided. Measurements shall include voltage distortion, current distortion and power factor at the point common coupling per IEEE 519, 1992. The test shall be run for the full range of drive operation as is practicable.
- G. The Division 23 Contractor shall provide motor nameplate data.

END OF SECTION 230530

SECTION 230531 – MOTOR CONTROLLERS

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 enclosed controllers rated 600 volts and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Sentinel switches.
 - 3. Solid state speed controllers for single phase motor applications.
- B. Related sections include the following:
 - 1. Division 23, Section 230530: Adjustable Frequency Drives for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 horsepower.
 - 2. Division 23, Section 230500: Common Work for HVAC for electrical/mechanical coordination, including delineation of responsibilities for control and control power wiring.
- C. Division of Responsibilities: The Division 23 Contractor shall furnish and set in place all required motor controllers for equipment furnished under this division, including fuses and overload heaters. The Division 26 Contractor shall provide all power wiring to and from the controllers. All control wiring and associated conduits shall be the responsibility of the Division 23 Contractor.
- D. Sizing: Motor Controllers shall be sized in compliance with NFPA 70 considering the actual rated full load amps of the driven motor operating at the upper limit of its service factor.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate data.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

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2. Wiring Diagrams: Power, signal, control wiring and all control devices.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and testing agency.
- E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 1. Routine maintenance requirements for enclosed controllers and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a Nationally Recognized Testing Laboratory (NRTL) as defined by Occupational Safety and Health Administration (OSHA) in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. 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.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03, Section 033000: Cast-in-Place Concrete.
- C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Spare Fuses: Furnish one (1) spare for every five (5) installed, but no fewer than one (1) set of three (3) of each type and rating.
 2. Indicating Lights: Ten (10) of each type installed.

PART 2: PRODUCTS

2.1 MOTOR SENTINEL SWITCHES

- A. Provide for fractional horsepower motors where no remote control is required. (Toggle switches may be used for controlling single phase motors of 1/8 horsepower or less rating equipped with integral thermal protection).

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with “quick-make, quick-break” toggle or pushbutton action, and marked to show whether unit is “off,” “on,” or “tripped”.
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.
 1. Control Circuit: 120 volts; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

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2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, selectable Class 10/20/30 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch. Magnetic controller portion shall comply with the paragraph above.
1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
 2. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- D. Factory Finishes: Manufacturer's standard light gray, ANSI 61, paint applied to factory assembled and tested enclosed controllers before shipping.
- E. Accessories:
1. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
 2. Delete any remaining paragraphs and subparagraphs if not applicable. Coordinate with Drawings.
 3. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
 5. Control Relays: Auxiliary and adjustable time-delay relays.
 6. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
 7. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.
- F. Subject to compliance with requirements, provide products by one of the following:
1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary
 2. Danfoss Inc.; Danfoss Electronic Drives Div.
 3. General Electrical Company; GE Industrial Systems
 4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group
 5. Siemens/Furnas Controls
 6. Square D

2.3 SOLID STATE SPEED CONTROLLERS FOR SINGLE PHASE MOTORS

- A. UL listed. 120 volts, solid state, full wave phase control circuitry with infinitely variable speed adjustment. High-gain RFI suppression filter, minimum speed trim, and integral on-off control knob. 15 amps rating and compatible with shaded pole or permanent split capacitor motors. KB Electronics “KBWC-115” or approved equal.

2.4 ENCLOSURES

- A. Description: Flush or surface mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3: EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower and full load current rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 provisions.
- B. Install freestanding equipment on concrete bases. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.
- D. Identify enclosed controller, components, and control wiring according to Division 26 provisions.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual and automatic control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low and high pressure cutouts, high-temperature cutouts, and motor overload protectors.

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3.5 CONNECTIONS

- A. Conduit installation requirements are specified in Division 26 sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Report results in writing.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control – Motor Starters". Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01.

END OF SECTION 230531

SECTION 230533 – ELECTRIC HEAT TRACING

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. Self-regulating electric heat tracing
- B. Controls
- C. Accessories

1.3 SUBMITTALS

- A. Provide the following with shop drawing submission:
 - 1. Tabulation of Each Heat Trace Circuit including ID number, pipe name, pipe size, pipe length, heat trace size, heat trace length, normal circuit current draw (amps), and inrush circuit current draw (amps at 0 degrees Fahrenheit)
 - 2. Electrical Schematic of Total Heat Trace System including each heat trace circuit (include ambient thermostat, pipe line thermostats and circuit draw from previous tabulation; recommend circuit size)
 - 3. Isometric Schematic of Piping identifying each circuit location and each thermostat location
 - 4. Product Data (include derating for 277 volts)
 - 5. Installation Data

PART 2: PRODUCTS

2.1 ELECTRIC HEAT TRACING

- A. Electric heat tracing shall be of the self-regulating type in which the power output is regulated in response to the pipe temperature. Heat trace conductor shall:
 - 1. Decrease output as the system reaches thermal stability.
 - 2. Be capable of being cut to desired lengths in the field.
 - 3. Be capable of overlap without burnouts.
 - 4. Be capable of splicing anywhere along its length.
- B. Heat tracing shall operate on available electrical power. Unless shown otherwise on the drawings, heat tracing shall be 277 volts.

- C. Heat tracing shall be rated for 150 degrees Fahrenheit maximum continuous exposure temperature in a nonhazardous environment. Tracing shall consist of a flat, flexible, low heat density electric heater strip of parallel circuit construction, consisting of two (2) 16 American wire gauge (AWG), buss bars and a continuous inner core of self-regulating conductive polymer material. This core shall be insulated with a polyolefin jacket plus provided with a tinned copper braid and an outer jacket of either fluoropolymer or polyolefin covering the braid as appropriate for the application.
1. Manufacturers (pipe sizes 6 inches and smaller):
 - a. Raychem 5XL
 - b. Nelson LT5-J
 - c. Delta-Therm IN5-F
 2. Manufacturers (pipe sizes 8 inches and larger):
 - a. Raychem 8XL
 - b. Nelson LT8-J
 - c. Delta-Therm IN8-F
- D. Heat tracing on flat surfaces shall be rated for 150 degrees Fahrenheit maximum continuous exposure temperature in a non- hazardous environment. Tracing shall consist of a flat, flexible, low heat density electric heater strip of parallel circuit construction, consisting of two (2) 16 AWG buss bars and a continuous inner core of self-regulating conductive polymer material. This core shall be insulated with a polyolefin jacket plus provided with a tinned copper braid and an outer jacket of either fluoropolymer or polyolefin covering the braid as appropriate for the application.
1. Manufacturers:
 - a. Raychem 8XL
 - b. Nelson LT8-J
 - c. Delta-Therm IN8-F
- E. All valves and fittings shall be insulated with equivalent pipe lengths of heater strip in accordance with manufacturer's recommendations.

2.2 CONTROLS

- A. Provide the Manufacturer's Standard Control and Monitoring package with LED panel display indicating program mode, actual temperature, control temperature, heater current, power on, heater on, alarm conditions, programming parameters, and ground fault/overcurrent protection. Provide appropriate contacts for monitoring of circuits alarm and status conditions by the building automation system. Monitor power availability on load side of circuit protection.
1. Provide control panel enclosure as follows:
 - a. NEMA 12 for indoor applications
 - b. NEMA 4 for outdoor applications

2. Manufacturers:
 - a. Raychem HTPG
 - b. Nelson CM-1
 - c. Delta-Therm GFPE
- B. Each length of heat trace on piping with normally active flow shall be controlled by a strap-on pipe thermostat to prevent operation above 40 degrees Fahrenheit. An outdoor ambient thermostat shall be provided to de-energize the entire circuit at outdoor temperatures above 50 degrees Fahrenheit.
- C. Each length of continuous pipe with possibly inactive flow (condenser water return riser and condenser water supply riser from sump) shall be provided with heat trace having its own strap-on pipe thermostat and junction box to prevent operation above 40 degrees Fahrenheit.
- D. Each length of continuous pipe with normally inactive flow (drain lines and dead end mains) shall be provided with heat trace and shall be automatically energized when outdoor ambient drops below 50 degrees Fahrenheit without use of a strap-on pipe thermostat.
- E. Each length of continuous pipe shall have its own junction box. All wiring between junction boxes shall be provided and shall be run in weatherproof conduit. A single source of power shall be provided by the Electrical Contractor to the heat trace control panel. The HVAC Contractor shall be responsible for the circuitry from the monitoring panel. All work will be performed by a registered electrical Contractor according to Division 26 Specifications. Individual piping circuits shall be wired separately from this source. Provide NEMA 3R disconnect switches to isolate individual heat trace circuits.

2.3 ACCESSORIES

- A. Provide heat tracing installation accessories as required for a complete and functional system including, but not limited to:
 1. Glass cloth, adhesive fiberglass tape, heat-conductive putty, clips and cable ties
 2. Splices, silicone end seals, and tee kits.
 3. Power connection kit
 4. Ground fault protection devices
- B. Provide warning tape on piping with heat tracing. Warning tape to be continuously printed “Electrical Tracing”; and be constructed of 3 millimeters vinyl with pressure-sensitive, permanent, waterproof, self-adhesive back.
 1. Width for markers on pipes 6 inches and smaller (including insulation): ¾ inch minimum
 2. Width for markers on pipes 8 inches and larger (including insulation): 1-½ inches minimum

PART 3: EXECUTION

3.1 INSTALLATION

- A. Install electric heating cable according to manufacturer's recommendations.
- B. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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- C. Install electric heating cables after piping has been tested and before insulation is installed.
- D. Install electric heating cables according to IEEE 515.1.
- E. Install insulation over piping with electric cables according to Division 23, Section 230700: HVAC Insulation.
- F. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- G. Set field-adjustable switches and circuit-breaker trip ranges.
- H. Protect installed heating cables and leads, from damage.
- I. Provide power wiring between control panel and individual heating cables per the requirements of Division 26.

END OF SECTION 230533

SECTION 230548 – VIBRATION CONTROLS

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 the following:
 1. Isolation Pads
 2. Isolation Mounts
 3. Restrained Elastomeric Isolation Mounts
 4. Freestanding and Restrained Spring Isolators
 5. Combination Elastomeric/Spring Hangers
 6. Spring Hangers with Vertical-Limit Stops
 7. Pipe Riser Resilient Supports
 8. Resilient Pipe Guides
 9. Steel and Inertia, Vibration Isolation Equipment Bases
 10. Flexible Hose Piping Connectors
 11. Spherical Rubber Flexible Connectors
 12. Stainless Steel Flexible Connectors

1.3 SUBMITTALS

- A. Product Data for the following:
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading (including thrust forces of fans) due to equipment weight and operation to select vibration isolators, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code – Steel”.

PART 2: PRODUCTS

2.1 GENERAL

- A. All rotating mechanical equipment shall be mounted on, or hung with, vibration isolators.
- B. The work specified herein shall include providing all labor, tools, equipment, materials, etc., necessary for a complete operational vibration isolation system.
- C. Isolators shall be selected to provide stable starting and stopping, and equipment shall not have excessive movement.
- D. When required to prevent excessive lateral motion due to fan starting, provide a lateral-type thrust restraint isolator. Lateral thrust restraint isolator shall not interfere with horizontal isolation.
- E. Select isolators for not less than the deflections indicated on the schedule. Isolators shall be properly selected for the weights of the mechanical equipment provided.
- F. Isolators, and associated fasteners located outdoors shall be hot dipped galvanized.
- G. External isolators for exterior equipment shall be provided with vertical restraint limit stops to prevent excessive vertical movement due to wind forces.
- H. Vertical restraint limit stops shall be used where the weight of the equipment can change significantly due to the drainage of water from the equipment (e.g. cooling towers, chillers).

2.2 VIBRATION ISOLATORS – GENERAL REQUIREMENTS

A. Springs

1. Spring isolators shall be freestanding, unhooused, laterally stable steel springs wound from a high-strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50 percent overload capacity.
2. Springs shall be selected to provide minimum operating static deflections shown on the vibration isolation schedule below.

B. Elastomer Element

1. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range.

C. Hanger Bracket

1. The hanger bracket shall be welded steel and designed to carry a 500 percent overload without failure and to allow a support rod misalignment through a 30 degrees arc without metal-to-metal contact or other short circuit.

2.3 BASES

A. Type 1 – Structural Rail Bases

1. Bases shall be structural beam sections, with welded-on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer.
2. Beam sections shall not be structurally connected to each other. Minimum section depth of each member shall be equivalent to 8 percent of the longest span between supporting isolators.
3. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment.
4. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model SBB
 - b. Mason Industries, Model ICS
 - c. Amber Booth Custom Fabricated Structural Steel Rail Bases

B. Type 2 – Integral Structural Rail Bases

1. Bases shall be fabricated from structural beam sections as described above, except that lateral cross members will be added to form a structurally integral, welded frame to provide a rigid, distortion-free common frame to support and anchor separate equipment components or driving and driven members.
2. Acceptable Products:
 - a. Peabody Noise Control, Inc. Model SFB
 - b. Mason Industries Model WF
 - c. Amber Booth Custom Fabricated Structural Steel Rail Bases

C. Type 3 – Concrete Inertia Bases

1. Bases shall be constructed of concrete cast into a prefabricated inertia base frame assembly designed and supplied by the isolation materials manufacturer. Concrete shall be cast into base in the field.
2. Frame members shall be welded to form a structurally integral assembly, complete with primer-painted steel perimeter members, welded and tied reinforcing rods, recessed isolator brackets, and equipment anchoring bolts. Bases shall be shipped ready for pouring of concrete fill in the field.

3. Acceptable Products:

- a. Peabody Noise Control, Inc., Model CIB
- b. Mason Industries Model K
- c. Amber Booth Custom Fabricated Structural Steel/Concrete Inertia Bases

2.4 ISOLATORS

A. Type A – Machinery Mounting Pads

1. Pad mounts shall be double ribbed elastomer multiple layer with metal shims between. Pads shall be 65 durometer and designed to permit 120 pounds per inch loading. Provide bearing plates to distribute loads.
2. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model NGD
 - b. Mason Industries Model WSW
 - c. Amber Booth Model SP-NR Style E.

B. Type B – Restrained Spring Isolators

1. Vibration isolators for equipment which is subject to load variations and large external or torqueing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment.
2. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure.
3. Spring elements shall meet all the specified characteristics described in paragraph 2.2 A of this section.
4. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model FLS
 - b. Mason Industries Model SLR
 - c. Amber Booth Model CT

C. Type C – Freestanding Isolators

1. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock-nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
2. Spring elements shall meet all the specified characteristics described in paragraph 2.2 A of this section.
3. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model FDS
 - b. Mason Industries Model SLF
 - c. Amber Booth Model SW

D. Type D – Neoprene Vibration Isolators

1. Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in top steel load transfer plate for bolting to supported equipment and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs.
2. Neoprene vibration isolators shall have minimum operating static deflections as shown on the vibration isolation schedule or as indicated on the project documents but not exceeding published load capabilities.
3. Except where support rails come integral with equipment, provide Type 1 or Type 2 rail bases to distribute the load.
4. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model RD
 - b. Mason Industries Model ND
 - c. Amber Booth Model RV.

2.5 THRUST RESTRAINTS

- A. Thrust restraints will be provided where required to reduce movements associated with fan thrust.
- B. Spring elements shall meet all the specified characteristics described in paragraph 2.2 A of this section.
- C. Thrust restraints will be provided in sets of two (2), mounted about the centerline of the fan outlet. The thrust restraints shall include threaded adjustment rod with hardware, fan and ductwork mounting bracket angles, bracket back-up plates, and all attachment hardware.
- D. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model HSR
 - b. Mason Industries Model WB
 - c. Amber Booth Custom Fabricated Thrust Restraints

2.6 HANGERS

A. Type E – Neoprene Hanger

1. Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40 inches shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap.
2. Elastomer insert shall meet all the specified characteristics described in paragraph 2.2 B of this section.
3. Hanger bracket shall meet all the specified characteristics described in paragraph 2.2 C of this section.
4. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model RH
 - b. Mason Industries Model HD
 - c. Amber Booth Model BRD

B. Type F – Spring Hanger

1. Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4 inches, shall be hangers consisting of a freestanding, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket.
2. Hanger bracket shall meet all the specified characteristics described in paragraph 2.2 C of this section.
3. The spring element shall meet all the specified characteristics described in paragraph 2.2 A of this section.
4. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model SH
 - b. Mason Industries Model PCHS
 - c. Amber Booth Model BSW-2

C. Type G – Combination Neoprene/Spring Hanger

1. Vibration isolators for suspended equipment, where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with an elastomer-in-shear insert, complete with load transfer plates and assembled in a welded steel bracket.
2. The elastomer-in-shear element shall meet all the specified characteristics described in paragraph 2.2 B of this section.
3. The spring element shall meet all the specified characteristics described in paragraph 2.2 A of this section.
4. The welded hanger bracket shall meet all the specified characteristics described in paragraph 2.2 C of this section.
5. Acceptable Products:
 - a. Peabody Noise Control, Inc., Model SRH
 - b. Mason Industries Model PCDNHS
 - c. Amber Booth Model BSWR-2

D. Additional Requirements for Spring Hangers

1. Springs on hangers for piping and ductwork shall be factory pre-compressed.

2.7 FLEXIBLE HOSE PIPING CONNECTORS

- A. Minimum 12 inches long flexible hose constructed of EPDM liner or a corrugated Type 321 stainless steel tube with outer stainless steel reinforcing braid. Rated for a maximum working temperature 200 degrees Fahrenheit. Rated for minimum working pressure of 300 pounds per inch in sizes up to 2 inches. Steel, threaded end connections.

2.8 STAINLESS STEEL FLEXIBLE CONNECTORS

- A. Stainless-steel bellows with woven, flexible, stainless- steel, wire-reinforcing protective jacket; 150 pounds per inch gauge minimum working pressure and 250 degrees Fahrenheit maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of ¾-inch misalignment.
- B. Acceptable Manufacturers:
 - 1. Metraflex ‘SST and ‘SLP’Mason Industries ‘FFL’ and ‘MN’
 - 2. Hyspan Series ‘4500’
 - 3. Flexicraft ‘FF Long’ and ‘TT Long’

2.9 SPHERICAL RUBBER FLEXIBLE CONNECTORS

- A. Molded twin spherical type with integral cable or control rod restraints, and reinforced with an external root ring between spheres. Neoprene or EPDM body with nylon or kevlar reinforcement, with internal steel wire, molded within the raised face ends. Connector pressure rating shall be at least 150 pounds per inch at 220 degrees Fahrenheit with a minimum 3 to 1 safety factor. Steel flanges shall be one-piece, free-floating, class 150.
 - 1. Control cables shall be of the galvanized aircraft type, and be an integral part of the joint requiring no field adjustment.
 - 2. Control rods with neoprene sleeves and neoprene washers to eliminate metal-to-metal contacts.
 - 3. On rotating equipment, install flexible rubber connectors parallel to the rotating shaft.
- B. Acceptable Manufacturers:
 - 1. Metraflex ‘DoubleCableShere’
 - 2. Mason Industries SafeFlex ‘SFDEJ’
 - 3. Flexicraft ‘Ultrasphere’

2.10 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory assembled and tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-and wind-control devices to indicate capacity range.

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PART 3: EXECUTION

3.1 APPLICATIONS

- A. Vibration isolation for equipment shall be provided in accordance with the schedule below except as otherwise noted on the drawings or in another specification section. In the event of a conflict between this table and another specific indication, the other specific indication as a whole shall take precedence over this schedule.

<u>EQUIPMENT LOCATION</u>												
ISOLATED EQUIPMENT	SLAB ON GRADE				LESS THAN 21' STRUCTURAL SPAN				21' STRUCTURAL SPAN OR MORE			
	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	
INDOOR WATER CHILLERS												
Centrifugal Screw, and Scroll	B	.75"	–	–	B	1.00"	–	–	B	1.75"	–	
Reciprocating	B	.75"	–	–	B	1.00"	–	–	B	1.75"	–	
Absorption	B	.75"	–	–	B	1.00"	–	–	B	1.75"	–	
COOLING TOWERS, AIR COOLED CHILLERS, EVAPORATIVE CONDENSERS, AND CLOSED CIRCUIT FLUID COOLERS												
<u>With Axial (Propeller) Fans</u>												
Less than 301 RPM	B	2.50"	–	–	B	3.50"	–	–	B	3.50"	–	
301 to 500 RPM	B	2.00"	–	–	B	2.50"	–	–	B	2.50"	–	
Above 500 RPM	B	1.50"	–	–	B	2.00"	–	–	B	2.00"	–	
<u>With Centrifugal Fans</u>												
Less than 301 RPM	B	2.50"	–	–	B	3.50"	–	–	B	3.50"	–	
301 to 500 RPM	B	2.00"	–	–	B	2.50"	–	–	B	2.50"	–	
Above 500 RPM	B	1.50"	–	–	B	2.00"	–	–	B	2.00"	–	
PUMPS												
<u>Inline (Hung)</u>												
Less than 15 HP	–	–	–	G	–	1.00"	–	G	–	1.50"	–	
<u>Base Mounted Closed Coupled (End Suction or In-Line)</u>												
Less than 10 HP	C	1.00"	2*	–	C	1.50"	3	–	C	1.50"	3	
10 HP and above	C	1.00"	3	–	C	1.50"	3	–	C	2.00"	3	
<u>Flexibly Coupled End Suction</u>												
Less than 50 HP	C	1.00"	3	–	C	1.50"	3	–	C	2.00"	3	
50HP and above	C	1.00"	3	–	C	1.50"	3	–	C	2.00"	3	
<u>Split Case</u>												
Less than 50 RPM	C	1.00"	3	–	C	1.50"	3	–	C	1.75"	3	
50 to 125 RPM	C	1.00"	3	–	C	1.50"	3	–	C	2.00"	3	
150 HP and above	C	1.00"	3	–	C	2.00"	3	–	C	2.00"	3	

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SLAB ON GRADE					LESS THAN 21' STRUCTURAL SPAN				21' STRUCTURAL SPAN OR MORE			
ISOLATED EQUIPMENT	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	
AIR COMPRESSORS												
<u>Tank Mounted</u>												
Less than 15 HP	C	1.00"	–	–	C	1.00"	–	–	C	1.75"	–	
150 HP and above	C	1.00"	3	–	C	1.00"	3	–	C	1.75"	3	
<u>Base Mounted</u>												
Less than 15 HP	C	1.00"	3	–	C	1.00"	–	–	C	1.00"	–	
150 HP and above	C	1.00"	3	–	C	1.00"	3	–	C	1.75"	3	
Reciprocating	C	1.00"	3	–	C	1.00"	3	–	C	1.75"	3	
RADIATORS, AIR COOLED CONDENSING UNITS, DRY COOLERS, AND AIR COOLED CONDENSERS												
Less than 301 HP	D	0.25"	–	–	B	3.50"	–	–	B	3.50"	–	
301 to 500 RPM	D	0.25"	–	–	B	2.50"	–	–	B	2.50"	–	
AIR HANDLING UNITS, UNIT HEATERS, CABINET FANS, FAN COILS, HEAT PUMPS, AND AIR CONDITIONING UNITS												
<u>Roof Mounted</u>												
	–	–	–	–	C	1.00"	4	–	C	1.75"	4	
<u>Below 15 HP</u>												
	D	0.25"	–	G	C	1.00"	–	G	C	1.00"	–	
<u>15 HP and above – 6" Static Pressure & Below</u>												
Less than 301 RPM	D	0.25"	–	G	C	3.50"	–	G	C	3.50"	–	
301 to 500 RPM	D	0.25"	–	G	C	2.50"	–	G	C	2.50"	–	
Above 500 RPM	D	0.25"	–	G	C	1.75"	–	G	C	1.75"	–	
STEAM CONDENSATE PUMPS AND CONDENSATE RECEIVER SETS												
	A	0.25"	–	–	B	1.00"	–	–	B	1.00"	–	
<u>15 HP and above – Over 6" Static Pressure</u>												
Less than 301 RPM	C	0.75"	2*	G	C	3.50"	3	G	C	3.50"	3	
301 to 500 RPM	C	1.00"	2*	G	C	2.50"	3	G	C	2.50"	3	
Above 500 RPM	C	1.00"	2*	G	C	1.75"	3	G	C	1.75"	3	
TUBE AXIAL, TUBULAR CENTRIFUGAL, AND SQUARE IN-LINE CENTRIFUGAL FANS												
<u>22" and Below Wheel Diameter</u>												
	D	0.25"	–	G	C	1.00"	–	G	C	1.00"	–	
<u>24" and above Wheel Diameter – 2" Static Pressure and Below</u>												
Less than 301 RPM	C	2.50"	2*	G	C	3.50"	3	G	C	3.50"	3	
301 to 500 RPM	C	1.00"	2*	G	C	1.75"	2*	G	C	2.50"	3	
Above 500 RPM	C	1.00"	2*	G	C	1.75"	2*	G	C	1.75"	2*	
<u>24" and above Wheel Diameter – Over 2" Static Pressure</u>												
Less than 301 RPM	C	2.50"	3	G	C	3.50"	3	G	C	3.50"	3	
301 to 500 RPM	C	1.75"	3	G	C	1.75"	3	G	C	2.50"	3	
Above 500 RPM	C	1.00"	3	G	C	1.75"	3	G	C	1.75"	3	

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ISOLATED EQUIPMENT	SLAB ON GRADE				LESS THAN 21' STRUCTURAL SPAN				21' STRUCTURAL SPAN OR MORE			
	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	HANGER	ISOLATOR	DEFLECTION	BASE	
BASE-MOUNTED CENTRIFUGAL FANS AND UTILITY SETS												
<u>22" and Below Wheel Diameter</u>												
50HP and below	D	1.00"	2*	G	C	2.00"	2*	G	C	3.00"	2*	
Above 50HP	C	1.75"	3	G	C	2.50"	3	G	C	3.00"	3	
<u>24" and above Wheel Diameter – 50 HP and Below</u>												
Less than 301 RPM	C	2.50"	2*	G	C	3.50"	2*	G	C	3.50"	2*	
301 to 500 RPM	C	1.75"	2*	G	C	2.50"	2*	G	C	2.75"	2*	
Above 500 RPM	C	1.75"	2*	G	C	2.00"	2*	G	C	2.00"	2*	
<u>24" and above Wheel Diameter – Above 50 HP</u>												
Less than 301 RPM	C	2.50"	3	G	C	3.50"	3	G	C	3.50"	3	
301 to 500 RPM	C	2.00"	3	G	C	2.50"	3	G	C	2.50"	3	
Above 500 RPM	C	1.75"	3	G	C	2.00"	3	G	C	2.50"	3	

*=Base 1 may be substituted for Base 2 provided isolated equipment is rigid and will resist torquing.

B. Notes for the above table:

1. Provide Type 1, 2, or 3 Base if required to stabilize supported equipment.
2. Provide 12 inches thick Type 3 Base for pumps over 75 horsepower.
3. Provide Type Base large enough to provide elbow support for piping.
4. Provide Type 1 or 2 Base if required to support equipment properly.
5. Isolator natural frequency shall be 40 percent of the lowest equipment operating speed.
6. Provide Type 3 Base weighing 10 times maximum equipment unbalanced forces.
7. Provide thrust restraints for fans scheduled to operate over 2 inches total static pressure and where the thrust force exceeds 10 percent of the fan weight.
8. Provide external vibration isolation on air handling units when factory supplied internal isolation is unavailable.

C. Noise and vibration isolator types and minimum operating static deflections for suspended or floor-mounted piping shall be as follows:

1. Type E, Type F, and Type G hangers, or Type A and Type C floor mounts, with minimum operating static deflections equivalent to 100 percent of connected equipment isolator deflection shall be used to support all piping over 1 inch outside diameter located within mechanical equipment rooms or for a minimum of 50 feet of piping length away from the equipment whichever is greater, from connections to vibration isolated mechanical equipment or electrical equipment (such as generators or radiators).
2. For suspended piping, use Type E or Type F. (*Exception:* The first five hanger points connected to isolated equipment shall be Type G.)

3. For floor-mounted piping, use a Type C isolator for the first five support points. The 6th point and beyond may be a Type A or C isolator.
- D. Noise and vibration isolator types and minimum operating static deflections for suspended or floor-mounted sheet metal ductwork, air plenums, duct silencers, and similar air distribution elements shall be as follows:
 1. Type G hangers, or Type C floor mounts with minimum operating static deflections equivalent to 50 percent of connected equipment isolator deflection, or ½ inch, whichever is greater, shall be used to support all sheet metal air distribution elements located within mechanical equipment rooms and for a minimum of 50 feet of duct length away from connections to vibration-isolated mechanical equipment.
- E. Isolator types are scheduled to establish minimum standards. Labor saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages, provided isolators supplied incorporate the specified isolator type and do not degrade the noise and vibration isolation of equipment mounted.
- F. Specified supplemental equipment base types can be deleted for unitary packaged air handling equipment having a rigid frame and casing providing a distortion-free platform for attachment of vibration isolators.
- G. Provide flexible connections on all ductwork connected to isolated equipment. Neoprene rubber flexible connection and mounting flange shall have a pressure rating at least 20 percent greater than duct system pressure.

3.2 FLEXIBLE CONNECTOR APPLICATIONS

- A. Provide flexible hose piping connectors on piping connections to the following rotating equipment:
 1. Suspended Water Source Heat Pumps
- B. Provide spherical rubber flexible connectors on all piping connections to hydronic pumps 10 horsepower and greater.
- C. Provide stainless steel flexible connectors on connections to the following:
 1. Closed circuit cooling towers
 2. ERU and other vibrating equipment piping connections larger than 2 inches
 3. Hydronic pumps less than 10 horsepower
- D. Provide stainless steel flexible connectors on piping crossing building expansion joints.

3.3 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 VIBRATION-CONTROL DEVICE INSTALLATION

- A. Comply with requirements in Division 07, Section 075000: Roofing Systems for installation of roof curbs, equipment supports, and roof penetrations.
- B. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor-bolt and mounting hole in concrete base.
- C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- E. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 FIELD QUALITY CONTROL

- A. The Contractor shall perform tests and inspections:
 - 1. Measure isolator deflection.
 - 2. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- B. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Equipment shall be level and plumb during operation.

SECTION 230553 – IDENTIFICATION 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 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.4 SUMMARY

- A. Section includes:
 - 1. Equipment Labels
 - 2. Warning and Information Labels
 - 3. Pipe Labels
 - 4. Duct Labels
 - 5. Valve Tags
 - 6. Ceiling Markers

PART 2: PRODUCTS

2.1 EQUIPMENT LABELS

- A. Provide multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - 1. Labels shall have a white background with black lettering.
 - 2. Labels shall be able to withstand temperatures up to 160 degrees Fahrenheit.
 - 3. Minimum Label Size shall not be less than 2-1/2 inches by 3/4 inch. Length and width can vary for required label content.

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4. Minimum Letter Size shall not be less than ¼ inch for name of units if viewing distance is less than 24 inches, ½ inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds ($\frac{2}{3}$) to three-fourths ($\frac{3}{4}$) the size of principal lettering.
 5. Fasten labels to equipment with stainless-steel rivets or self-tapping screws. Utilize contact-type permanent adhesive outdoors or for watertight applications.
- B. Primary label content is to include equipment's drawing designation or unique Owner's equipment number. Secondary label content is to include other information such as capacities, operating characteristics, or areas served.

2.2 WARNING AND INFORMATION LABELS

- A. Provide warnings and information labels where indicated on drawings or required by the specifications. Labels shall multilayer, multicolor, plastic labels for mechanical engraving, ⅛ inch thick, with predrilled holes for attachment hardware. Warning Labels shall have a yellow background with black lettering.
1. Information labels shall have a white background with red lettering.
 2. Labels shall be able to withstand temperatures up to 160 degrees Fahrenheit.
 3. Minimum label size shall not be less than 2-½ inches by 2-½ inches. Length and width can vary for required label content.
 4. Minimum letter size shall not be less than ¼ inch for name of units if viewing distance is less than 24 inches, ½ inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 5. Fasten labels where indicated with stainless-steel rivets or self-tapping screws. Utilize contact-type permanent adhesive outdoors or for watertight applications.
- B. Provide label content as indicated.

2.3 PIPE LABELS

A. Pipe Labels (Above Ground—Indoor)

1. Pipe bands indicating contents and flow direction shall be flexible vinyl film with acrylic pressure sensitive adhesive suitable for pipe surface temperatures of minus 40 to 220 degrees Fahrenheit.
2. Manufacturers:
 - a. Seton Opticode
 - b. W.H. Brady B-350 Perma-Code
 - c. Bunting Identiflow

B. Pipe Labels (Above Ground—Outdoor)

1. Pipe bands indicating contents and flow direction shall be snap-on markers consisting of a surface-printed and overcoat-protected vinyl base material suitable for pipe surface temperatures from minus 40 to 150 degrees Fahrenheit.
2. Manufacturers:
 - a. Seton Weather-Code, Style AA
 - b. W.H. Brady B-915 Brady Snap-On
 - c. Bunting

C. Pipe Markers (Underground)

1. Metallic Pipe – Underground metallic pipe shall be identified by underground warning tape. Tape shall be
2. 0.004 inch thick, 6 inch wide polyethylene tape, color coded, with continuous message stating “Caution” and stating which type of pipe is buried

D. Pipe marking shall comply with ANSI A13.1 Scheme for the Identification of Pipe Systems. Markers shall be in compliance with respect to:

1. Marker length
2. Background color
3. Letter color
4. Letter size

2.4 DUCT LABELS

A. For exposed installations, provide color-coded ductwork labels with factory lettering indicating fan system identification, service, and direction of flow. Duct labels for indoor ductwork shall be flexible vinyl film with acrylic pressure-sensitive adhesive suitable for duct surface temperatures of minus 40 to 220 degrees Fahrenheit.

B. For installations in mechanical rooms and above ceilings, spray painted stencils will be acceptable.

C. Exterior ducts do not required labels.

2.5 VALVE TAGS

A. Provide 0.032 inch thick Brass tags with stamped numbers and letters (black-filled), 1-½ inches square with ½ inch numbers and ¼ inch letters.

B. Fastening shall be by brass “S” hooks, brass jack chains, or brass ball chains.

C. Provide project valve charts. Valve charts shall be 8-½ inches by 11 inches (minimum or of sufficient size), wood or aluminum framed with plexiglass covers. Include valve numbers, sizes, functions, and locations. Coordinate location with Owner. Charts shall have key plan denoting approximate valve location.

D. Include a copy of the project valve chart in the Operation and Maintenance Manuals.

2.6 CEILING MARKERS

A. Provide for concealed equipment, dampers, valves, sensors, and other devices.

B. Provide labels shall identifying the correct tile to be removed for filter change out access.

C. Provide color-coded ceiling markers on ceiling at concealed valve locations. Markers shall be a minimum of ⅞ inch diameter, and shall include engraving to indicate service.

1. Manufacturers:
2. Seton ECM
3. W.H. Brady
4. EMED Company

PART 3: EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.2 WARNING AND INFORMATION LABELS INSTALLATION

- A. Inscribe required message on, and attach warning/information labels where indicated.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels as follows:
 - 1. Markers shall be placed on piping at 20 feet maximum intervals. In addition, wherever a pipe passes through a wall, floor, or ceiling, it should be marked on each side of the wall, floor, or ceiling. Where pipe insulation or pipe is to be painted, it should be painted to match the background color of its contents (as indicated below). Fire protection piping should be painted red. In addition to pipe marking, valves shall have brass tags indicating system and valve number.
 - 2. Piping shall have direction of flow arrows matching the legend and background colors adjacent to each marker and at branches.
- B. Colors for pipe marking systems shall be in accordance with ANSI standards.
- C. Underground piping shall be identified with identification tape continuously while below grade. Depth of tape shall be 12 inches below grade for piping buried up to 30 inches deep, and 18 to 24 inches above pipe for depths below 30 inches deep.

3.4 DUCT LABEL INSTALLATION

- A. Locate duct labels as follows:
 - 1. Markers shall be placed on ductwork at 20 feet maximum intervals on bottom and most visibly accessible side. In addition, wherever a duct passes through a wall, floor, or ceiling, it should be marked on each side of the wall, floor, or ceiling. Where duct insulation or duct is to be painted, it should be painted to match the background color of its contents (as indicated below).
 - 2. Ducts shall have direction of flow arrows matching the legend and background colors adjacent to each marker and at branches.
- B. Colors for duct marking systems shall be as follows:
 - 1. Legend: Black
 - 2. Background: Yellow

3.5 VALVE-TAG INSTALLATION

- A. Provide identification tags for valves including control valves and fire alarm valves; shutoff valves serving individual fixtures and equipment shall not be tagged so long as the valve is within line of sight of the fixture or piece of equipment.
- B. Provide valve charts in an approved location secured to wall.
- C. All valves located above ceilings shall be marked on the ceiling with valve identification pins.

END OF SECTION 230553

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SECTION 230593 – TESTING, ADJUSTING AND BALANCING

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:
 1. Balancing of Air Systems
 2. Balancing of Hydronic Piping Systems
 3. Fume Hood Testing
 4. Final Report
 5. Final Inspection
 6. Additional Adjustment

1.3 QUALITY ASSURANCE

- A. Provide air and water system balancing and testing by an approved member of the Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing Adjusting and Balancing Bureau (TABB). The balancers must submit to the Architect a resume of experience, a sample of the forms to be used for the final report, and an inventory of the instruments to be used. Types, serial numbers and dates of last calibration of instruments used shall be listed in final balance reports.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB Contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" article.
- B. Contract Documents Examination Report: Within forty-five (45) days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within sixty (60) days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" article.
- D. Certified TAB reports.

1.5 WARRANTY

- A. Provide a guarantee on AABC/NEBB/TABB forms stating that AABC/NEBB/TABB will assist in completing requirements of the Contract Documents if the Testing Adjusting and Balancing (TAB) firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2: PRODUCTS

2.1 TEST HOLE CAPS

- A. Test holes shall be closed with caps suitable for duct static pressure scheduled.

PART 3: EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. It shall be the TAB firm's responsibility to review the drawings and to notify the Engineer if additional valves and dampers are required to properly balance the various systems prior to the installation of those systems. If the TAB firm reviews the drawings and does not notify the Engineer that additional valves and dampers are required, then the TAB firm shall be responsible to provide additional valves and dampers as required to properly balance the various systems at no additional cost to the Owner.
- C. Examine approved submittal data of HVAC systems and equipment.
- D. Examine system and equipment installations to verify that they are complete. Systems shall be cleaned, pressure tests completed and approved, and in continuous operation before balancing begins. Minimum continuous operation shall be twenty-four (24) hours.
- E. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine strainers for clean screens and proper perforations.
- G. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational and that automatic dampers are open.
 4. Manual dampers are operable and fully open.
 5. Equipment and duct access doors are securely closed.
 6. Balance, smoke, and fire dampers are open.
 7. Isolating and balancing valves are open and control valves are operational.
 8. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 9. Windows and doors can be closed so indicated conditions for system operations can be met.
 10. Systems are started and operating in a safe and normal condition.

11. Temperature control systems are installed, complete, and operable.
12. Thermal overload protection is in place for fans, pumps, chillers, and other equipment.
13. Start-up air filters are removed and final filters are clean and properly installed.
14. Duct and fan systems are clean.
15. Fans are rotating correctly.
16. Air coil fins are cleaned and combed.
17. Duct end caps are in place.
18. Air outlets are installed and connected.
19. Leak testing on duct system has been performed in accordance with SMACNA standards.
20. Pumps are rotating correctly.
21. Permanent strainers are clean and in place.
22. Gauges and test ports are properly located for balancing.

3.3 GENERAL REQUIREMENTS FOR TESTING AND BALANCING

- A. Provide complete testing and balancing of each and every fan, trunk duct, branch duct, ducted outlet and return, coil, pump, water system and heat exchanger.
- B. Testing and balancing procedures on each system shall be performed in accordance with the procedures contained in the following:
 1. AABC's: National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems
 2. NEBB's: Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
 3. SMACNA's: HVAC Systems – Testing, Adjusting, and Balancing
 4. TABB's: International Standards for Environmental Systems Balance
- C. Provide test wells, and openings as required by the testing agency at no additional cost to the Owner.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed.
- E. Neatly mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, and similar controls and devices, to show final settings.
- F. Coordinate with the General Contractor to ensure proper balancing above inaccessible ceilings before the ceilings are completed.
- G. Final tests and adjustments necessary to demonstrate compliance with specified performance requirements for major items of equipment (such as boilers, air conditioning units and refrigeration machines) shall be directly supervised by the manufacturer's representatives.
- H. The Architect shall be notified in writing of the date and time of final balancing and testing activities. Notification must be received at least forty-eight (48) hours in advance so that the Architect can be present if he so wishes.

3.4 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent of design values
 - 2. Air Outlets and Inlets: Minus 5 to plus 10 percent of design values
 - 3. Heating-Water Flow Rate: Minus 5 to plus 5 percent of design values
 - 4. Cooling-Water Flow Rate: Minus 5 to plus 5 percent of design values

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for air systems. Air systems and appurtenances shall be adjusted and balanced to deliver the air quantities as specified, indicated on the drawings, or as directed. Check the sum of required outlet volumes against required fan volumes.
- B. Check for proper sealing of air duct system and air-handling unit components.
- C. The system shall be set up to provide minimum design fresh air.
- D. The following shall be recorded for each air handling unit, and heat recovery unit if applicable, at the time of testing:
 - 1. Outdoor temperature, date, and time
 - 2. Condition of filter (change if dirty)
 - 3. Cooling coil condition (wet/dry)
- E. The following data shall be recorded for each fan system:
 - 1. Fan and motor revolutions per minute
 - 2. Motor current and voltage
 - 3. Fan, coil, and filter static pressures
 - 4. Name plate data of fans and motors
 - 5. Motor sheave, fan pulley, and belt sizes
- F. Traverse the main supply, return, and exhaust ducts to determine cubic feet per minute deliveries of the fan. If fan cubic feet per minute are not within specified tolerances, re-adjust fan speed by adjusting sheave or replacing pulleys, whichever is applicable, to obtain specified cubic feet per minute.
- G. After it has been determined that the fans are providing design cubic feet per minute at required static pressures, balancing of the outlets may proceed. Outlets shall be balanced at volume dampers and not at diffuser or register dampers.
- H. If the system is equipped with an economizer free-cooling system, the balancer shall traverse the main supply ducts with the system set at 100 percent outside air. If readings indicate more than a 5 percent variation in total air supply, the fans or dampers shall be readjusted. Volume dampers shall be permanently marked at the final balance condition.
- I. After completion of the system air balancing and acceptance of the final report by the Architect, a final recording of the following items shall be provided and posted at the supply fan unit under cooling design conditions:

1. Outside temperature, date, and time
2. Filter static pressure
3. Coil static pressure and air temperature entering and leaving coils
4. Suction static pressure
5. Discharge static pressure and leaving air temperature

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure fan static pressures to determine actual static pressure.
 2. Measure static pressure across each component that makes up an air-handling unit.
 3. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 4. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes. Do not make fan-speed adjustments that result in motor overload or operation in the motor's service factor (unless operation in the service factor has been approved by the Architect/Engineer). Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. After the fan systems have been adjusted, adjust the air systems as follows:
 1. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 2. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Adjust terminal outlets and inlets for each space to indicate airflows within specified tolerances indicated above.
 1. Adjust patterns of adjustable outlets for proper distribution without drafts. Install additional baffles as required.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. For variable-air-volume systems, simulate diversity as follows:
 1. When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure fan static pressures to determine actual static pressure.
 2. Measure static pressure across each component that makes up an air-handling unit.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- C. After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set the outside-air dampers at minimum and the return and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. When total airflow is correct, balance the air outlets downstream from terminal units to within the specified tolerances described above.
 - a. Adjust patterns of adjustable outlets for proper distribution without drafts. Install additional baffles as required.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow.
 6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as follows:
 - a. Adjust volume dampers for the return main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - b. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for water systems. Water systems and appurtenances shall be adjusted and balanced to deliver the water quantities as specified, indicated on the drawings, or as directed. Modify pumps and/or controls to produce design flow. Check the sum of branch-circuit flows against associated pump flow rates.
- B. Check that hydronic systems are filled, clean, and free of air.
- C. Calibrated balance valves shall be used to balance water flow for terminal devices. Automatic control valves shall be set for full flow conditions during balancing procedure. Verify water flows at orifices located at branch mains as shown on the drawings. If flows are not within specified tolerances, adjust balancing valves.
- D. Air handling unit coils shall be balanced by calibrated balance valves.
- E. Pump capacities shall be determined by differential pressure measurements. Water circuits shall be adjusted by balancing valves provided as part of the installation, and balancing valves shall be permanently marked after final balance is complete so that they may be returned to their correct position if disturbed.

Pump balancing valves shall be adjusted to provide the lowest discharge pressure possible while maintaining flow to all devices.

- F. The following data shall be recorded for each water system:
 - 1. Pump motor current and voltage
 - 2. Entering and leaving water flow rates, temperatures and pressures at coils, etc.
 - 3. Differential pressure across pumps

3.9 ADDITIONAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps.
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gauge heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within specified tolerances.
- B. After the pump systems flows have been verified, adjust the air handler and terminal unit flows as follows:
 - 1. Set calibrated balancing valves at calculated pre-settings.
 - 2. Measure flow at air handlers and terminal units and adjust, where necessary, to obtain first balance.
 - 3. Measure flow at pump and set main balancing valve to achieve flow that is 5 percent greater than indicated flow.
 - 4. Adjust air handlers and terminal units flow to within specified tolerances as follows:
 - a. Determine the air handler or terminal unit with the highest percentage over indicated flow.
 - b. Adjust each air handler or terminal unit in turn, beginning at the one with the highest percentage over indicated flow and proceeding to the one with the lowest percentage over indicated flow.
 - 5. Measure pump flow rate and repeat balance procedure if flow rates are not within specified tolerances.
 - 6. Record settings and mark balancing devices.

3.10 PROCEDURES FOR DIRECT EXPANSION (DX) COILS IN ENERGY RECOVERY UNITS

- A. Measure the following data for each coil:
 - 1. Airflow
 - 2. Dry-bulb temperature of entering and leaving air
 - 3. Wet-bulb temperature of entering and leaving air for cooling coils
 - 4. Air pressure drop

3.11 PROCEDURES FOR CLOSED CIRCUIT COOLING TOWERS

- A. Verify proper rotation of fans and spray pump.
- B. Measure entering- and leaving-air and water temperatures, and outdoor air dry and wet bulb temperatures.

3.12 PROCEDURES FOR LABORATORY FUME HOODS

- A. Before performing laboratory fume hood testing, measure, adjust and record the supply airflow and airflow patterns of each supply air outlet that is located in the same room as the hood. Adjust the air outlet flow pattern to minimize turbulence and to achieve the desired airflow patterns at the face and inside the hood. Verify that adequate makeup air is available to achieve the indicated flow of the hood.
- B. Measure, adjust, and record the airflow of each laboratory fume hood by duct Pitot-tube traverse with the laboratory fume hood sash in the design open position.
 - 1. For laboratory fume hoods installed in variable exhaust systems, measure, adjust, and record the hood exhaust airflow at maximum and at minimum airflow conditions.
 - 2. For laboratory fume hoods designed with integral makeup air, measure, adjust, and record the exhaust and makeup airflow.
- C. For laboratory fume hoods that are connected to centralized exhaust systems using automatic dampers, adjust the damper controller to obtain the indicated exhaust airflow.
- D. After balancing is complete, do the following:
 - 1. Measure and record the static pressure at the hood duct connection with the hood operating at indicated airflow.
 - 2. Measure and record the face velocity across the open sash face area. Measure the face velocity at each point in a grid pattern. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter of the opening.
 - a. For laboratory fume hoods designed to maintain a constant face velocity at varying sash positions, also measure and record the face velocity at 50 and 25 percent of the design open sash position.
 - b. Calculate and report the average face velocity by averaging all velocity measurements.
 - c. Calculate and report the exhaust airflow by multiplying the calculated average face velocity by the sash open area. Compare this quantity with the exhaust airflow measured by duct Pitot-tube traverse. Report differences.
 - d. If the average face velocity is less than the indicated face velocity, retest the average face velocity and adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity.
 - 3. Check each laboratory fume hood for the capture and containment of smoke by using a hand-held emitting device. Observe the capture and containment of smoke flow pattern across the open face and inside the hood. Make adjustments necessary to achieve the desired results.
- E. With the room and laboratory fume hoods operating at indicated conditions, perform an “as-installed” performance test of the laboratory fume hood according to ASHRAE 110. Test each laboratory fume hood and document the test results.

**BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES AND CONSTRUCTION STANDARDS
DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING**

3.13 FINAL REPORT – GENERAL REQUIREMENTS

- A. The HVAC Contractor shall obtain copies of the final Air Flow and Water Flow Balance and Test Reports from the balancing agency. Submit same to the Architect in accordance with the shop drawing submittal requirements for the Architect's evaluation and approval.
- B. The report shall be a typewritten or computer generated printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- C. Include a certification sheet in front of binder signed and sealed by a Registered Professional Engineer (OH PE license required).
- D. Include a list of instruments used for procedures, their serial numbers, and proof of calibration.

3.14 FINAL REPORT – DETAILED REQUIREMENTS

- A. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves
 - 2. Fan curves
 - 3. Manufacturers' test data
 - 4. Field test reports prepared by system and equipment installers
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data
- B. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page
 - 2. Name and address of the TAB Contractor
 - 3. Project name
 - 4. Project location
 - 5. Architect's name and address
 - 6. Engineer's name and address
 - 7. Contractor's name and address
 - 8. Report date
 - 9. Signature of TAB supervisor who certifies the report
 - 10. Table of Contents with the total number of pages defined for each section of the report (Number each page in the report.)
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance
 - b. Notable characteristics of systems
 - c. Description of system operation sequence if it varies from the Contract Documents
 - 12. Nomenclature sheets for each item of equipment

13. Data for terminal units, including manufacturer's name, type, size, and fittings
14. Notes to explain why certain final data in the body of reports vary from indicated values
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers
 - b. Conditions of filters
 - c. Cooling coil, wet- and dry-bulb conditions
 - d. Face and bypass damper settings at coils
 - e. Fan drive settings including settings and percentage of maximum pitch diameter
 - f. Settings for supply-air, static-pressure controller
 - g. Other system operating conditions that affect performance

C. Packaged Chiller Reports:

1. Unit Data:
 - a. Unit identification
 - b. Make and model number
 - c. Manufacturer's serial number
 - d. Refrigerant type and capacity in pounds
 - e. Starter type and size
 - f. Starter thermal protection size
 - g. Compressor make and model number
 - h. Compressor manufacturer's serial number
2. Water-Cooled Condenser Test Data (Indicated and Actual Values):
 - a. Refrigerant pressure in pounds per square inch gauge
 - b. Refrigerant temperature in degrees Fahrenheit
 - c. Entering-water temperature in degrees Fahrenheit
 - d. Leaving-water temperature in degrees Fahrenheit
 - e. Entering-water pressure in feet of head or pounds per square inch gauge
 - f. Water pressure differential in feet of head or pounds per square inch gauge
3. Evaporator Test Reports (Indicated and Actual Values):
 - a. Refrigerant pressure in pounds per square inch gauge
 - b. Refrigerant temperature in degrees Fahrenheit
 - c. Entering-water temperature in degrees Fahrenheit
 - d. Leaving-water temperature in degrees Fahrenheit
 - e. Entering-water pressure in feet of head or pounds per square inch gauge
 - f. Water pressure differential in feet of head or pounds per square inch gauge

4. Compressor Test Data (Indicated and Actual Values):
 - a. Suction pressure in pounds per square inch gauge
 - b. Suction temperature in degrees Fahrenheit
 - c. Discharge pressure in pounds per square inch gauge
 - d. Discharge temperature in degrees Fahrenheit
 - e. Oil pressure in pounds per square inch gauge
 - f. Oil temperature in degrees Fahrenheit
 - g. Voltage at each connection
 - h. Amperage for each phase
 - i. Kilowatt input
 - j. Crankcase heater in kilowatt
 - k. Chilled-water control set point in degrees Fahrenheit
 - l. Condenser-water control set point in degrees Fahrenheit
 - m. Refrigerant low-pressure-cutoff set point in pounds per square inch gauge
 - n. Refrigerant high-pressure-cutoff set point in pounds per square inch gauge

5. Refrigerant Test Data (Indicated and Actual Values):
 - a. Oil level
 - b. Refrigerant level
 - c. Relief valve setting in pounds per square inch gauge
 - d. Unloader set points in pounds per square inch gauge
 - e. Percentage of cylinders unloaded
 - f. Bearing temperatures in degrees Fahrenheit
 - g. Vane position
 - h. Low-temperature-cutoff set point in degrees Fahrenheit

D. ERU Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
 - a. Unit identification
 - b. Location
 - c. Make and type
 - d. Model number and unit size
 - e. Manufacturer's serial number
 - f. Unit arrangement and class
 - g. Discharge arrangement
 - h. Sheave make, size in inches, and bore
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches

- j. Number, make, and size of belts
 - k. Number, type, and size of filters
2. Supply Fan Motor Data:
- a. Motor make, and frame type and size
 - b. Horsepower and revolutions per minute
 - c. Volts, phase, and hertz
 - d. Full-load amperage and service factor
 - e. Sheave make, size in inches, and bore
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches
3. Test Data (Indicated and Actual Values):
- a. Total air flow rate in cubic feet per minute
 - b. Total system static pressure in inches water gauge
 - c. Fan revolutions per minute
 - d. Discharge static pressure in inches water gauge
 - e. Filter static-pressure differential in inches water gauge
 - f. Hot gas reheat-coil static-pressure differential in inches water gauge
 - g. Primary direct expansion (DX) heating-cooling-coil static-pressure differential in inches water gauge
 - h. Outdoor airflow in cubic feet per minute
 - i. Exhaust airflow in cubic feet per minute
 - j. Temperatures before and after each side of energy recovery heat exchangers
 - k. Coil Data:
 - 1) System identification
 - 2) Location
 - 3) Coil type
 - 4) Number of rows
 - 5) Fin spacing in fins per inch on center
 - 6) Make and model number
 - 7) Face area in square feet
 - 8) Tube size in NPS
 - 9) Tube and fin materials
 - 10) Circuiting arrangement
 - 11) Air flow rate in cubic feet per minute
 - 12) Average face velocity in feet per minute
 - 13) Air pressure drop in inches water gauge
 - 14) Outdoor-air, wet- and dry-bulb temperatures in degrees Fahrenheit

- 15) Return-air, wet- and dry-bulb temperatures in degrees Fahrenheit
- 16) Entering-air, wet- and dry-bulb temperatures in degrees Fahrenheit
- 17) Leaving-air, wet- and dry-bulb temperatures in degrees Fahrenheit
- 18) Condenser water flow rate in gallons per minute
- 19) Water pressure differential in feet of head or pounds per square inch gauge
- 20) Entering-water temperature in degrees Fahrenheit
- 21) Leaving-water temperature in degrees Fahrenheit
- 22) Refrigerant expansion valve and refrigerant types
- 23) Refrigerant suction pressure in pounds per square inch gauge
- 24) Refrigerant suction temperature in degrees Fahrenheit

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
 - a. System identification
 - b. Location
 - c. Make and type
 - d. Model number and size
 - e. Manufacturer's serial number
 - f. Arrangement and class
 - g. Sheave make, size in inches, and bore
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches
2. Motor Data:
 - a. Motor make, and frame type and size
 - b. Horsepower and revolutions per minute
 - c. Volts, phase, and hertz
 - d. Full-load amperage and service factor
 - e. Sheave make, size in inches, and bore
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches
 - g. Number, make, and size of belts
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cubic feet per minute
 - b. Total system static pressure in inches water gauge
 - c. Fan revolutions per minute
 - d. Discharge static pressure in inches water gauge
 - e. Suction static pressure in inches water gauge

F. Variable Air Volume (VAV) Box Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification
 - b. Location and zone
 - c. Apparatus used for test
 - d. Area served
 - e. Make
 - f. Number from system diagram
 - g. Type and model number
 - h. Size
 - i. Effective area in square feet
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cubic feet per minute
 - b. Air velocity in feet per minute
 - c. Preliminary air flow rate as needed in cubic feet per minute
 - d. Preliminary velocity as needed in feet per minute
 - e. Final air flow rate in cubic feet per minute
 - f. Final velocity in feet per minute
 - g. Space temperature in degrees Fahrenheit

G. Electric Duct Heater Reports: Include the following:

1. Unit Data:
 - a. System and air-handling-unit identification
 - b. Location and zone
 - c. Room or riser served
 - d. Coil make and size
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cubic feet per minute
 - b. Entering-air temperature in degrees Fahrenheit
 - c. Leaving-air temperature in degrees Fahrenheit

H. Pump Test Reports: Calculate impeller size by plotting the shut-off head on pump curves and include the following:

1. Unit Data:
 - a. Unit identification
 - b. Location

- c. Service
 - d. Make and size
 - e. Model number and serial number
 - f. Water flow rate in gallons per minute
 - g. Water pressure differential in feet of head or pounds per square inch gauge
 - h. Required net positive suction head in feet of head or pounds per square inch gauge
 - i. Pump revolutions per minute
 - j. Impeller diameter in inches
 - k. Motor make and frame size
 - l. Motor horsepower and revolutions per minute
 - m. Voltage at each connection
 - n. Amperage for each phase
 - o. Full-load amperage and service factor
 - p. Seal type
2. Test Data (Indicated and Actual Values):
- a. Static head in feet of head or pounds per square inch gauge
 - b. Pump shutoff pressure in feet of head or pounds per square inch gauge
 - c. Actual impeller size in inches
 - d. Full-open flow rate in gallons per minute
 - e. Full-open pressure in feet of head or pounds per square inch gauge
 - f. Final discharge pressure in feet of head or pounds per square inch gauge
 - g. Final suction pressure in feet of head or pounds per square inch gauge
 - h. Final total pressure in feet of head or pounds per square inch gauge
 - i. Final water flow rate in gallons per minute
 - j. Voltage at each connection
 - k. Amperage for each phase
- l. Instrument Calibration Reports:
- 1. Report Data:
 - a. Instrument type and make
 - b. Serial number
 - c. Application
 - d. Dates of use
 - e. Dates of calibration

3.15 FINAL INSPECTION

- A. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Architect.
- B. TAB firm test and balance engineer shall conduct the inspection in the presence of the Architect.
- C. The Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to 10 percent of the total measurements recorded.
- D. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as “failed”.
- E. If the number of “failed” measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- F. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
- G. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment to the HVAC Contract.

3.16 ADDITIONAL ADJUSTMENT

- A. If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting when the conditions occur.
- B. Provide an additional twenty-five (25) hours for after occupancy adjustment. Adjustments shall include but not limited to diffuser rebalance, coil rebalance, pump rebalance and fan rebalance.

END OF SECTION 230593

SECTION 230700 – HVAC INSULATION

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. Section includes:

1. Insulation Materials:
 - a. Flexible Elastomeric
 - b. Mineral Fiber
2. Fire-Rated Insulation Systems
3. Insulating Cements
4. Adhesives
5. Mastics
6. Lagging Adhesives
7. Sealants
8. Factory-Applied Jackets
9. Field-Applied Jackets
10. Tapes
11. Securements
12. Corner Angles

B. Related sections:

1. Division 23, Section 233300: Duct Accessories

- C. This section only addresses piping insulation within the building and above grade. Below grade piping insulation is specified in other Division 23 sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated include thermal conductivity, thickness, and jackets (both factory and field applied).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

Insulation thicknesses shall meet the minimum requirements of ASHRAE 90.1 – 2004, the Ohio Mechanical Code, and this specification, whichever of the three requires the greatest insulation thickness.

- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23, Section 230529: Hangers and Supports for HVAC.
- B. Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2: PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Suitable for temperatures up to 220 degrees Fahrenheit. Maximum flame spread and smoke developed index of 25 and 50 respectively per ASTM E84.

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1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
 2. Minimum Insulating Value: Thermal conductivity (k) at 75 degrees Fahrenheit is 0.27 BTU/(hr·ft²·°F) or less.
- D. Mineral-Fiber Blanket Duct Insulation:** 1.5 pounds per cubic foot density, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” article.
1. Shall only be used on ductwork.
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Duct Wrap
 - b. Johns Manville; Microlite
 - c. Knauf Insulation; Duct Wrap
 - d. Owens Corning; All-Service Duct Wrap
 3. Minimum Insulating Value: Thermal conductivity (k) at 75 degrees Fahrenheit is 0.24 BTU/(hr·ft²·°F) or less at a compression of 25 percent. Tested as per ASTM C518.
- E. Mineral-Fiber Board Insulation:** 4.25 pounds per cubic foot density, mineral or glass fibers bonded with a thermosetting resin suitable for temperatures up to 350 degrees Fahrenheit. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied FSK jacket or ASJ. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Commercial Board
 - b. Johns Manville; 800 Series Spin-Glass
 - c. Knauf Insulation; Insulation Board
 - d. Owens Corning; Fiberglas 700 Series
 2. Minimum Insulating Value: Thermal conductivity (k) at 75 degrees Fahrenheit is 0.24 BTU/(hr·ft²·°F) or less.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200
 - b. Johns Manville; Micro-Lok
 - c. Knauf Insulation; 1000 Pipe Insulation
 - d. Manson Insulation Inc.; Alley-K
 - e. Owens Corning; Fiberglas Pipe Insulation
2. Type I, 850 degrees Fahrenheit Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” article.
3. Minimum Insulating Value: Thermal conductivity (k) at 75 degrees Fahrenheit is 0.23 BTU/(hr·ft²·°F) or less.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. CertainTeed Corp.; FlameChek
 - b. Johns Manville; Firetemp Wrap
 - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket
 - d. Thermal Ceramics; FireMaster Duct Wrap
 - e. 3M; Fire Barrier Wrap Products
 - f. Unifrax Corporation; FyreWrap
2. Minimum Insulating Value: Thermal conductivity (k) at 200 degrees Fahrenheit is 0.54 BTU/(hr·ft²·°F) or less.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Insulco, Division of MFS, Inc.; Triple I
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik

2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aero seal
 - b. Armacell LCC; 520 Adhesive
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75
 - d. RBX Corporation; Rubatex Contact Adhesive
 - 2. For indoor applications, use adhesive that has a VOC content of 50 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80
 - d. Marathon Industries, Inc.; 225
 - e. Mon-Eco Industries, Inc.; 22-25
 - 2. For indoor applications, use adhesive that has a VOC content of 80 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80
 - d. Marathon Industries, Inc.; 225
 - e. Mon-Eco Industries, Inc.; 22-25
 - 2. For indoor applications, use adhesive that has a VOC content of 50 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC Jacket

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive
 - c. P.I.C. Plastics, Inc.; Welding Adhesive
 - d. Speedline Corporation; Speedline Vinyl Adhesive
2. For indoor applications, use adhesive that has a VOC content of 50 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-35
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90
 - c. ITW TACC, Division of Illinois Tool Works; CB-50
 - d. Marathon Industries, Inc.; 590
 - e. Mon-Eco Industries, Inc.; 55-40
 - f. Vimasco Corporation; 749
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perms at 43 mils dry film thickness
3. Service Temperature Range: Minus 20 to plus 180 degrees Fahrenheit
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight
5. Color: White

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-10
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15
 - d. Marathon Industries, Inc.; 550
 - e. Mon-Eco Industries, Inc.; 55-50
 - f. Vimasco Corporation; WC-1/WC-5

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625 inch dry film thickness
3. Service Temperature Range: Minus 20 to plus 200 degrees Fahrenheit
4. Solids Content: 63 percent by volume and 73 percent by weight
5. Color: White

2.6 SEALANTS

A. Joint Sealants

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76-8
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44
 - c. Marathon Industries, Inc.; 405
 - d. Mon-Eco Industries, Inc.; 44-05
 - e. Vimasco Corporation; 750
2. Materials: Compatible with insulation materials, jackets, and substrates
3. Fire- and water-resistant, flexible, elastomeric sealant
4. Service Temperature Range: Minus 40 to plus 250 degrees Fahrenheit
5. Color: Aluminum
6. For indoor applications, use sealants that have a VOC content of 250 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76
2. Materials: Compatible with insulation materials, jackets, and substrates
3. Fire- and water-resistant, flexible, elastomeric sealant
4. Service Temperature Range: Minus 40 to plus 250 degrees Fahrenheit
5. Color: White
6. For indoor applications, use sealants that have a VOC content of 250 grams per liter (g/L) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, craft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I
 - 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with craft-paper backing; complying with ASTM C 1136, Type II; maximum permeance .02 perms

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. EPDM Membrane for Exterior Ductwork: The top of the exterior ductwork shall be built up with insulation in such a manner as to ensure a positive drain of rain water from the center to the sides of the ducts. The pitch of the built up section shall be ¼ inch per foot. Care should be taken to assure that no low areas appear to prevent “pooling” of water. Board insulation shall be cut and mitered as necessary to fit the shape of the ducts. Insulation shall be adhered to duct with mastic spread over entire sheet metal surface to assure a complete bond. Insulation board shall have seams and joints taped with 4-inch wide vapor barrier tape in strict accordance with the manufacturer's requirements. Finish over insulation shall be cured EPDM rubber roofing membrane, 60 mils thickness, securely glued in place (100 percent adhesive coverage) with seams 4 inches overlapped and sealed for a completely watertight installation. Do not locate seams on top surface of ducts.

Insulation and membrane shall extend over counterflashing where duct extends through roof curbs. Adjoining surfaces shall be waterproofed and flashed.

- C. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with craft-paper backing.
- D. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; minimum 20 mils thickness; roll stock ready for shop or field cutting and forming (Jacket shall not exceed a flame spread rating of 25, or a smoke developed rating of 50.)
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Johns Manville; Zeston 300 Series
 - b. PIC Plastics, Inc.; FG Series
 - c. Speedline Corporation; 25/50 Smoke-Safe
 - 2. Adhesive: As recommended by jacket material manufacturer
 - 3. Colors: Piping systems exposed in the Attic and in Mechanical Equipment Rooms (except high temperature hot water) shall be colored-coded from a selection of manufacturers' standard colors with at least 12 colors to choose from. Final color selection for each piping system shall be made by the Owner.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate:
 - a. Shapes: 45 and 90 degrees, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories
 - b. Color coded to match the adjoining jacket color

5. Factory-fabricated tank heads and tank side panels

E. Aluminum Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14
 - a. Sheet and roll stock ready for shop or field sizing
 - b. Finish and thickness are indicated in field-applied jacket schedules
 - c. Moisture Barrier for Indoor Applications: 3 mils thick, heat-bonded polyethylene and craft paper
 - d. Moisture Barrier for Outdoor Applications: 3 mils thick, heat-bonded polyethylene and craft paper
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket
 - 2) Preformed two-piece or gore, 45 and 90 degrees, short- and long-radius elbows
 - 3) Tee covers
 - 4) Flange and union covers
 - 5) End caps
 - 6) Beveled collars
 - 7) Valve covers
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available
 - f. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - 1) Childers Products, Division of ITW; Metal Jacketing Systems
 - 2) PABCO Metals Corporation; Surefit
 - 3) RPR Products, Inc.; Insul-Mate

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835
 - b. Compac Corp.; 104 and 105
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ

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2. Width: 3 inches
 3. Thickness: 11.5 mils
 4. Adhesion: 90 ounces force/inch in width
 5. Elongation: 2 percent
 6. Tensile Strength: 40 pound force/inch in width
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape
- B. FSK Tape:** Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827
 - b. Compac Corp.; 110 and 111
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ
 2. Width: 3 inches
 3. Thickness: 6.5 mils
 4. Adhesion: 90 ounces force/inch in width
 5. Elongation: 2 percent
 6. Tensile Strength: 40 pound force/inch in width
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape
- C. PVC Tape:** White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive (Suitable for indoor and outdoor applications.)
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555
 - b. Compac Corp.; 130
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape
 - d. Venture Tape; 1506 CW NS
 2. Width: 2 inches
 3. Thickness: 6 mils

4. Adhesion: 64 ounces force/inch in width
5. Elongation: 500 percent
6. Tensile Strength: 18 pounds force/inch in width

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - a. Childers Products; Bands
 - b. PABCO Metals Corporation; Bands
 - c. RPR Products, Inc.; Bands
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, ¾ inch wide with wing or closed seal
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands (Spring size determined by manufacturer for application.)

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135 inches diameter shank, length to suit depth of insulation indicated with integral 1-½ inches galvanized carbon-steel washer
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CWP-1
 - 2) GEMCO; Cupped Head Weld Pin
 - 3) Midwest Fasteners, Inc.; Cupped Head
 - 4) Nelson Stud Welding; CHP
2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T
 - 2) GEMCO; Perforated Base
 - 3) Midwest Fasteners, Inc.; Spindle
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inches thick by 2 inches square

- c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106 inches diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer; product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016 inches thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150
 - 2) GEMCO; R-150
 - 3) Midwest Fasteners, Inc.; WA-150
 - 4) Nelson Stud Welding; Speed Clips
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - c. Wire: 0.080 inches nickel-copper alloy
 - 1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - C & F Wire
 - Childers Products
 - PABCO Metals Corporation
 - RPR Products, Inc.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 inch by 1 inch, PVC according to ASTM D 1784, Class 16354-C, white or color-coded to match adjacent surface

PART 3: EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Verify that systems and equipment to be insulated have been tested and are free of defects.
- C. Verify that surfaces to be insulated are clean and dry.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 degrees Fahrenheit. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 degrees Fahrenheit with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Provide insulation continuously through roof penetrations. Install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- K. Install insulation continuously through sleeves and openings in penetrations that are not fire rated.
- L. Insulation shall stop at electric duct heaters. Ends of insulation shall be sealed and lapped with vapor barrier.
- M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

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1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- O. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center
 3. Overlap jacket longitudinal seams at least 1-½ inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches on center.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- S. For above ambient services, do not install insulation to the following:
1. Vibration-control devices
 2. Testing agency labels and stamps
 3. Nameplates and data plates
 4. Manholes
 5. Handholes
 6. Cleanouts

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions that are not fire rated.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 07, Section 078400: Fire Stopping for fire stopping and fire resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07, Section 078400: Fire Stopping.

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 5. Do not weld anchor pins to ASME-labeled pressure vessels.
 6. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 7. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches on center in both directions.
 8. Do not over compress insulation during installation.
 9. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 10. Impale insulation over anchor pins and attach speed washers.
 11. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 12. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 13. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches on center. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches on center. Use this network for securing insulation with tie wire or bands.
 14. Stagger joints between insulation layers at least 3 inches.
 15. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 16. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 17. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install $\frac{3}{8}$ -inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - 2. Fabricate boxes from aluminum, at least 0.060 inches thick.
 - 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

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7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word “UNION”. Match size and color of pipe labels.
 10. For high temperature hot water systems, insulation and jacket materials shall be suitable for operating temperatures up to 450 degrees Fahrenheit.
- C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers’ recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers' recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches on center.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory-or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

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- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 degrees Fahrenheit at 18 feet intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inches wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward-clinching staples, 1 inch on center. Install vapor barrier consisting of factory-or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 degrees Fahrenheit at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-½-inches laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers' recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal all joints on piping systems indicated to have a vapor barrier. Seal end joints with weatherproof sealant recommended by insulation manufacturer on all installations. Secure jacket with stainless-steel bands 12 inches on center and at end joints.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Install duct wrap system in accordance with manufacturer's instructions and referenced standards. Provide multiple layers as required to achieve a 2-hour fire-rated enclosure.
- C. Insulate duct access panels and doors to achieve same fire rating as duct. The Contractor may utilize fire rated duct access doors if specifically UL listed for use with the fire rated duct wrap system.
- D. Provide a warning label on each side of wrapped duct every 20 feet to discourage future Contractors from disturbing the final installation of duct wrap. Letters shall be 3 inches high characters, fire engine red, stenciled on. Wording shall be "2 HOUR FIRE-RATED DUCT WRAP".
- E. Provide a label at each location of access panel, filter, panel damper, etc., to identify locations where access has been covered up or overlapped by the blanket. Label in same fashion as defined above. Stencil shall say "ACCESS PANEL", etc., and shall show size and location of panel, etc.

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- F. Install fire stopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07, Section 078400: Fire Stopping.

3.11 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.12 DUCT INSULATION, GENERAL REQUIREMENTS

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air (Except that associated with ERU-1, 2, or 3)
2. Indoor, exposed supply and outdoor air (Except that associated with ERU-1, 2, or 3)
3. Indoor, concealed return located in non-conditioned space
4. Indoor, exposed return located in non-conditioned space
5. Indoor, concealed exhaust and relief between isolation damper and penetration of building exterior
6. Indoor, exposed exhaust and relief between isolation damper and penetration of building exterior

- B. Duct silencers, damper frames, and other duct accessories effectively forming a portion of the duct system shall be insulated as specified for the connecting ducts unless explicitly indicated otherwise.

C. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1
2. Factory-insulated flexible ducts
3. Factory-insulated plenums and casings
4. Flexible connectors
5. Vibration-control devices
6. Factory-insulated access panels and doors
7. Indoor exhaust ducts associated with ERU-1, 2, 3, and 4, except as noted on the drawings
8. Indoor supply ducts associated with ERU-1, 2, and 3
9. Ducts provided with UL Listed 2-hr rated insulation system

3.13 DUCTWORK INSULATION APPLICATIONS

A. Duct Insulation Schedule:

Per Engineers recommendation

B. Schedule Notes:

TBD

3.14 PIPING INSULATION SCHEDULE

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Piping systems shall be insulated in accordance with the schedule below, including flanges, fittings, valves, expansion joints, vents, drains and similar appurtenances.
- C. Piping located where it is subject to freezing (such as condensate drain lines routed in exterior walls) shall be provided with a minimum 1 ½ inches of insulation in addition to the thickness scheduled below.
- D. Where a field applied jacket is indicated, install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- E. Note: Where field applied jacketing is indicated, the installation shall include valve and fitting covers. “Valve covers” shall include all pipeline appurtenances, such as balancing valves, strainers, drain valves, air vents, etc.
- F. Piping Insulation Schedule:

Per Engineers recommendation

3.15 EQUIPMENT INSULATION SCHEDULE

TBD

END OF SECTION 230700

SECTION 230900 – INTEGRATED AUTOMATION CONTROL SYSTEM

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General Requirements and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. Division 23, Section 230901: Control Sequences of Operation

1.2 SUMMARY

- A. The work includes the extension of the existing Andover Controls Campus Wide Integrated Automation System, including the provision of all labor, materials, equipment, accessories, services and tests necessary to complete and place into satisfactory operation a complete integrated automatic control system as shown on the drawings and hereinafter specified.
- B. The Integrated Automation Control System (IACS) shall be totally electronic utilizing microprocessor based direct digital temperature controllers and fully modulating electronic valve and damper actuators. System shall be complete in all respects including microprocessor, graphic touch screens, sensors, actuators, and software in order to provide the functions described.
- C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.
- D. Manufacturer Andover Controls
- E. Control System Sub-Contractor: Work shall be furnished and installed by U & S Services, Inc.:
Contact information: 95 Stark Street, Tonawanda NY, 14150;
Phone: 716-693-4490;
Fax: 716-693-5280
Russ Stuber: stuberr@usservicesinc.com

1.3 QUALITY ASSURANCE

- A. The equipment and software proposed by the integrated system supplier shall be currently in manufacture. No custom products shall be allowed unless required by the specification. The manufacturer for a minimum of 5 years, including spare parts, board repairs and software revisions, shall support all products.

1.4 SUBMITTALS

- A. Refer to General Conditions.
- B. All shop drawings shall be prepared on AutoCAD software or equivalent. The Contractor shall furnish a diskette containing the identical information.
- C. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring.

- D. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification:
 - 1. Valve schedules with pipe sizes, flow rates, design and actual pressure drops
 - 2. Damper schedules with duct size, operator type/size, free area, flow rates, and pressure drops
 - 3. Descriptive point list
 - 4. Sequence of operation using descriptive prose and fully annotated English language flow charts
 - 5. Complete description of graphics, reports, alarms and configuration of the workstation software

1.5 COORDINATION

- A. Refer to Divisions 23 and 26 sections for requirements for mechanical and electrical work.

PART 2: PRODUCTS

2.1 SYSTEM OVERVIEW

- A. The integrated system shall consist of PC-based workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
- B. There shall be two levels of controllers. Level 1 controllers shall contain a high speed LAN communication bus capable of sharing data among personal computer workstations, other Level 1 controllers, and central file server. Level 1 controllers will also contain a communication bus to Level 2 controllers.
- C. Level 2 controllers, referred to throughout the specification as application specific controllers, shall reside on the field bus of the Level 1 controllers. Level 2 controllers are dedicated IACS controllers for standalone operation of HVAC equipment and lighting. These controllers shall communicate to either a workstation on the high speed LAN or a portable laptop service tool for the purpose of monitoring and programming.
- D. System size shall range from 4 input points and 4 output points to a minimum of 64000 inputs and 32000 outputs. Expansion shall be modules ranging from 4 inputs/4 outputs to 32 inputs/32 outputs.

2.2 LEVEL 1 CONTROLLERS

- A. Level 1 controllers shall provide intelligent, standalone control of HVAC and lighting functions including integration to third party devices such as fire panels and chiller controllers. Each unit shall have its own internal RAM memory and will have the option for UPS battery-backed operation in the event of a power failure (network controllers only).
- B. Level 1 controllers may be programmed from a dumb terminal, operator workstation, or laptop service tool, provide RS232C connections to modems and printers, and shall contain sufficient memory for global control strategies, user defined reports, telecommunication programs, and central alarming.

C. LAN-BASED NETWORK CONTROLLERS

- 1. Level 1 controllers shall operate over a high speed, local area network communicating on Ethernet protocol. They shall perform overall coordination, accept control programs, perform automated HVAC and lighting functions, control peripheral devices and perform all necessary mathematical functions.

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2. The controller shall be a microcomputer of modular design. The word size shall be 16 bits or larger, with a memory cycle time of less than 1 microsecond. LAN-based Level 1 controllers will share information with and from the entire network of Level 1 and Level 2 controllers for full global control.
3. Each controller shall permit multi-user operation from workstations and laptop computers connected either locally or over the Level 1 network. LAN-based network controllers shall be able to communicate with up to 16 I/O modules, with each module having up to 32 inputs/16 outputs.

2.3 LEVEL 2 CONTROLLERS

- A. Level 2 controllers, also referred to as application specific controllers shall provide intelligent, standalone control HVAC, and lighting equipment. Each unit shall have its own internal RAM memory and will continue to operate all local control functions in the event of a failure to any Level 1 controller.
- B. All application specific controllers shall be able to share information with and from the entire network for full global control.

C. SYSTEM CONTROLLERS

1. These controllers contain up to 16 inputs and 8 outputs and are used for control of chillers, boilers and air handling units.
2. The input/output (I/O) capacity of each controller can be further expanded with optional modules. System controllers are fully programmable, contain a real time clock and battery protection for the RAM memory, include connections for the Level 2 network, a port for the Laptop Service Tool and operate standalone when network communications are lost.
3. System controllers also contain built-in override switches for each output and can optionally include a LCD display and keypad for viewing point status and adjusting system parameters.

D. LOCAL CONTROLLERS

1. Local controllers contain up to 8 inputs/8 outputs and are used for control of air handling units, roof top units, exhaust fans and other packaged HVAC equipment. The I/O capacity of each controller can be further expanded with optional modules.
2. Local controllers are fully programmable, contain battery protection for the RAM memory, include connections for the Level 2 network, a port for the Laptop Service Tool, and operate standalone when network communications are lost.
3. Local controllers are optionally available with built-in override switches for each output, a real time clock and can optionally include a LCD display and keypad for viewing point status and adjusting system parameters.

E. TERMINAL EQUIPMENT CONTROLLERS

1. Terminal equipment controllers contain up to 5 inputs/4 outputs and are used for control of variable air volume units, heat pumps, unit ventilators, and fan coil units.
2. The I/O capacity of each controller can be further expanded with optional modules. Terminal equipment controllers are fully programmable, contain battery protection for the RAM memory, include connections for the Level 2 network, a port for the Laptop Service Tool and operate standalone when network communications are lost.

F. GRAPHIC TOUCH SCREEN DISPLAY CONTROLLER

1. The touch screen controller is fully user programmable, and contains a LCD display with a minimum size of 24 lines by 40 characters.
2. Each controller will store multiple graphic screens for displaying custom menus, floor plans, equipment schematics, and keypads.
3. Operators can input information in the form of set points, command output devices such as fans, pumps or lighting circuits, or utilize the programmable touch cells to emulate a high security keypad.

G. EXPANSION MODULES

1. A family of input and output modules shall be available for all system, local and terminal equipment controllers. These modules shall provide for additional point capacity for each standalone controller.
2. Each controller shall support the addition of at least two modules without the need for external power.

2.4 OPERATOR WORKSTATION

A. WORKSTATION

1. Provide a personal computer running Microsoft Windows Professional operating system. The application software shall be capable of communication to all Level 1 and Level 2 controllers, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions. For multiple user systems, a minimum of 64 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other client workstations without the requirement for manual copying of files. The workstation shall consist of the following minimum specifications:
 - 1) Intel Core 2 Duo, 2.0 Gigahertz Processor
 - 2) 2 gigabits of DDR2 RAM Memory
 - 3) 160 gigabytes Serial ATA Hard Drive
 - 4) Integrated Video Card Intel GMA3100
 - 5) 19 Inches LCD Monitor
 - 6) 48x32 CD-RW/DVD Optical Drive
 - 7) 10/100 megabits per second Integrated Ethernet Port
 - 8) USB Mouse
 - 9) 104 Key USB Windows Keyboard
 - 10) Color Ink Jet Printer
 - 11) Available USB or Parallel Port
 - 12) APC BE500U UPS, 500 volt-ampere/325 watts
 - 13) Microsoft Windows Professional SP2

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2. The software shall be capable of communication to all Level 1 and Level 2 controllers, feature high-resolution color graphics, alarming, event recording, reporting, scheduling, and be user configurable for all data collection and data presentation functions.
3. Communications to Level 1 controllers shall be via Ethernet and/or fiber optic LAN connection.

2.5 SYSTEM ARCHITECTURE

A. GENERAL

1. The network architecture shall consist of two levels. The top level shall be high speed LAN designed to support Level 1 controllers, workstations and a file server. The second level shall be RS485 bus to support a family of dedicated application specific controllers for control of HVAC equipment and lighting. The second level bus shall communicate bidirectional with the high speed LAN through Level 1 controllers for transmission of global data.
2. Suppliers proposing systems that require more than two communication levels are not acceptable.

B. HIGH SPEED LAN

1. This local area network shall operate under the Ethernet protocol at a minimum speed of 10 Mbps. The high speed LAN will provide transfer of point data, alarms and file activity among Level 1 controllers, workstations and the file server. The high speed LAN shall support a minimum of 255 nodes consisting of Level 1 controllers and 64 workstations.
2. Any data from a Level 2 controller can also be transmitted onto this bus through a Level 1 controller. The high speed LAN shall support multiuser communications and multi-session activity. All global data sharing shall occur simultaneously with the transmission of alarm data or user activity.

C. FIELD BUS

1. The Level 2 bus, or field bus, supports local control units of modular size for operation of the building's HVAC and lighting systems.
2. This RS485 bus shall operate at a minimum speed of 19200 baud, with a minimum length of 4000 feet or 32 nodes before requiring a network repeater. A minimum of 127 application specific HVAC or lighting controllers shall be configurable on the field bus.
3. Manufacturers with baud rates of less than 19200 shall be limited to sixty-four (64) Level 2 controllers to insure adequate global data and alarm response times.
4. The field bus shall permit peer to peer communications among all Level 2 controllers and allow simultaneous communications with laptop computer service tools that are connected to a Level 2 controller. Failure of the Level 1 controller will not impair the operation of its associated field bus.

D. NETWORK TRANSPARENCY

1. All points contained on Level 1 and Level 2 controllers shall be considered global points. Any program in any controller on the network shall be able to reference any point in any controller regardless of its location on the network.

E. WORKSTATION COMMUNICATIONS

1. Workstations shall be connected directly to the high speed LAN.
2. The University IT Department shall provide network authorization or permissions to the operator workstation to allow remote access over the Internet for remote configuration, programming or service.

F. LAPTOP SERVER TOOL COMMUNICATIONS

1. The optional laptop computer service tool shall communicate to Level 1 controllers.

G. THIRD PARTY DRIVER COMMUNICATIONS

1. The RS232C or RS485 ports on the Level 1 Network Controllers shall be optionally configurable for communication to third party controllers such as EPA certified leak detection probes, fire panels, boiler and chiller controllers, or other microprocessor based devices.

2.6 HARDWARE

A. LEVEL 1 LAN-BASED NETWORK CONTROLLERS

1. Level 1 network controller has its own on-board CPU, clock/calendar, EEPROM, RAM, ROM, communication port(s) to the field bus, a communication port to the high speed LAN, and RS232 ports for communication to printers, modems, terminals and other third party devices. Level 1 network controllers are capable of complete standalone operation.
2. Level 1 controllers shall perform automated control of HVAC equipment and lighting, control peripheral devices, and coordinate communications to other Level 1 and Level 2 controllers in the network.
3. The Level 1 controller shall contain control programs in combination of EPROM and battery backed-up RAM. Each Level 1 controller shall have the intelligence to perform all building control strategies, without communication to other controllers, for functions not requiring data from other controllers.
4. Level 1 controllers shall support multi-user communications from workstations and/or locally connected terminals or laptop service tools.

B. LEVEL 2 CONTROLLERS

1. A Level 2 controller has its own on-board CPU, RAM, ROM, I/O, laptop communication port, and network connection to the field bus.
2. The Level 2 controller contains on-board I/O for complete standalone operation.

C. LEVEL 1 FIRMWARE

1. The firmware shall consist of the operating system, communication software, programming language, and resident control application software. The firmware also contains user interface software to support dumb terminal operation where specified.

D. LEVEL 2 FIRMWARE

1. The firmware shall consist of the operating and communication software. Level 2 controllers may be optionally programmed from the operation where specified.

E. APPLICATION SOFTWARE

1. The custom application software shall reside in battery backed RAM or EEPROM. RAM will also be used for storing trend data, alarms and clock/calendar information.

F. AGENCY APPROVALS

1. All controllers shall be listed under UL916 as Energy Management Equipment and CSA 22.2. All controllers shall comply with FCC Part 15, Subpart J for radiated and conducted noise levels.

G. NETWORK DEVICES

1. Network devices shall include repeaters, media converters, interface cards and bridges as required at each level of the specified architecture.

2.7 LAN-BASED EQUIPMENT CONTROLLERS

- A.** A minimum of 256K of RAM shall be provided for storing application software and system operation. Each controller shall contain a minimum of 1Mb of ROM memory for the system firmware. Firmware shall be flash upgradeable.

- B.** LAN-based equipment controllers shall provide communication to the field bus, and connection to the laptop service tool.

- C.** Each controller will have access to any of the inputs, outputs, and calculated variables contained in Level 2 controllers that are connected to it through its local field bus.

D. REAL TIME CLOCK (RTC)

1. The controller shall contain a battery backed uninterruptable “Real Time Clock” accurate to 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. In normal operation, the system clock will be based on the frequency of the AC power. The system automatically corrects for daylight savings time and leap years.

E. POWER SUPPLY

1. The power supply will operate from 120/220 volts AC, 60/50 hertz power, with a tolerance of plus/minus 20 percent. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning.

F. AUTOMATIC RESTART AFTER POWER FAILURE

1. Upon restoration of power, the equipment controller shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

G. BATTERY BACK-UP

1. Each equipment controller shall have at least seven (7) years of battery backup to maintain all volatile memory. Where UPS operation is desired, it shall be a minimum of one (1) hour.

H. INDICATOR LAMPS

1. Equipment controllers will have as a minimum LED indication of CPU status, power, field bus status, and error status.

I. PACKAGING

1. Equipment controllers shall be housed in a locking enclosure. The enclosure will include knockouts on all sides of the cabinet for connection to field and power wiring.

2.8 LEVEL 2 CONTROLLERS

A. DESCRIPTION

1. Level 2 controllers shall provide stand-alone control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure to its associated Level 1 controller.
2. Control programs shall be stored in battery backed-up RAM and EPROM. Each Level 2 controller shall have the intelligence to perform all control strategies, without communication to other controllers, for control functions not requiring data from other controllers.
3. Each Level 2 controller shall be able to have its program edited and/or modified either locally through a laptop computer service tool or through a workstation connected to a Level 1 controller.
4. Each level 2 controller shall complete its internal scan in less than one second. Each scan shall consist of updating of inputs, importing of data from other controllers, performing mathematical calculations and sequencing appropriate outputs for local loop control.

B. NOISE PROTECTION

1. Level 2 controllers that power with 120 volts AC shall permit continuous shorting of any input to 120 volts AC. Level 2 controllers that power with 24 volts AC shall permit continuous shorting of any input to 24 volts AC.
2. All outputs shall be isolated to a minimum 1500 volts AC.

C. COMMUNICATION PORTS

1. Each controller shall provide communication to the field bus. A port shall be provided for connection to a laptop service tool to support local programming and parameter changes.
2. It shall be possible from this port to access and program any controller on the field bus, any Master Level controller on the high speed LAN, or any controller on a different field bus.

D. NETWORK COMMUNICATIONS

1. Each controller will be able to exchange information between other Level 2 controllers and Level 1 controllers during each field bus scan.
2. The network structure shall be transparent such that each system controller may store and reference any global variables in the network for use in the local controller's calculations of programs. Each system controller shall be capable of storing and referencing global variables.

E. AUTOMATIC RESTART AFTER POWER FAILURE

1. Upon restoration of power, the controller shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, implement special startup strategies as required.

F. BATTERY BACK UP

1. Each Level 2 controller shall have at least seven (7) years battery back up to maintain all volatile memory.

G. INDICATOR LAMPS

1. Level 2 controllers will have as a minimum power indication, LED indication of CPU status, and field bus status.

2.9 SYSTEM CONTROLLERS

A. The system controller is designed to provide direct digital control to air handling units, hot water and chilled water plants, and other HVAC systems.

B. System controllers shall have a minimum of 64 kilobytes of user RAM memory and 128 kilobytes of EPROM.

C. Inputs – the input section of the system controller shall provide a minimum of 16 universal inputs. Each input shall be configurable through software as a digital (dry contact), analog (0 to 10 volts), pulse (up to 5 hertz) or thermistor point. The analog to digital resolution shall be a minimum of 12 bits.

D. Outputs – there shall be a minimum of eight (8) universal outputs configurable as a digital (24 volts AC Form C relays), analog (0 to 20 volts DC or 0 to 20 milliamps), tristate, or pulse width modulation signal.

E. Overrides – each output shall have a built-in override switch capable of auto-on/off operation. Each analog output shall also include a potentiometer that can be adjusted manually to override the entire range of the analog signal.

F. Expansion port – the system controller shall have a port to accept a family of I/O modules. Up to two modules shall be powered directly from the power supply of the system controller.

G. REAL TIME CLOCK (RTC)

1. The system controller shall contain a Real Time Clock, accurate to 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of the week. Each controller shall be capable of receiving a signal over the network from the Level 1 controller to synchronize all clocks to the same time.

H. POWER SUPPLY

1. The system controller shall have a built-in, selectable power supply of 24 volts AC, 110 volts AC or 220 volts AC, 50/60 hertz. The power supply will tolerate 20 percent swings in supply voltage.

I. PACKAGING

1. System controllers shall be available in either a NEMA 1 rated enclosure or optionally in a package suitable for panel mounting.

J. LOCAL DISPLAY

1. Each system controller shall have the option of a built-in LCD display and keypad. The display shall have minimum size of 2 lines by 16 characters. From the keypad, operators shall be able to view point status, adjust set points and change other operating parameters.

2.10 LOCAL CONTROLLERS

- A. The local controller is designed to provide direct digital control of air handling units, boilers, chillers, roof top units and other packaged HVAC equipment.
- B. Local controllers shall have a minimum of 32 kilobytes of user RAM memory and 128 kilobytes of EPROM.
- C. Inputs – the input section of the local controller shall provide a minimum of 8 universal inputs. Each input shall be configurable through software as a digital (dry contact), analog (0 to 5 volts), pulse (up to 5 hertz) or thermistor point. The analog to digital resolution shall be a minimum of 10 bits.
- D. Outputs – there shall be a minimum of 8 digital outputs utilizing 24 volts AC Form C relays. Each output shall be capable of on/off and pulse width modulation control.
- E. Overrides – each output shall have an optional built-in override switch capable of auto-on-off operation.
- F. Expansion port – the local controller shall have an optional port to accept a family of I/O modules. Up to two (2) modules shall be powered directly from the power supply of the local controller.

G. REAL TIME CLOCK (RTC)

1. The local controller shall contain an optional real time clock, accurate to 10 seconds per day. The RTC shall provide the following information: time of day, day month, year, and day of the week.
2. Each controller shall be capable of receiving a signal over the network from the Level 1 controller to synchronize all clocks to the same time.

H. POWER SUPPLY

1. The local controller shall have a built-in power supply of 24 volts AC, 50/60 hertz. The power supply will tolerate 20 percent swings in supply voltage.

I. PACKAGING

1. Local controllers shall be available in either a NEMA 1 rated enclosure or optionally in a package suitable for panel mounting.

J. LOCAL DISPLAY

1. Local controllers shall have the option for a built-in LCD display and keypad. The display shall have a minimum size of 2 lines by 16 characters. From the keypad, operators shall be able to view point's status, adjust set points and change operating parameters.

2.11 TERMINAL EQUIPMENT CONTROLLERS

- A. The terminal equipment controller is designed to provide direct digital control of variable air volume units, heat pumps, unit ventilators, fan coil units and other miscellaneous HVAC equipment.

- B. Terminal equipment controllers shall have a minimum of 32 kilobytes of user RAM memory and 128 kilobytes of EPPROM.
- C. Inputs: The input section of the terminal equipment controller shall provide a minimum of four (4) universal inputs. Each input shall be configurable through software as a digital (dry contact), analog (0 to 5 volts), pulse (up to 5 hertz) of thermistor point. The analog to digital resolution shall be a minimum of 10 bits. A fifth input shall be optionally available for measuring airflow. The airflow sensor shall be included as part of the controller, and accurate to plus/minus 5 percent over a range of 0 to 1 inch water gauge
- D. Outputs – there shall be minimum of four (4) digital outputs utilizing 24 volts AC Form C relays. Each output shall be capable of on/off and pulse width modulation control.
- E. Expansion port – the terminal equipment controller shall have an optional port to accept a family of I/O modules. Up to two (2) modules shall be powered directly from the power supply of the terminal equipment controller.
- F. POWER SUPPLY
 - 1. The terminal equipment controller shall have a built-in power supply of 24 volts AC, 50/60 hertz. The power supply will tolerate 20 percent swings in supply voltage.

G. PACKAGING

- 1. Terminal equipment controllers shall be available in a package suitable for panel mounting.

2.12 GRAPHIC TOUCH SCREEN DISPLAY CONTROLLER

- A. The touch screen display controller is fully user programmable and contains a LCD display with a size of 24 lines by 40 characters. The screen contains up to 64 cells that are activated by the touch of a finger. The screen will display various graphic images, database values, and predefined control animations such as buttons, keypads, and gauges to enable operators to easily view and modify system information.
- B. Up to 32 touch-screen controllers can reside on each field bus. Each controller has complete access to any database information found in those controllers on the network.
- C. MEMORY
 - 1. Touch screen controllers shall have a minimum of 64 kilobytes of user RAM memory and 128 kilobytes of EPROM.
- D. LCD DISPLAY
 - 1. The display shall be capable of generating two color images of floor plans, equipment schematics, and control animations and database values. The screen shall have a minimum resolution of 320 by 200 characters, and will issue an audible sound upon touching the screen.
- E. REAL TIME CLOCK (RTC)
 - 1. The touch screen display controller shall contain a real time clock, accurate to 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of the week. Each controller shall be capable of receiving a signal over the network from the Level 1 controller synchronize all clocks to the same time.

F. POWER SUPPLY

1. The controller shall have a built-in power supply of 24 volts AC, 50/60 hertz. The power supply will tolerate 20 percent swings in supply voltage.

G. PACKAGING

1. The display controller is intended for flush mounting on a wall or separate enclosure.

2.13 EXPANSION MODULES

- A. Expansion modules are designed to increase the amount of I/O available to each System, Local or Terminal equipment controller above its base level. Module types shall include as a minimum digital inputs, digital outputs, analog outputs, and pneumatic outputs.
- B. It shall be possible to add up to two modules of any type to Level 2 controllers having an expansion port. There will be no limitations in software placed upon any points that originate from expansion modules. Input modules shall contain 8 digital inputs capable of accepting dry contacts or pulses.
- C. Each output module shall provide either two digital, analog or pneumatic outputs. Digital output shall be available in either 24 volts AC or 120 volts AC/220 volts AC rated relays. Analog outputs shall provide either 0 to 10 volts DC or 0 to 20 milliamps.
- D. Pneumatic outputs shall provide a 3 to 15 pounds per inch signal, with built-in feedback of the branch pressure. All output modules shall include override switches and potentiometers where applicable.

2.14 NETWORK DEVICE

A. REPEATERS

1. High Speed LAN – repeaters shall be available for the Ethernet based LAN in single point and multi point configurations. Multi-point repeaters (hubs) shall be modular to allow support for mixed media applications. When repeaters are mounted in a Level 1 Network Controller, power shall be obtained directly from the controller, allowing the repeater to function from the built-in UPS of the controller during power outages. Systems not containing this functionality must furnish an external UPS.
2. Field Bus – the field bus driver will provide amplification to allow for expansion beyond thirty-two (32) Level 2 controllers or 4000 feet. For each additional group of thirty-two (32) controllers or 4000 feet, an additional driver will be required. Drivers that can provide multiple channels from a single card are acceptable. An option shall be available for a field bus driver that converts RS485 twisted pair communications into RS232C duplex fiber optics.

B. NETWORK INTERFACE CARDS

1. The network interface card shall provide connection to the Ethernet-based high-speed local area network. Ethernet cards shall be RJ-45 twisted pair.

C. BRIDGES

1. For Ethernet based networks, the system shall be compatible with both local and remote bridges for the purpose of isolating networks, and routing information to distant locations over high speed phone lines.
2. Local bridges must be capable of line speed throughput. Acceptable vendors include Cabletron or approved equal.

2.15 SYSTEM SOFTWARE

- A. Controller software refers to the capabilities of the firmware resident in each Level 1 or Level 2 controller. As such it describes the overall operating capabilities, communications, and application level functionality of the particular controller.
- B. All controller level firmware is to be resident in ROM, and must be flash upgradeable.
- C. Workstation software encompasses the operating system, database and application software for use on the personal computer workstations. This software may be provided on diskettes, tapes or CD ROMs.
- D. Workstation and controller software is sold as a software license and is intended to be upgraded over time as new features become available.

E. LEVEL 1 CONTROLLERS

- 1. Level 1 Controllers consist of LAN-based network controllers, remote site master controllers, and LAN-based equipment controllers. The operating system shall be resident in ROM memory, with all application software stored in battery-backed RAM. Application software will only be limited by the amount of RAM memory available. There will be no restrictions placed on the type of application programs in the system.
- 2. Each controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function by Level 1 controllers shall not be interrupted due to normal user communications, including interrogation, program entry, printout of the program for storage, etc.
- 3. Once programmed, Level 1 controllers operate in a standalone fashion. All points including software points (variables) are to be accessible on the network as global points by simply referencing the name of the controller from which the point originates. No special programming shall be required in order to share points among different controllers.
- 4. When programming a controller through either a dumb terminal or laptop computer, editing and word processing features will include as a minimum:
 - a. Cut, copy, paste, and undo
 - b. Search and replace
 - c. Comments
 - d. Scrolling
 - e. Character, line, and page cursor control
- 5. When programming in terminal mode, the system will allow full screen, character editing for correction or modification of any portion of a program. Syntax errors will be highlighted, and programmers must make corrections prior to the program being compiled.
- 6. When programming Level 2 controllers, the programming environment will be identical to Level 1 programming with automatic uploading and downloading of the compiled code to the controller.
- 7. All input, output, and internal software points shall be configurable from menus in the operator workstation, the laptop service tool, or through a dumb terminal connected to a Level 1 network or remote site master controller.

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8. Each input shall be software selectable to operate as a digital point, analog voltage, temperature sensor, or a pulsed signal. Output point types may include digital, analog or tristate. The software shall permit scaling of analog inputs and outputs in engineering units, with automatic conversions for both linear and non-linear devices.

F. DATABASE IDENTIFICATION

1. User must be able to assign unique identifiers for each connected I/O point, variable, or controller in the system. Identifiers may have up to sixteen alpha/numeric characters. All referenced in the programs, reports and command messages shall be by these identifiers.
2. Each point name can have up to forty (40) character descriptions, and optionally engineering units (up to eight (8) characters). All analog points shall be stored as floating point numbers and displayable in integer scientific notation formats.

G. USER PROGRAMMING LANGUAGE

1. The application software shall be user programmable. This includes all strategies, sequences or operation, control algorithms, parameters, and set points. The language shall utilize English statements and allow for the construction of logical sentences and phrases. High level languages such as basic and C are unacceptable.
2. The language shall be structured to allow for the easy configuration of control programs, functions, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories.
3. The language shall allow the creation of timers anywhere in the logic of a program. Each timer shall increment in seconds and increment to a maximum of 365 days.
4. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

H. APPLICATION SOFTWARE

1. The system shall include software modules in either loadable libraries or ROM memory for the creation of standard application programs. Modules will include as a minimum:
 - a. PID Algorithm
 - b. Self-Tuning PID
 - c. Calendar Functions: seconds, minutes, hour, day of week, day of month, day of year, month and year
 - d. Curve fit
 - e. Optimum Start
 - f. Psychometric Functions

I. MATHEMATICAL FUNCTIONS

1. Each controller shall be capable of performing basic mathematical functions (+, -, X, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both.

2. The controller shall be capable of performing complex logical statements including operations such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

J. PASSWORDS

1. Level 1 network controllers will have up to five levels of passwords. The highest level will allow access to all functions within the system.
2. The remaining 4 levels will provide increasingly less functionality down to complete restriction from viewing on a given controller.

K. HISTORY LOGGING

1. Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 365 days. Any system variables (input, output, math calculations, flags, etc.) can be logged in history.
2. A maximum of 32767 values can be stored in each log. Each log will record either, instantaneous, average, minimum, or maximum value of the point. Logs can be automatic or manual.
3. It shall be possible to calculate the average of a log, the standard deviation, the sum, minimum or maximum. It shall also be possible to reference any value within a log for use in a control program.

L. ALARMING

1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan and can result in the display of one or more alarm message reports.
2. Messages and reports can be sent to the optional display panel, a local terminal, a workstation, or via modem to a remote-computing device.

M. OVERRIDING SYSTEM POINTS

1. It shall be possible to dial a point in the system and modify it to user definable value. Any points that have been disabled will be kept in a log and viewable by an operator at any time.

N. LEVEL 2 CONTROLLERS

1. Level 2 Controllers provide application specific control of HVAC equipment and lighting. The operating system shall be resident in ROM memory, with all application software stored in battery-back RAM. Application software will only be limited by the amount of RAM memory available. There will be no restrictions placed on the type of application programs in the system.
2. Each controller shall be capable of parallel processing executing all control programs simultaneously. Any program can affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function by Level 2 controllers shall not be interrupted due to normal user communications, including interrogation, program entry, printout of the program for storage, etc.
3. Each controller, once programmed, operates its equipment in a standalone fashion. All points, including software points (variables), are to be accessible on the network as global points by simply referencing the name of the controller from which the point originates. No special programming shall be required in order to share among different controllers.

4. All input, output, and internal software points shall be configurable from menus in the operator workstation, the laptop service tool, or through a dumb terminal connected to a Level 1 network or remote site master controller.
5. Each input shall be software selectable to operate as a digital point, analog voltage, temperature sensor, or a pulsed signal. Output point types may include digital, analog or tristate. The software shall permit scaling of analog inputs and outputs in engineering units, with automatic conversions for both linear and non-linear devices.
6. Where Level 2 controllers contain override switches, the software shall detect the override position of the switch and record the actual value of the override for both digital and analog output types.

O. DATABASE IDENTIFICATION

1. Users must be able to assign unique identifiers for each connected I/O point, variable, or controller in the system. Identifiers may have up to sixteen alpha/numeric characters. All references in the programs, reports, and command messages shall be by these identifiers. Each point name can have up to a 40-character description, and optional engineering units (up to 8 characters).
2. All analog points shall be stored as floating point numbers and displayable in integer or scientific notation formats.

P. APPLICATION PROGRAMS

1. Utilizing the user programming language specified above, application specific programs will be developed for each Level 2 controller including but not limited to start/stop sequences, valve and damper modulation, equipment optimization, energy management routines, and safety interlocks.

Q. ALARMING

1. For each system point, up to eight (8) alarms can be created based on high/low limits or conditional expressions.
2. All alarms will be tested each scan and can result in the display of one or more alarm messages or reports through a host workstation.

R. HISTORY LOGGING

1. Each controller shall be capable of logging any point over user defined time intervals ranging from 1 second to 365 days. Points include inputs, outputs, math calculations, set points, and internal variables.
2. A minimum of 2000 values can be stored in each log. Each log will record either the instantaneous, average, or minimum value of the point. Logs can be automatic or manual.

S. SCHEDULES

1. Time schedules configured at an operator workstation are to be optionally stored in the Level 2 controller. Each schedule shall have multiple start and stop times per day, automatically adjust for holidays, day light savings and leap years. The number of schedules per Level 2 controller will be limited only by available memory.

T. EXPANSION MODULES

1. There will be no special programming required when assigning points originating from an expansion module.
2. There will be no limitation on application programs that reference points from expansion modules.

U. OVERRIDING SYSTEM POINTS

1. It shall be possible to disable a point in a Level 2 controller and modify it to a user definable value.
2. Any points that have been disabled will be kept in a log and viewable by an operator at any time.

2.16 GRAPHIC TOUCH SCREEN DISPLAY CONTROLLER SOFTWARE

- A. The software in the display controller provides text and graphic displays on the controller's LCD screen. The actual programs shall be created using a dumb terminal connected to a Level 1 network controller, a laptop service tool, or an Operator Workstation and stored in the local RAM memory of the display controller.
- B. The touch screen shall have a minimum of 64 programmable cells for interaction with an operator. Each cell will be individually addressable in a program for the purpose of selecting different displays, activating control of remote devices, changing set points, etc.
- C. Touch screen display programs shall be able to reference any point values found in Level 1 and Level 2 controllers including inputs, outputs, and calculated variables. Point referencing shall be accomplished by providing the full name of the point inside the program. This will automatically result in establishing communication with the remote point whenever the particular program is in operation.
- D. Each controller shall allow for the storage of multiple programs whose purpose is to create the images seen on the display and to interpret the pressing of the touch cells into actions taken by the resident programs. The actual programs shall be written in the same user programming language specified under Level 1 controllers. The language shall include key words for drawing lines, rectangles, ellipses, and allow for video effects such as fills and reverse video.
- E. In addition to generic drawing tools, the display shall contain a library of predefined shapes for ease in creating animated controls including gauges, buttons, level fills, text displays, and keypads.

2.17 WORKSTATION SOFTWARE

- A. Workstation functions will include monitoring and programming of Level 1 and Level 2 controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data connection, and operator-initiated control actions such as schedule and set point adjustments.
- B. The workstation software must be able to communicate to all Level 1 and Level 2 controllers, and where necessary integrate information that is common to one or more controllers. It shall be possible to program off-line to any controller.
- C. The software will be oriented towards operators and programmers. In the operators' mode, all information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the IACS system.
- D. All operator function shall be selectable through a mouse. A “windows” environment shall be used to allow multiple functions to be displayed on the screen simultaneously.

E. OPERATING SYSTEM

1. The software will utilize the Microsoft Windows Professional multitasking operating system.

F. NETWORK COMMUNICATIONS

1. Acceptable network protocols include Ethernet. The file server acts as the central database for the workstations, so that all additions or changes made by one operator are immediately available to other operators on the network.
2. Each workstation shall also be able to communicate out each of its serial ports to remote site master controllers via modems. Each workstation shall support the use to two simultaneous serial devices, in addition to communication over high speed LAN.

G. SYSTEM DATABASE

1. The workstation database shall consist of all points and programs in each of the controllers that have been assigned a network.
2. The database will contain all workstation files including graphic slides, alarm reports, text reports, trend logs, schedules, and polling records. The software shall conform to the following:
 - a. Utilize Microsoft's SQL database server.
 - b. The system will verify that the database in each controller is identical to the one at the workstation. If any discrepancy is found, it will automatically modify its database or notify an operator of the error.
 - c. The database shall also contain host level points consisting of variables, which can be used for host level reports, and alarming. These variables can be set point of the result of any Boolean algebra expression.
 - d. Object Tree: It shall be possible for an operator to view the entire database through graphical object tree display. This tree will present all controllers and their associated readers and I/O, programs, graphics, alarms, and reports in an easy to understand structure.

H. SYSTEM CONFIGURATION

1. Configuration of the database shall be through application modules, each having a unique “icon” for easy visual identification. Each module will provide a windowed menu in which to enter the required database information.
2. Each site, whether local or remote, shall have a separate record for storing pertinent communication parameters.
3. Controllers will be associated with a specific site file. The controller record will also contain the controller passwords and communication logon and logoff text strings as required.
4. Point records will include, as a minimum, a 32-character point description, engineering units, logging parameters, point status, and point value.
5. All database records will be available to the user at all times, regardless of the current tasks being performed by the workstation.

I. COLOR GRAPHIC DISPLAYS

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of geographic maps, building schematics, floor plans, and mechanical and electrical systems.
2. These graphics shall contain point information from the database including any attributes associated with points (engineering units, etc.). Operators shall be able to command equipment or change set points from a graphic through the use of the mouse.
3. VGA, bit-mapped displays. The user shall have the ability to import CAD generated picture files.
4. An outline graphics drawing editor that provides for all standard geometric shapes, shading, up to 256 colors, cutting and pasting of objects, inclusion of text, and zooming.
5. Built-in control panel objects such as buttons, knobs, gauges, line graphs, etc. to enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
6. Status changes or alarm conditions can be highlighted by objects changing screen location, size, color, and text, blinking or changing from one display to another.
7. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators will be able to move from one graphic to another by selecting an object with a mouse, no menus will be required.
8. The graphic system shall allow for one touch modification of any analog or digital point in the database regardless of its location on the network.

J. ALARM MANAGEMENT

1. The software shall be capable of both accepting alarms directly from Level 1 and Level 2 controllers. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgement, and have the option for displaying graphics and reports. Alarm management features shall include:
2. A minimum of 255 alarm levels, each alarm level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.
3. When an alarm occurs, the alarm counter will be incremented by one.
4. Printout of the alarm or alarm report to an alarm printer or report printer.
5. Print the alarm acknowledgment of Return to Normal message.
6. Sound an audible beep on alarm initiation or acknowledgment.
7. It shall be possible to direct alarm displays to all or any workstation or LAN-based network controller. Each configured path can be assigned on a unique basis on its alarm level.

K. REPORT GENERATION

1. The software will contain a built-in report generator, featuring word processing tools for the creation of custom building reports.
2. Reports can be of any length and contain any point within the database of Level 1 and Level 2 controllers.
3. The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.
4. It shall be possible to run other executable programs whenever a report is initiated.
5. Report generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

L. ACTIVITY LOGGING

1. Every action taken by an operator that changes the database will be automatically recorded in the activity log.
2. This log is only viewable by the System Administrator, and can be sorted by activity type, date and time, user, and controller. The size of the log shall be user definable with a minimum of 100000 entries.
3. Only the System Administrator shall have the right to delete activities from the database.

M. SCHEDULING

1. It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style configured for either monthly or weekly operation. Scheduling shall be programmable up to one year in advance.
3. Each schedule will appear on the screen as a monthly calendar correctly showing the day, weekday, month and year. It shall be possible to scroll from one month to the next and view or alter any of the schedule times.
4. Schedules will be assigned to a controller, and attached to specific reader or person. Any changes made at the workstation will automatically be updated to the corresponding schedule in the controller.
5. It shall be possible to configure multiple holiday schedules in a yearly format. Holiday schedules will override the standard operating schedule for those days that have been defined as holidays. Holidays shall be differentiated on the calendar through color coding of the date. Any changes to a holiday schedule will be automatically updated to the standard schedule to which it has been superimposed.
6. There shall also be provision for special day schedules. Special day schedules will override both the standard schedule and its associated holiday schedule. Special days will be differentiated on the calendar through color coding of the date. Any changes to a special day schedule will be automatically updated to the standard schedule to which it has been superimposed.
7. The use of holiday or special day schedules is strictly optional. Standard schedules do not require either of these two types of schedules.

8. The scheduling application shall include built-in editing tools to permit users to copy and paste portions of schedules to different days, weeks or months. Users can select from a particular day, a range of days, or a nonconsecutive group of days over which to edit a schedule.

N. PROGRAMMER'S ENVIRONMENT

1. The programmer's environment will include access to a superset of the same programming language supported in the Level 1 controllers. Here the programmer will be able to configure application software offline (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software.
2. The programmer will have software tools to allow copying of database information from one controller to selected controllers on the network. This information can be any subset of a particular system including data points, graphics, alarms, schedules and reports. Once copied, the tool will automatically download these changes to the specified controller(s) on the network. These same tools will also work with controllers located at remote sites.

O. PASSWORD PROTECTION

1. The software shall employ a two tiered password system. The first tier shall consist of the user's name. The second tier shall be a unique password consisting of 8 alphanumeric characters. Each password shall have a unique access level. At least six (6) levels will be defined as follows:
 - a. No Access: No communications allowed to a particular controller or site
 - b. Custodial: View all applications, but perform no database modifications
 - c. Clerical: Custodial privileges plus the ability to acknowledge alarms
 - d. Operator: All privileges except system configuration
 - e. Engineering: All configuration privileges except passwords
 - f. Administrative: All privileges
2. The password level for each user shall be changeable based on the particular controller, the information, or the function to be performed. With this capability, users that have engineering privileges on one controller or mechanical system may have only clerical privileges on a second system or controller.

P. SAVING/RELOADING PROGRAMS

1. The workstation software shall have an application to save and restore field controller memory dumps. Each file shall be stored on the hard disk, and shall be accessible for reloading from the object tree. Each record shall have a minimum 16-character record name and a 32-character description.
2. The Save/Reload application shall have the capability to set the system clock in a Level 1 controller. Default values stored in the workstation database shall be sent to the controller during a reload operation without operator involvement.

Q. AUTOMATIC MONITORING

1. The software shall allow for the collection of data and reports from any Level 1 or Level 2 controller through either a hardware or modem communication link. The time schedules and content of the polling shall be user configurable and include any subset of the controller's database including application programs.

R. TRENDING

1. The software shall be capable of displaying historical data in either a tabular or graphical format.
2. Any field point or calculated variable will be available for trending. The data presented can either originate from the controller or from archived data stored on the hard disk of the workstation or file server.
3. In a tabular form, the trend display can have up to sixteen (16) columns. Each column will contain a minimum of 6599 rows.
4. In the graphical format, the trend shall plot up to sixteen (16) separate variables over the requested time period.
5. The time period for each trend shall be user selectable, from one (1) minute to one (1) year.

S. LAPTOP SERVICE TOOL

1. The laptop service tool software shall provide the editing capability described for all Level 1 and Level 2 controllers, making it equivalent in functionality to a dumb terminal.
2. Connected to a Level 1 Network Controller or Remote Site Master Controller, the service tool shall permit saving and reloading on controller program to/from hard disk or removable disk.

T. NETWORK COMMUNICATIONS

1. Once connected to any Level 1 or Level 2 controller, it shall be possible for the operator to communicate directly with any other controller in the network. This communication shall include monitoring of points, editing of programs, and downloading/uploading files from disk.

U. PASSWORD PROTECTION

1. Password protection will be identical to that specified for LAN-based network controllers.

V. DATABASE SYNCHRONIZATION

1. If any changes are made to a controller's database by the laptop service tool, these changes will be automatically reported to the network file server when present.

2.18 FIELD DEVICES GENERAL

- A. Included with field devices are all sensors, transmitters, transducers, relays, switches, and power supplies necessary for the operation of the Level 1 and Level 2 controllers.
- B. All field devices shall include the associated wiring, mounting, and enclosures.
- C. Also included are control valves, valve actuators, damper actuators, and conventional controls necessary for a completely functioning system in accordance with the sequence of operation.

- D. The Contractor shall provide all field devices per the performance requirements set forth in this section. All devices selected by the Contractor must be contained in the Submittal documents and are subject to approval by the Engineer.
- E. In the case of an existing facility, and as desired by the building Owner, the Contractor shall use wherever possible identical field devices to those already existing.
- F. All sensors and signal conditioning equipment will be of the type which are universally accepted in the industry, can easily be second sourced and are compatible with all of the manufacturer's equipment.
- G. Material furnished shall be standard cataloged products of recognized manufacturers regularly engaged in the production of such material and shall be the latest design.

2.19 INPUT DEVICES

- A. Input devices shall include sensors for measuring temperature, humidity, flow, pressure, current, kilowatts, equipment status and carbon dioxide. Actual sensors for this project are determined by the point list.
- B. Where transducers are required to convert the raw sensing element into an industry standard signal, the transducer may be supplied as an integral unit with the field sensor, or mounted separately in a field interface, or as part of the controller. All transducers will be calibrated.
- C. System accuracy of sensed conditions shall be as follows:
 - 1. Plus/minus 0.5 degrees Fahrenheit for space temperature in the 0 to 230 degrees Fahrenheit range
 - 2. Plus/minus 0.5 degrees Fahrenheit for duct temperature in the 0 to 230 degrees Fahrenheit range
 - 3. Plus/minus 1.0 degrees Fahrenheit for outside air temperatures in the minus 30 to 230 degrees Fahrenheit range
 - 4. Plus/minus 1.0 degrees Fahrenheit for water temperatures in the minus 30 to 230 degrees Fahrenheit range
 - 5. Plus/minus 1 percent for kilowatt-hour (kWh) and kilowatt (kW) monitoring.
 - 6. Plus/minus 3 percent for relative humidity in the 10 to 95 percent range
 - 7. Plus/minus 0.1 inches for static pressure over 0 to 5 inches water gauge
 - 8. Plus/minus 0.1 inches for filter status differential over a 0 to 2 inches range
 - 9. Plus/minus 1 percent for pressure switches
 - 10. Plus/minus 2 percent for air flow
 - 11. Plus/minus 3 percent for water flow
 - 12. Plus/minus 1 percent for differential water pressure
- D. The system shall maintain the specified analog end-to-end accuracy throughout the warranty period from sensor to controller readout.

E. PACKAGING

1. Architectural housing for space mounting.
2. Weatherproof/sunshield housing for outdoors.
3. Thermal well housing for water applications.
4. Protective housing for duct mounting.

F. ENVIRONMENTAL RATINGS

1. Moisture of condensation is a factor.
2. Vibration exists from ductwork, equipment, etc.
3. Reasonably expected transient conditions exist for temperatures, pressures, humidity's, etc. outside the normal sensing range.

G. TEMPERATURE SENSORS

1. Temperature sensors shall be thermistors (10 kilohms at 77 degrees Fahrenheit).
2. Sensors in the return or discharge duct shall be of the single point type. Sensors in the mixed air will be of the average type.
3. Thermowells shall be brass or stainless steel for non-corrosive fluids below 250 degrees Fahrenheit and 300 series stainless steel for all other applications.
4. Room temperature sensors will be available in a minimum of three configurations:
 - a. Sensing elements only
 - b. Sensing elements, set point adjustment, and override switch
 - c. Sensing element, LCD display and keypad
5. Refer to the drawings and/or point list for the specific sensor type for each location.

H. HUMIDITY SENSORS

1. Humidity sensors shall be available in accuracy's ranging from 2 to 5 percent.
2. Packaging options shall include those for wall, duct, and outside air mounting.
3. All sensors shall be field calibrated with a portable service tool.

I. PRESSURE SENSORS

1. Differential air pressure, static pressure, and velocity pressure sensors shall be furnished by Veris, Kele, Modus, Setra or equivalent.
2. Liquid, water, or steam pressure sensors shall be furnished by Kele, Modus, Setra, or equivalent.
3. Pressure switches shall be furnished by United Electric, Dwyer or equivalent.

J. FLOW SENSORS

1. Duct and plenum mounted airflow measuring stations shall be Ebtron Hybrid series (no substitutions permitted). Stations used in exhaust ductwork shall utilize stainless steel sensor mount tubing with Kynar thermistor brackets.
2. Fan inlet measuring stations may be Ebtron Hybrid series as described above or a Pitot tube type.
 - a. Pitot tube type fan-inlet mounted airflow measuring stations shall consist of a network of static and total pressure sensors, factory positioned and connected in parallel, to produce and equalized velocity pressure. Sensor point shall be distributed for equal area averaging. The measured velocity pressure converted to airflow (cubic feet per minute) shall have accuracy within 2 percent of the full scale throughout the velocity range from 700 to 4,000 feet per minute. Flow-straightening vanes shall be incorporated into the structure. The unit shall be suitable for continuous operation up to a temperature of 250 degrees Fahrenheit. Differential pressure transducers shall measure and transmit pressure signals to the direct digital controller.
 - b. The differential pressure transducers shall be selected so that the usable full scale of the device shall be no greater than 90 percent of the natural span.
 - c. Stations used in exhaust ductwork shall be constructed of stainless steel.
 - d. Provide products from Ultratech Industries, Air Monitor Corporation Fan-E, or approved equal.
3. Water flow sensors shall be furnished by Onicon, Data Industrial, Hershey, Istech or equivalent.

K. DIGITAL SENSORS

1. All digital inputs will be provided by dry contacts. The contacts will be wired normally open or normally closed as required.
2. Motor status (pumps, fans, etc.) by current sensing switch shall be Veris model H708 current operated switch with adjustable setting. If Variable Frequency Drives are utilized, motor status shall be indicated by an analog feedback signal from the drive.
3. Pump flow status by differential water pressure shall use Penn P74 or equivalent.

L. POWER SENSORS (CURRENT, KILOWATT, AND KILOWATT-HOUR)

1. Chiller amps shall be sensed by current transducers. The range of operation shall be from zero to a value not more than 50 percent of FLA. Use Veris, or equivalent.
2. Utility metered or sub-metered kilowatt-hour or kilowatt shall be sensed by a pulse producing transducer furnished by the power authority.

M. CARBON DIOXIDE SENSORS (CO₂)

1. Carbon Dioxide shall be sensed by a Carbon Dioxide sensor/transmitter. The range of operation shall be 0 to 1000 parts per million with an analog output of 0 to 10 volts DC or 4 to 20 milliamps.
2. The unit shall be single point calibration with electrically isolated output and power. Use Veris, or equivalent.

2.20 OUTPUT DEVICES

- A. The use of multiplexers will not be accepted.
- B. All digital outputs will be electrically isolated from the digital controller by interface relays.
- C. Field relays shall have a minimum life of one (1) million cycles without failure.
- D. Contactors shall have a minimum life of 100000 cycles without failures.

2.21 ELECTRONIC ACTUATORS

- A. The actuators shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper or valve shaft without the need for connecting linkage. The fastening clamp assembly shall be of a “V” bolt design with associated “V” shaped toothed cradle attaching the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a “V” clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or set screw type fasteners are not acceptable.
- B. The actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
- C. For power-failure and safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable. All spring return actuators shall be capable of both, clockwise or counterclockwise, spring return operation by simply changing the mounting orientation.
- D. Proportional actuators shall accept a pulse-width modulation (PWM) of 0 to 10 volts DC or 0 to 20 megamps (MA) control input and provide a 2 to 10 volts DC or 4 to 20 megasiemens (MS) operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 volts DC position feedback signal. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
- E. All 24 volts AC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 volts ampere for AC or more than 8 watts for DC applications. Actuators operating on 120 volts AC power shall not require more than 10 volts ampere.
- F. Actuators shall be provided with a conduit fitting and a minimum 3 feet of electrical cable and shall be pre-wire to eliminate the necessity of opening the actuator housing to make electrical connections.
- G. Actuators shall be designed for a minimum of 60000 full stroke cycles at the actuator’s rated torque and shall have a 2-year manufacturer’s warranty, starting from the date of installation. The Manufacturer shall be ISO9001 certified and shall be Underwriters Laboratories Standard 873 listed. All actuators shall be as manufactured by Belimo.

2.22 CONTROL VALVES

- A. All valves shall be fully proportioning, tight closing, quiet in operation and be arranged to fail safe, in either a normally open or normally closed position in event of a power failure. Open and closed position shall be as specified to suit job conditions.
- B. Provisions shall be made for valves operating in sequence with other valves or damper operators to have adjustable ranges and starting points to provide flexibility of adjustment in sequencing and throttling range.

- C. All valves shall be equipped with rubber, silicon, or neoprene diaphragms, throttling plugs and removable composition disks. In general, valves from ½ inch to 2 inches shall have screwed bronze bodies. Valves 2 inches to ½ inch and over shall have flanged cast-iron bodies.
- D. Valves shall be sized by temperature control manufacturer and guaranteed to meet the heating and cooling requirements as specified and shall be such that sound level due to velocity is acceptable.
- E. All valves shall have the same pressure rating as the pipe in which they are installed. The Control Contractor shall submit to the Engineer prior to installation, the complete valve schedule listing calculated (Cv) and actual Cv rating of the valve to be provided. For sizing purposes, a nominal 3 pounds per inch drop shall be calculated for pressure loss across a valve.

2.23 CONTROL DAMPERS

- A. The controls sub-Contractor shall furnish all control dampers not specifically specified as part of the mechanical equipment to the mechanical sub-Contractor for installation in the ductwork.
- B. Bleed-in bypass air dampers and fan isolation dampers associated with EF-1A, -1B, -3A, and -3B shall have frames constructed of 16-gauge galvanized steel structural hat channel with tabbed corners for reinforcement for 11-gauge structural equivalence. Blades shall be 14-gauge equivalent thickness galvanized steel, roll-formed airfoil type for low pressure drop and low noise generation. Blade edge seals shall be Ruskiprene type or equivalent suitable for minus 72 to plus 275 degrees Fahrenheit, mechanically locked into the blade edge. Adhesive or clip-on type seals are unacceptable. Jamb seals shall be flexible metal, compression type to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable. Bearings shall be corrosion resistant, permanently lubricated stainless steel sleeve type turning in an extruded hole in the damper frame. Axles shall be hexagonal positively locked into the damper blade. Linkage shall be concealed out of air-stream, within the damper frame to reduce pressure drop and noise. Submittal must include leakage, maximum air flow and maximum pressure ratings based on AMCA Publication 500. Damper shall leak less than 3 cubic feet per minute/square feet at 1 inch of static pressure and shall be AMCA licensed as a class 1A damper. A 36 inches x36 inches sized damper shall have no more than .06 inches water gauge static pressure drop at 2000 feet per minute face velocity. Dampers shall be Ruskin CD60 model.
- C. All other dampers shall be of heavy gauge, all galvanized construction. Blades shall not exceed 6 inches in width, and all blade shafts shall be one piece extruded steel. All dampers shall be fitted with neoprene or silicone rubber blade and jam seals. Shaft bearings shall be nylon, and all operating hardware shall be of reinforced non-corrosive metal or cadmium plated steel. Temperature range shall be minus 20 to 200 degrees Fahrenheit and leakage shall be AMCA Certified to be less than 10 cubic feet per minute per square foot of damper, based on 2000 feet per minute approach velocity with 4 inches water gauge static pressure.
- D. All dampers specified to be automatic operating shall be supplied with shaft extended to accommodate the specified operator.
- E. All two-position dampers shall have parallel blades. Modulating dampers shall have opposed blades with the exception of face and bypass dampers, which shall be made up of two sections of parallel blade dampers with the blades of one damper opposed to the blades of the other for proper mixing.

PART 3: EXECUTION

3.1 MOUNTING AND INSTALLATION PRACTICES

- A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
- B. Dampers will be furnished by the IACS Contractor and installed by the Mechanical Contractor.

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- C. Automatic control valves will be furnished by the IACS Contractor and installed by the Mechanical Contractor.
- D. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
- E. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150 percent of the rated coil voltage.
- F. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
- G. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.
- H. For building static pressure, the high pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside in the building.

3.2 ENCLOSURES

- A. For all I/O devices, which require field, interface devices, these devices, where practical, will be mounted in a field interface panel (FIP). All other field interface devices will be mounted at the point of field interface in a separate enclosure suitable for the location. The Contractor shall provide an enclosure, which protects the devices from dust, moisture, conceals integral wiring and moving parts.
- B. The FIP shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
- C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for 20 percent spare mounting space. All locks will be keyed identically.
- D. All wiring to and from the FIP will be a screw type terminal. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
- E. All wiring within the FIP will be run in plastic raceway to give a neat and workmanlike appearance.

3.3 LOCATION

- A. The location of sensors is per mechanical and architectural drawings and the descriptions in the sequences of operation.
- B. Space humidity sensors or temperature sensors will be mounted away from machinery generating heat, direct light and diffuse air streams.
- C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
- D. Field enclosures shall be located immediately adjacent to the controller panels to which it is being interfaced.

3.4 IDENTIFICATION

- A. All I/O field devices (except space sensors) that are not mounted within the FIP shall be identified with nameplates.

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- B. All I/O field devices inside the FIP shall be labeled.
- C. The identification shall match all documentation and identify the function (i.e. mixed air temperature sensor).
- D. Calibration settings shall be marked with paint or indelible ink.
- E. Each terminal strip termination shall be tagged with an identification that matches the control drawings.
- F. The outside of each FIP shall be identified with a label matching the identification name shown on the drawings.

3.5 CONTRACTOR RESPONSIBILITIES

- A. Installation of the IACS system shall be performed by the IACS Contractor or subcontractor. All installation shall be under the personal supervision of the Contractor.
- B. The IACS Contractor shall certify all work as proper and complete and shall reflect actual installation of the project record documentation.

3.6 COMPLIANCE

- A. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
- B. Provide plenum rated coaxial cable when running in return air plenums.

3.7 FIBER OPTIC CABLE

- A. Acceptable fiber optic cable shall include the following sizes: 50/125, 62.5/125, or 100/140. Only glass fiber is acceptable.
- B. Fiber optic cable shall only be installed and terminated by an experienced Contractor. The IACS Contractor shall submit to the Engineer the name of the intended Contractor of the fiber optic cable with his submittal documents.

3.8 ENCLOSURES

- A. All controllers and field interface panels shall be mounted in new enclosures unless otherwise stated in this specification.
- B. All outside mounted enclosures shall meet the NEMA-4 ratings.
- C. The tubing and wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.
- D. All tubing shall be connected to enclosures through conduit. Use bulkhead fittings where appropriate.

3.9 SOFTWARE INSTALLATION

- A. The IACS Contractor shall provide all labor necessary to install, initialize, startup and debug all system software as described in this section. This includes any operating system software on other third party software necessary for successful operation of the system.

3.10 DATABASE CONFIGURATION

- A. The IACS Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.11 COLOR GRAPHIC DISPLAY

- A. Unless otherwise directed by the Owner, the IACS Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for set point charges as required by the Owner.

3.12 REPORTS

- A. The IACS Contractor will configure a minimum of six (6) reports for the Owner as listed below:
 1. Central Plant Status Report
 2. Air Handler Status Report
 3. VAV Status Report
 4. Energy Consumption Report
 5. Space Temperature Report
 6. Specialty Equipment Status Report

3.13 DOCUMENTATION

- A. As built software documentation will include the following:
 1. Descriptive point list
 2. Application program listing
 3. Application programs with comments
 4. Printouts of all reports
 5. Alarm list
 6. Printouts of all graphics

3.14 IDENTIFICATION

- A. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- B. Identify all pneumatic tubing with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
- C. All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against cross-referenced with as-built drawings.
- D. Junction box covers will be marked to indicate that they are a part of the IACS system.

3.15 INSTALLATION PRACTICES

- A. Level 1 controllers are to be mounted vertically.
- B. The 120 volts AC power wiring to each Level 1 controller shall be dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
- C. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
- D. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.

3.16 POWER AND CONTROL WIRING

- A. All IACS equipment power shall be the responsibility of the Division 26 Electrical Contractor.
- B. It is the responsibility of the Contractor to coordinate with the Division 26 Electrical Contractor on the final locations to which IACS equipment power is wired.
- C. The power shall be obtained from dedicated circuits on the nearest available 120 volts panel and clearly labeled. Power for any IACS equipment that is controlling equipment that operates under emergency power shall be obtained from emergency power panels.
- D. All power wiring for the IACS equipment shall be done with a dedicated earth ground by means of wire media only, originating at the power service source earth ground. This applies to all Level 1 and Level 2 controllers along with workstations and the file server.
- E. Use of Raceways: All control power and signal wiring, outside of control panels, in exposed areas, shall be run in rigid steel conduit or EMT. Wiring located in inaccessible areas (in walls, above hard ceilings, in shafts, etc.) shall be installed in conduit.
- F. All low voltage control wiring (less than 30 volts AC) if located in concealed but accessible areas, may employ plenum rated, UL-verified Limited-Combustible FHC 25/50 Type CMP (UL 2424), outside of conduits.
- G. Cable installed outside of conduits but must be installed in a neat, workmanlike manner in association with building contours and in compliance with the NEC. Wiring shall not droop or be secured with devices that may abrade the insulation jacket.
- H. Wiring shall be independently supported from structure and shall not be secured to any conduit, pipe, or duct. Acceptable supports include J-hooks, straps, and cable trays. ATC wiring shall not be set in existing cable trays or trays installed by other divisions unless specific permission is granted by the Architect/Engineer and the building Owner. Wiring shall not rest on the top of ceilings.
- I. All conduit shall be EMT to within 3 feet of the device. Within 3 feet, flexible conduit may be employed.
- J. All wiring and conduit shall be run either parallel or perpendicular to walls constructed in the area served. All takeoffs or junctions shall be made at 90 degree angles.
- K. Pull strings shall be provided in all conduits for the future addition of wires.
- L. Pull strings shall be provided in all conduits for the future addition of wires.

- M. All sensors mounted in wall shall have conduit stubbed to above wall.
- N. Control Signal Wiring: All control wiring including low voltage (24 volts) and line voltage (120 volts) control and interlock wiring for HVAC systems and equipment will be provided under Division 23. Control wiring shall be in accordance with the National Electrical Code and Division 26 of these specifications and shall not be in conflict with state and local codes. Wiring for controls, except the low voltage conductors, shall be single conductor solid or stranded copper not less than No. 14 AWG, 90 degrees C., with 600 volts Type THHN/THWN insulation. Wiring in panel construction may be No. 16 or No. 18 AWG copper provided same is properly protected and/or is in accordance with the NEC. No temperature control wiring installed under this contract shall be installed in conduits for the building lighting and power circuit system. Low voltage 2-conductor and 3-conductor wire shall be twisted (6 turns per foot), 16 or 18 AWG wire, 90 degrees Celsius, and 600 volts THHN/THWN insulation. Cable shall be as manufactured by Alpha Wire Company, Belden Wire Company, Standard Wire and Cable, or approved equal. All conduit, fittings, hangers and accessories for control wiring installed under Division 23 shall conform to the levels of quality specified under Division 26.
1. All wiring shall be properly color-coded or identified (using terminal numbers) or both at the termination point in the control panels so that wiring between the panel and the sensing/control device can be easily identified. Provide wire identification tags (using terminal numbers) in all control panels designating terminal connection points so that wiring between the panel and the sensing/control device can be easily identified.
 2. Analog Input, Binary Input, Analog Output and low voltage Binary Output wires shall be routed uniformly in a singular bundle or through a single conduit.
 3. Singular or multiple 120 volts Binary Output wires shall be routed uniformly in a singular bundle or through a single conduit. High voltage (120 volts) Binary Output wiring shall not be installed in the same bundle or conduit as AI, Binary Input, or Analog Output wiring unless otherwise specified.

3.17 COMMISSIONING OF THE CONTROL SYSTEM

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
- B. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 2. Calibration test pneumatic and electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 3. Engage a factory-authorized service representative to perform startup service.
 4. Replace damaged or malfunctioning controls and equipment.
 - a. Start, test, and adjust control systems.
 - b. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - c. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

5. Verify DDC as follows:
 - a. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 - b. Verify operation of human machine interface.
 - c. Verify local control units including self-diagnostics.
- C. General Testing Procedure: Each phase of testing must be completed and accepted before proceeding to the next step of testing. It shall be the responsibility of this contract to coordinate and schedule the required trades and officials required to complete testing. Project completion delays caused by inadequate coordination and scheduling or delays caused by failure to meet test specifications shall be the responsibility of this contract.
 1. Test plans shall be provided for each phase of testing and shall define all the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests; identifying simulation programs, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested.
 2. Test procedures for each phase of testing shall be developed from the test plans and design documentation. The procedures shall consist of detailed instructions for test setup, execution and evaluation of test results. Test reports shall be used to document the results of each test.
 3. Testing shall be performed in two basic steps. Phase One is a test which verifies the accuracy of the sensors and end devices and general system operation, flexibility and response. Phase Two is operational sequence testing which verifies the proper operation of control strategies to match the sequence of operation.
- D. Phase One Testing: Calibration of each instrumentation device connected to the DDC system shall be performed by making a comparison between the reading at the respective device and the display at the supervisory HMI using a standard which is traceable to the national bureau of standards and shall be at least twice as accurate as the device to be calibrated. Written permission must be obtained from the Owner that this phase of testing has been successfully completed with the proper documentation before proceeding with the next phase of testing. All sensors/transducers, etc. shall be tested to verify that they meet the accuracy as specified.
 1. The general performance tests shall be used to demonstrate the specified overall system performance and accuracy of the DDC system. System performance shall be verified on all systems on the specified failure modes upon DDC system failure or loss of power, and that all systems return to DDC system control automatically upon resumption of DDC system operation or return of power. Exercises shall be performed on the system according to the written test procedures in order to verify response time of all system activities (i.e., control loop response, alarm response, updating of temperatures, and other values).
 - a. System Controller and HMI:
 - 1) Scan rate
 - 2) Analog I/O accuracy
 - 3) Battery back-up duration
 - 4) Screen refresh rate

- b. Sensors:
 - 1) Visually inspect for proper installation and pneumatic or electrical connections.
 - 2) If the process variable can be simulated, input 0 percent range value and record the measured process variable, device output and displayed value at the DDC system terminal. Repeat this process for 50 percent and 100 percent of the process variable range.
 - 3) If the process variable cannot be simulated, use the ambient value for the process variable and record the measured process variable, device output and displayed value at the DDC system terminal. Simulate the device output signal current/voltage for 0 percent and 100 percent of the process variable range and record the measured device output signal and the displayed value at the DDC system terminal.
- c. Transducers:
 - 1) Visually inspect for proper installation and pneumatic or electrical connections.
 - 2) Enter 0 percent range value at the DDC system terminal and measure and record the device's input and output signal values. Repeat for 50 percent and 100 percent of device's range.
- d. Final Elements:
 - 1) Visually inspect for proper installation and electrical connections.
 - 2) Enter 0 percent range value at the DDC system terminal and measure and record the device's input and output signal values. Repeat for 50 percent and 100 percent of device's range.
 - 3) Step the final element from 0 percent to 100 percent range value at the DDC system terminal and measure and record the device's 0 percent to 100 percent speed. Repeat for 100 percent to 0 percent of device's range.
- e. Phase Two (Operational Sequence) Testing: Operational sequence testing shall be performed to demonstrate compliance of the completed DDC system with the contract documents. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. Provide and schedule operational testing for each season (winter, summer, etc.) applicable to specific control sequence. Operational sequence testing as specified shall not be started until after the receipt of written permission by the Owner, based on written certification of successful completion of the general performance testing as specified.
 - 1. Documentation: The Operational Check Verification Form shall be completed for each control loop. Any deviations or unsatisfactory results shall be noted in the remarks and signed and dated by the field engineer.

END OF SECTION 230900

SECTION 230901 – CONTROL SEQUENCES OF OPERATION

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. Drawings generally depict the location of duct and pipeline pressure sensors, wall pushbuttons, space temperature sensors, duct smoke detectors, ductwork mounted airflow measuring stations, field installed dampers, and equipment.
 - 2. Drawing M801 indicates the ventilation and exhaust control requirements for laboratories containing fume hoods.
- B. Division 23, Section 230900: Integrated Automation Control System for general DDC system control requirements and devices.

1.2 GENERAL REQUIREMENTS

- A. All set points, thresholds, differentials, time delays, reset schedules, etc. indicated in the following sequences of operation are initial recommendations and shall be adjustable by the building operator at the DDC workstation or web browser via system graphics without reprogramming (i.e. no alteration of system program code shall be required). All temperatures indicated in the sequences are in degrees Fahrenheit.
- B. The DDC system shall have the ability to override the operational status of all fans, dampers, pumps, and control valves via override command at the operator's workstation or via the web browser.
- C. All inputs, outputs, and calculated points of the DDC system shall be capable of being trended. The DDC system provider shall establish trends for any points the Owner deems necessary. Trends shall be initially set for a sampling rate of once every five (5) minutes for each point or as required by the Owner. Trends shall be maintained for a minimum of seven days for all terminal equipment unless required otherwise by the Owner. Viewing of trend graphs shall be available at the DDC workstation or via the web browser. DDC controllers, panels and workstations shall be selected with adequate memory and storage capacity. The workstation shall issue an alarm and provide the user opportunity to save trend data to files prior to erasure of that data. Auto-save features shall be incorporated into the system to retain user-selected trend data without requiring continual user input.
- D. All damper and valve actuators shall be electric and shall have spring return mechanisms (except for 6 inches valves and larger which do not require spring return).
- E. End switches shall be a device that verifies the physical position of the damper. The use of auxiliary contacts on the actuator to indicate position is not acceptable. End switches shall be used to provide a “digital in” to the DDC system or, where indicated, shall be wired in series with the fan motor starter holding coil to prevent operation of the fan until the damper is confirmed fully open (end switch closed with damper in the fully open position).
- F. Provide engraved plastic laminate signage, in letters minimum $\frac{3}{16}$ inch high, at all space fan start/stop momentary contact buttons, timing switches, etc. The signage shall indicate the switch/system function (i.e. on/off switch for hood exhaust fan).

- G. All supply air, coil, and heat exchanger (HX) discharge temperature sensors shall have averaging elements. Space and duct return air, and outdoor air temperature sensors may have single point sensing elements. Supply air sensors installed downstream of fans but before another heat transfer element (i.e. coil) may be of the single point type.
- H. The DDC system may utilize a single set of global outdoor air temperature and relative humidity sensors for the project. The DDC system shall calculate the outdoor air enthalpy, dew point, and wet bulb.

1.3 ENERGY RECOVERY UNITS (ERU)

- A. The following sequences and points list were written based on the Engineered Air basis of design. Note that the Engineered Air product has dedicated cooling and heating coils (in the reheat position), utilizes a heat pipe energy recovery heat exchanger with tilt control, and does not utilize a reversing valve.
- B. Unit Start/Stop: The DDC system shall monitor the outdoor supply air fan status and shall have start/stop control over the fan(s). Whenever an ERU is called to operate, the outdoor and exhaust dampers integral to the unit and any external isolation smoke dampers shall be fully opened, and when confirmed open via end switches, the outside air fan(s) shall be energized. The exhaust damper position shall also be monitored via end switch so that a run command can be issued for the associated exhaust fans. Whenever the unit fan(s) are de-energized for any reason, the unit dampers shall be fully closed. The GWSR control valve shall be fully open whenever one or more of the ERU compressors are operating. Whenever none of the compressors are operating and the outdoor air temperature is above 40 degrees Fahrenheit, the GWSR control valve shall be fully closed (after a time delay). Whenever the unit is de-energized and the outdoor air temperature is below 40 degrees Fahrenheit, the GWSR control valve shall be indexed to a 5 percent open position to prevent freezing. Unit isolation smoke dampers (when present) shall be fully closed whenever the unit is de-energized for any reason.
- C. Temperature Monitoring: The DDC system shall monitor the supply air temperature and relative humidity (sensors downstream of the supply fan). The dry bulb air temperature shall also be monitored both before and after all coils and heat exchangers in the Outside Air supply air stream. The DDC system shall monitor the exhaust air temperature and relative humidity both before and after the heat pipe heat exchanger. The DDC system shall calculate the supply air and building exhaust air dew points.
- D. Supply Fan Control – Single Supply Fan: The DDC system shall monitor the supply fan status and shall issue an alarm if it fails to run. The DDC system shall monitor the variable frequency drive fault status and speed feedback signal. The supply airflow rate shall be monitored through fan inlet or duct mounted airflow measuring stations. The DDC system shall also the supply duct remote differential pressure and shall modulate the speed of the fan to maintain the desired pressure.
- E. Supply Fan Control – Dual Fans: The DDC system shall monitor the supply fan status and shall issue an alarm if it fails to run. The DDC system shall monitor the variable frequency drives fault status and speed feedback signals. The DDC system shall control each of the two (2) supply fans through an independent pair of VFDs. The DDC system shall monitor the unit supply airflow rate through a duct or plenum mounted airflow measuring station. The fans shall normally be operated together and their speeds controlled in unison at the same speed to maintain the desired unit supply airflow rate. If one fan is de-energized for any reason other than a safety shutdown (such as smoke detection), the second fan shall continue to run and the VFD shall be indexed to the highest fan speed that does not produce a motor overloading condition, up to the desired unit supply airflow rate.
 - 1. The unit exhaust airflow rate shall be monitored.

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F. Supply Air Temperature and Humidity Control: The unit heat pump reverse cycle refrigeration system shall be controlled in sequence with the heat pipe energy recovery device to provide the desired unit outside air supply air dry bulb temperature and maximum dew point in accordance with the following reset schedule (the dry bulb temperature shall vary continuously between the two values indicated):

1. Reset schedule for ERU:

Outdoor Ambient Dry Bulb Air Temperature (degrees Fahrenheit)	ERU Supply Air Dry Bulb Temperature (degrees Fahrenheit)
Below 40	72
Between 40 and 70	Varies proportionally between 72 and 66
Above 70	66

For ERUs, dry bulb control over the cooling capacity shall be overridden to produce colder leaving air temperatures off the cooling coil than otherwise dictated by the above supply air reset schedule to limit the supply air dew point to no higher than the desired supply air dew point limit (54 deg. F.). The output of the hot gas reheat coil shall be modulated to provide the desired supply air dry bulb temperature in accordance with the reset schedule.

2. Reset schedule for ERU:

Outdoor Ambient Dry Bulb Air Temperature (degrees Fahrenheit)	ERU Supply Air Dry Bulb Temperature (degrees Fahrenheit)
Below 40	58
Between 40 and 70	Varies proportionally between 58 and 55
Above 70	55

For ERU-4, dry bulb control over the cooling capacity shall be as described above for ERUs to maintain a building return air relative humidity no higher than 50 percent. Whenever the building return air RH falls below 35 percent, the output of the electric humidifier shall be modulated to maintain the minimum relative humidity of 35 percent, with the humidifier’s output limited so as not to exceed an upper limit of 90 percent RH in the supply air downstream of the humidifier. Whenever the building return air RH is greater than 35 percent, the humidifier shall be de-energized.

Upon a loss of normal building power, ERUs normal reset schedule (above) shall be overridden and the unit supply air dry bulb temperature shall be varied to minimize the average deviation from set point all of the temperature control zones served by this air system, with the exception that the variation in supply air temperature shall be limited to prevent the temperature of the Animal Holding zone from deviating from set point more than plus/minus 3 degrees Fahrenheit.

G. Heat Pipe Tilt Control: The orientation (tilt angle) of the heat pipe shall be automatically positioned to provide both winter and summer heat recovery capabilities, and to modulate the heat recovery effect such that the desired unit supply air temperatures and humidity levels are achieved in conjunction with the unit refrigeration so as to minimize energy use.

1. For all ERUs, whenever the outdoor air dry bulb temperature is greater than the building return air temperature, the heat pipe shall be positioned for full summer heat recovery.

2. For ERUs, whenever the outdoor air dry bulb temperature is lower than 53 degrees Fahrenheit. The heat pipe shall be positioned for full wintertime heat recovery. Whenever the outdoor air dry bulb temperature is above 53 degrees Fahrenheit and below the desired supply air dry bulb temperature, the heat pipe shall be positioned to minimize heat transfer between the outside air and the exhaust airstreams.
 3. For ERUs, when the outdoor air temperature is greater than the desired supply air temperature but lower than the building return air temperature, the heat pipe shall be positioned to minimize energy transfer between the outside air and exhaust airstreams. When the outdoor air temperature is below the desired supply air temperature, the position of the heat pipe shall be modulated to produce a leaving dry bulb air temperature (on the outside air side) equal to the desired supply dry bulb air temperature.
- H. Heat Pipe Frost Prevention: The building return relative humidity and the leaving air temperature off the heat pipe HX on the exhaust side of the unit shall be monitored and the output of the outside air pre-heat coil shall be modulated to maintain the leaving air temperature on the exhaust side of the heat pipe HX above the frost point. The differential pressure across the exhaust and Outside Air sides of the heat pipe HX shall be monitored, and an alarm issued if the pressure drop rises above the high limit (115 percent above the normal HX pressure drop at peak design airflow).
- I. Safeties:
1. Filters: The DDC system shall monitor the pressure drop across all filter banks in the unit and shall issue an alarm whenever the pressure drop exceeds the high limit set point.
 2. Duct Pressure: Whenever the supply duct static pressure sensor senses a duct static pressure of 4 inches water gauge or higher (3 inches water gauge for ERU), the supply fan(s) shall be de-energized and an alarm shall be issued by the DDC system. The pressure switch shall be installed at or very near to the ERU supply duct connections.
 3. Smoke: Duct smoke detector located in the supply duct shall stop the unit fans via hardwired shutdown interlock if products of combustion are sensed. Smoke detectors shall be fire alarm system devices and shall be capable of remote reset. An alarm shall be generated at the DDC system by the monitoring of a second set of contacts on the smoke detector.
- J. Minimum Display Points: The following points, at a minimum, shall be displayed on the building DDC system graphic for each ERU (each ERU shall have a separate graphic):
1. Analog Input Outside Air Temperature
 2. Analog Input Outside Air Relative Humidity
 3. Calculated Outside Air Dew Point Temperature
 4. Calculated Outside Air Wet Bulb Temperature
 5. Analog Input Outside Air Supply Air Temperature Leaving Heat Pipe Heat Exchanger
 6. Analog Input Cooling Coil Discharge Air Temperature
 7. Analog Input Heating Coil Discharge Air Temperature
 8. Analog Input Supply Air Temperature
 9. Analog Input Supply Air Relative Humidity

10. Calculated Supply Air Dew point Temperature
11. Value Supply Air Dry Bulb Temperature Set Point
12. Value Supply Air Dew point Temperature High Limit Set point
13. Values Supply Air Temperature Reset Schedule
14. Value Building Return Air RH High Limit (ERU-4 only)
15. Value Building Return Air RH Low Limit
16. Analog Input Exhaust Air Temperature Entering Heat Pipe Heat Exchanger
17. Analog Input Exhaust Air RH Entering Heat Pipe Heat Exchanger
18. Calculated Exhaust Air Dew point Temperature Entering Heat Pipe Heat Exchanger
19. Analog Input Exhaust Air Temperature Leaving Heat Pipe Heat Exchanger
20. Analog Input Exhaust Air RH Leaving Heat Pipe Heat Exchanger
21. Calculated Exhaust Air Dew point Temperature Leaving Heat Pipe Heat Exchanger
22. Analog Output GSWR Control Valve
23. Value GSWR Control Valve Minimum Open Freeze Prevention Position
24. Analog Output Heat Pipe Tilt
25. Digital Output Compressor On-Off (one for each)
26. Digital Input Compressor Status (one for each)
27. Digital Output Hot Gas Bypass Valve (lowest capacity stage of cooling coil output control)
28. Analog Output Cooling Coil Refrigerant Valve
29. Analog Output Heating Coil Refrigerant Valve
30. Analog Output Outside Air SCR-Controlled Electric Preheat Coil
31. Analog Output Outside Air GSWS/R Pre-Heat Water Coil
32. Analog Output Humidifier Output
33. Digital Output Outside Air and Exhaust Dampers (the dampers that are integral to the ERU)
34. Digital Input Outside Air Damper End Switch (verifies full open status)
35. Digital Input Exhaust Damper End Switch (verifies full open status)
36. Analog Input Remote Supply Duct Pressure

37. Analog Input Unit Supply Airflow Rate
 38. Analog Input Unit Exhaust Airflow Rate
 39. Digital Output Supply Fan Start/Stop
 40. Digital Input Supply Fan Status
 41. Analog Output Supply Fan Speed Command
 42. Analog Input Supply Fan Speed Feedback Signal
 43. Analog Input Supply Fan Variable Frequency Drive Running Load Amps (RLA)
 44. Digital Input Supply Fan Variable Frequency Drive Alarm Status
- Note:* Each of the above supply fan/variable frequency drive points applies separately to each of the two fans.
45. Analog Input Heat Pipe Pressure Drop (Outside Air side)
 46. Analog Input Heat Pipe Pressure Drop (Exhaust side)
 47. Digital Input Supply Filter Pressure Drop Status
 48. Digital Input Exhaust Air Filter Pressure Drop Status
 49. Digital Input High Limit Supply Duct Pressure
 50. Digital Input Supply Duct Smoke Detector Alarm

1.4 EXHAUST FANS

- A. Start/Stop: The DDC system shall monitor the status of these fans and shall have stop/start control. The DDC system shall issue an alarm whenever either fan fails to run. The fans shall operate in a duty-standby fashion (i.e. only one fan runs). If the duty fan fails to run, the DDC system shall automatically energize the standby fan. Whenever a fan is called to run, its suction duct isolation damper shall stroke and once stroked fully open (verified via end switch), the fan motor shall be energized. Whenever a fan is de-energized, the associated isolation damper shall be fully closed.
- B. Bleed Damper Control: The DDC system shall monitor the remote exhaust duct differential pressure (DP) at each location indicated on the plans, and shall modulate the lead-lag bleed dampers to maintain the minimum desired duct differential pressure at all sensor locations (minus 1-½ inches water gauge DP). On a rise in differential pressure above set point (i.e. too much negative pressure in the duct) at all of the sensor locations, the lead damper shall modulate from the fully closed position up to 65 percent of damper shaft rotation. On a further rise in duct DP, the lag damper shall stroke open from a fully closed position up to a 65 percent damper shaft rotation. On a continued rise, the lead damper shall continue its movement from 65 percent up to a full open position, and then lastly the lag damper shall modulate from 65 percent towards 100 percent (full open). On a fall in duct DP the reverse actions shall occur.
- C. Duty-Standby Changeover Control: Every thirty (30) days, the DDC system shall energize the standby fan and de-energize the formerly operating fan. The new duty fan motor shall be energized and status verified prior to de-energizing the former duty fan's motor.

D. Minimum Display Points: The following points, at a minimum, shall be displayed on the building DDC system graphic:

1. Digital Output Exhaust Fan Start/Stop
2. Program Exhaust Fan Status
3. Analog Input Exhaust Fan (Kilowatt)
4. Analog Input Exhaust Fan-1B (Kilowatt)
5. Calculated Exhaust Fan Run Time
6. Calculated Exhaust Fan (Kilowatt-hour)
7. Analog Output Bleed Damper (2 required)
8. Digital Output Exhaust Fan Damper
9. Digital Input Exhaust Fan Damper End Switch
10. Analog Input Remote Exhaust Duct Differential Pressure (See plans for quantity)

1.5 WATER TO AIR HEAT PUMPS (HPs):

A. Controllers: units shall be provided with a factory-mounted micro-processor based controller furnished by the controls sub-Contractor to the heat pump manufacturer for factory-installation and wiring.

B. General: On a fall in space temperature below the heating set point, the compressor shall be energized in heating mode. On a rise in space temperature above the cooling set point, the unit compressor shall be energized in cooling mode. The heating and cooling control temperature differentials shall be independently adjustable. Whenever the compressor is called to run, the unit controller shall fully open the two-position ground loop water control valve. Once ground loop water flow is proven via hard-wired flow switch, or after a timing relay has timed out, the compressor shall be energized. Whenever the compressor is de-energized, the ground loop control valve shall be fully closed.

1. Upon a rise in water level in the A/C condensate drain pan, the unit shall be prevented from operating in cooling mode and the unit shall be in alarm.
2. For units provided with emergency power, the unit shall be provided with a random start timer that prevents operation of the compressor for a random period whenever the compressor is called to run.

C. Space Temperature Set point and Fan Operation Control: During the occupied mode, the DDC system shall set the unit space heating and cooling set points to the occupied values. The unit fan shall run continuously during occupied mode. During the unoccupied mode, the DDC system shall re-set the cooling and heating set points to the unoccupied values and the unit fan shall only operate whenever the compressor is energized. The recommended space temperature set points are as follows:

	Heating Set Point (degrees Fahrenheit)	Cooling Set Point (degrees Fahrenheit)
Building Occupied	72	74
Building Unoccupied	62	82

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- D. Occupied Cycle Control for HPs Serving Classrooms: The HP shall operate in the occupied and unoccupied cycles according to the building global occupancy schedule; however, the space temperature sensor shall have an occupied override pushbutton. System shall be placed in the occupied mode for a programmed time interval when the override button is depressed.
- E. Occupied Cycle Control for HPs Serving Laboratories/Spaces Containing Fume Hoods: The HP shall alternate between the occupied and unoccupied cycles based on space occupancy status as determined by space occupancy sensors provided by the Division 26 sub-Contractor. All space occupancy sensors in a given space shall be polled for status to determine the occupancy status.
 - 1. During the building’s global occupied mode, the unoccupied space temperature set point reset shall utilize a separately adjustable schedule from the schedule employed during the global building unoccupied mode. Recommended set points for the three modes are as follows:

	Heating Set Point (degrees Fahrenheit)	Cooling Set Point (degrees Fahrenheit)
Zone Occupied	72	74
Building Unoccupied/Zone Unoccupied	62	82
Building Occupied/Zone Unoccupied	67	78

- F. Smoke: Where indicated on the drawings, duct smoke detector located in the return duct or at return air inlet to the unit shall stop the unit fan via hardwired shutdown interlock if products of combustion are sensed. Smoke detectors shall be fire alarm system devices and shall be capable of remote reset. An alarm shall be generated at the DDC system by the monitoring of a second set of contacts on the smoke detector.
- G. DDC System Communication/Display Points: The following points, at a minimum, shall be communicated to the DDC system and displayed on the DDC system graphic for each HP:
 - 1. Analog Input Space Temperature
 - 2. Values Space temperature Set Points – Heating/Cooling/Occupied/Unoccupied
 - 3. Digital Input Occupied/Unoccupied Pushbutton Override Status
 - 4. Analog Input Discharge Air Temperature
 - 5. Digital Input Unit Fault Alarm Status
 - 6. Digital Output Unit Fan Start/Stop
 - 7. Digital Output GSWS Control Valve
 - 8. Program Heat Pump Run Status (based on analog input kilowatt draw point)
 - 9. Analog Input Unit Kilowatt Draw
 - 10. Calculated Run Time
 - 11. Calculated Kilowatt-hour Consumed
 - 12. Value Occupied Cycle Override Timeout Period
 - 13. Digital Input Smoke Detection (where indicated)

1.6 SOURCE WATER PUMPS:

- A. Pumping System Start/Stop: The DDC system shall monitor the status of SWP shall have start/stop control over these pumps. DDC shall issue an alarm whenever a pump fails to run. Each pump set shall operate in a duty-standby fashion. In each pair of main loop pumps (SWP), if the duty pump fails, the standby pump shall be energized. The DDC system shall log the run time of each main loop pump separately, and every 14 days the DDC system shall select the duty pump as the pump with the least amount of run time. The duty pump shall run continuously until the next change-over.
 - 1. During change-over events, the new lead pump shall ramp up simultaneously as the old lead pump slows down so as to minimize heat pump nuisance trips due to low flow conditions but to limit the discharge pressure rise to below relief valve limits.
- B. Building Loop Pump (SWP) Speed Control: The DDC system shall control the pump speeds through variable frequency controllers. The DDC system shall monitor the piping system differential pressure (DP) in each location indicated on the piping plans, and on a fall in differential pressure below the DP set point at any of the sensor, the pump speed shall be increased to maintain the DP set point at the sensor calling for the most pressure. On a rise in DP above set point at all sensors, the pump speed shall be decreased. DP set point at all sensors shall be 14 pounds per square inch gauge.
- C. Geothermal Well Field Heat Exchanger Loop Pump Speed Control: The DDC system shall monitor the flow rate of the building loop pumps and the flowrate of the geothermal HX loop pumps and shall vary the speed of the duty geothermal loop pump to maintain a flow rate through the geothermal HX equal to the total flow rate of the building loop.
 - 1. The DDC system shall monitor the building loop source water supply temperature (sensor located in common discharge of SWP), and whenever the building loop supply temperature falls below 59 degrees Fahrenheit (from a higher temperature) or rises above 54 degrees Fahrenheit (from a lower temperature), the duty pump in the geothermal HX loop shall be de-energized. Whenever the temperature rises above 63 degrees Fahrenheit (from a lower temperature) or falls below 50 degrees Fahrenheit (from a higher temperature) the duty geothermal HX loop pump shall be energized. Once energized, its speed shall be controlled as described above.
- D. SWP (Emergency Operation) and Crossover Bridge Valve Control: The DDC system shall energize SWP-3 whenever normal power is out and the two position valve on the crossover bridge between the two main loops shall close. Whenever normal power is available, SWP-3 shall be de-energized and the crossover bridge valve shall be fully open.
- E. SWP and CCCT Control: The DDC system shall monitor the building loop return water temperature and the outdoor air wet bulb temperature, and whenever the building return water temperature is above 68 degrees and the building return water temperature is at least 10 degrees higher than the outdoor air wet bulb temperature, SWP, the CCCT1 fan, and the CCCT spray pump shall be energized. Once energized, whenever the building return water temperature is falls below 63 degrees or when the building loop return water temperature is less than 5 degrees above the outdoor air wet bulb temperature, SWP and the CCCT fan and spray pump shall all be de-energized.
- F. CCCT Isolation Damper Control: Whenever CCCT is called to run, the isolation dampers shall open, and once confirmed fully open via end switches, the unit fan and spray pump shall be energized. This portion of the sequence shall be achieved through hard wiring interlocks in the CCCT factory control panel.
- G. CCCT Basin Heater Control: The packaged thermostatic control shall control the electric basin heaters to maintain a minimum basin temperature of 40 degrees Fahrenheit.

- H. DDC System Monitoring of CCCT: The DDC system shall monitor the basin temperature and shall issue an alarm whenever the temperature falls below 36 degrees Fahrenheit. The DDC system shall also monitor the operating status of the spray pump and the unit fan and shall issue an alarm whenever either fails to operate. The DDC system shall monitor the CCCT sump with a pair of float switches. An alarm shall be issued whenever the water level is at an overflow condition, or whenever the low limit level is reached. Programming shall be provided that locks out the low water level alarm whenever the tower is de-commissioned (drained) for the winter months. A decommissioned status shall be established through a manual command at the operator's workstation.
- I. Cartridge Filter Monitoring and Isolation Valve Control: The bypass cartridge filter isolation valve shall close whenever the building loop flow rate rises above 1115 gallons per minute. Whenever the building loop flow rate falls below 1040 gallons per minute, the valve shall open. Whenever normal power is out, the isolation valve shall close. The DDC system shall monitor the pressure drop across the filter and shall issue an alarm whenever the pressure drop exceeds the high limit (30 pounds per inch DP).
- J. Miscellaneous Monitoring: The DDC system shall monitor the temperature of the water coming back from the geothermal heat exchanger. The DDC system shall monitor the presence of water in the geothermal header vault and shall issue an alarm if water is sensed. The DDC system shall monitor the status of the glycol mix/fill tank pump and shall issue an alarm if the pump operates longer than 45 seconds.
- K. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:

For each pump powered by a VFD:

1. Digital Output Start/Stop
2. Program Pump Status
3. Analog Output Pump Speed
4. Digital Input Variable Frequency Drive Fault Status
5. Analog Input Pump (Kilowatt)
6. Calculated Pump (Kilowatt-hour)
7. Calculated Pump Run Time for SWP-3 and SWP-4
8. Digital Output Start/Stop
9. Program Pump Status
10. Analog Input Pump (Kilowatt)
11. Calculated Pump (Kilowatt-hour)
12. Calculated Pump Run Time
13. Analog Input Building Loop Differential Pressure (See plans for quantity)
14. Value Building Loop Diff. Pressure Set Point
15. Analog Input Building Loop Flow Rate
16. Analog Input Geothermal Heat Exchanger Loop Flow Rate
17. Digital Output Crossover Bridge Isolation Valve

18. Digital Output Cartridge Filter Isolation Valve
19. Digital Input Cartridge Filter Pressure Drop Alarm
20. Digital Input Normal Power Availability
21. Digital Output CCCT Start/Stop
22. Analog Input CCCT Basin Temperature
23. Program CCCT Fan Status
24. Program CCCT Spray Pump Status
25. Analog Input CCCT Fan KW
26. Analog Input CCCT Spray Pump KW
27. Calculated CCCT Fan Run Time
28. Calculated CCCT Spray Pump Run Time
29. Calculated CCCT Fan KWH
30. Calculated CCCT Spray Pump KWH
31. Analog Input Geothermal Heat Exchanger Supply Temperature (temp back from field)
32. Digital Input Geothermal Header Vault Water Alarm
33. Digital Input Mix/Fill Tank Pump Status
34. Analog Input Building Loop Supply Temperature
35. Analog Input Building Loop Return Temperature
36. Calculated Outdoor Air Wet Bulb Temperature
37. Value Tower On – Outside Air Wet Bulb/Building Return Temp Differential Set point
38. Value Tower Off – Outside Air Wet Bulb/Building Return Temp Differential Set point
39. Value Tower On – Building Return Temperature Set Point
40. Value Tower Off – Building Return Temperature Set Point

1.7 DOMESTIC WATER HEATING SYSTEM

- A. Temperature Controls: The DDC system shall monitor the water temperature in each of the hot water storage heaters, and whenever the temperature falls below 125 degrees Fahrenheit in either tank (sensors located at the midpoint of the tank), the duty tank-heat pump circulation pump shall be energized and the lead domestic water heat pump (DHP) shall be energized in the heating mode (cooling modes shall be locked out for the DHPs). On a continued drop in storage heater temperature below set point, additional DHPs shall be energized. On a further drop in storage heater temperature, after all DHPs are energized, the DDC system shall permit the electric elements in the storage heaters to be energized through the DDC system controlled electrical Contractor on the power supply to the storage heaters. On a rise in storage tank temperatures, the reverse shall occur. Whenever all DHPs are de-energized, the duty tank-DPH circulation pump shall be de-energized.

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1. Whenever a DHP is called to run, the respective GSWS control valve shall be fully opened. Whenever a DHP is de-energized, the respective GSWS control valve shall be fully closed (after a time delay).
 2. The staging order of the DHPs shall be re-arranged with every heating cycle in order to equalize the run time of the individual DHPs.
 3. The tank-DPH circulation pumps shall operate in a duty-standby fashion, and the DDC system shall alternate the duty status of the pumps with every heating cycle.
 4. The DDC system shall monitor the status of the tank-DHP circulation pumps and whenever a tank-DHP circulation pump fails to run, the DDC system shall issue an alarm and shall energize the standby pump.
- B. Sanitization Cycle: Every 7 days, in accordance with a time of day schedule, the system shall be automatically placed into a sanitization mode. The DDC system shall permit the electric elements in the storage heaters to operate, and the packaged temperature controls on the heaters shall bring the storage tank temperature up to 155 degrees Fahrenheit. Once the DDC system senses that this temperature has been sustained for 90 minutes, the DDC system shall de-energize the electric heating elements and the system shall return to normal operation.
- C. Building Domestic Water Re-circulation Pump: The DDC system shall have start/stop control over this pump and shall monitor the pump status. The DDC system shall issue an alarm whenever this pump fails to run. The DDC system shall operate this pump based on a time of day schedule.
- D. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic: For each domestic water tank, DHP circulation pump, building dome, and water recirculating pump:
1. Digital Output Start/Stop
 2. Program Pump Status
 3. Analog Input Pump KW
 4. Calculated Pump KWH
 5. Calculated Pump Run Time for each DHP
 6. Digital Input Unit Fault Alarm Status
 7. Digital Output Unit Start/Stop
 8. Program HP Run Status (based on Analog Input KW draw point)
 9. Analog Input Unit KW Draw
 10. Calculated Run Time
 11. Calculated KWH Used
 12. Digital Output GSWS Control Valve
 13. Digital Output Dom HW Storage Heater Electric Element Enable-Disable (2 required)
 14. Analog Input Dom. HW Storage Heater Temperature (2 required)

1.8 WATER, GAS, AND ELECTRICAL UTILITY MONITORING

- A. Water Metering: The DDC system shall monitor the water consumption of the building and the water consumption of the closed circuit cooling tower through separate water meters with a pulse contact outputs.
- B. Natural Gas Metering: The DDC system shall monitor the gas consumption of the building through a gas meter with a pulse contact output.
- C. Electrical Metering: The DDC system shall monitor the rate of electricity use by the building and the main switchgear and at all other points of monitoring indicated on the electrical drawings. The DDC system shall integrate electrical demand signals to produce KWH data. The DDC system shall sum the demand and KWH data separately for HVAC/Plumbing systems and electrical lighting.
- D. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 - 1. Digital Input Water Consumption Rate from Pulse Input – Total Building
 - 2. Calculated Water Consumption – Total Building
 - 3. Digital Input Water Consumption Rate from Pulse Input – Cooling Tower
 - 4. Calculated Water Consumption – Cooling Tower
 - 5. Digital Input Gas Consumption Rate from Pulse Input
 - 6. Calculated Gas Consumption
 - 7. Analog Input Electric Demand (Kilowatt) – Total Building
 - 8. Calculated Total Building (Kilowatt-hour)
- E. Consumption at each point of electric metering in the building distribution:
 - 1. Analog Input Electric Demand (Kilowatt)
 - 2. Calculated (Kilowatt-hour)
 - 3. Calculated HVAC and Plumbing Systems (Kilowatt-hour)
 - 4. Calculated Lighting Systems (Kilowatt-hour)

1.9 SUPPLEMENTAL ELECTRIC HEATERS

- A. Supplemental electric heaters shall be directly controlled by their remote wall thermostats (no direct DDC temperature control)
- B. The DDC system shall have enable-disable control over the electric heaters, and whenever the outdoor air temperature rises above 55 degrees Fahrenheit, the heaters shall be disabled. Whenever the outdoor air temperature falls below 52 degrees Fahrenheit, the heaters shall be enabled and permitted to run.

1.10 EMERGENCY GENERATOR MONITORING

- A. The DDC system shall monitor and display on the workstation the operating status of the emergency generator, the availability of normal power (through contacts on the transfer switch), and the fault status of the generator package. The DDC system shall issue an alarm whenever normal power is lost or when the generator is in a fault status.

1.11 VAV BOX – OCCUPANCY SCHEDULE CONTROLLED

- A. General: The outdoor air supply variable volume terminal unit (VAV box) shall be controlled independent of system pressure fluctuations by an application-specific, unit-mounted DDC controller provided by the ATC system supplier. The unit damper shall be modulated to maintain the desired unit airflow rate. The airflow rate set point shall be as scheduled for the occupied and unoccupied modes on the drawings. The unit shall be in the occupied mode whenever the building is in the occupied mode (building time of day schedule) or whenever the space is manually placed into the occupied mode for a programmed time interval via the local occupancy over-ride button.
- B. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 - 1. Analog Input Unit Airflow Rate
 - 2. Analog Output Unit Damper Position
 - 3. Program Building Occupied/Unoccupied Schedule Status
 - 4. Value Occupied Mode Airflow Rate Set Point
 - 5. Value Unoccupied Mode Airflow Rate Set Point
 - 6. Di Occupancy Override Pushbutton Status
 - 7. Value Occupied Cycle Override Timeout Period

1.12 OUTDOOR AIR SUPPLY VAV BOX – CONSTANT VOLUME CONTROLLED

- A. General: The outdoor air supply variable volume terminal unit (VAV box) shall be controlled independent of system pressure fluctuations by an application-specific, unit-mounted DDC controller provided by the ATC system supplier. The unit damper shall be modulated to maintain the desired unit airflow rate. The supply airflow rate set point shall be a constant value as indicated on the drawings.
- B. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 - 1. Analog Input Unit Airflow Rate
 - 2. Analog Output Unit Damper Position
 - 3. Value Airflow Rate Set Point

1.13 OUTDOOR AIR SUPPLY VAV BOX – BUILDING PRESSURIZATION CONTROLLED

- A. The DDC system shall measure the total outdoor air supply airflow rate delivered to the Building (from ERU) and the total exhaust airflow rate taken from the building (exhausted by EF), and shall modulate the supply airflow rate of the VAV box within the minimum and maximum values indicated on the drawings to maintain a pressurization rate (i.e. the total supply airflow rate amount in excess of the total exhaust airflow rate) of 300 cubic feet per minute.

- B. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 - 1. Analog Input VAV Box Airflow Rate
 - 2. Analog Output VAV Box Damper Position
 - 3. Value VAV Box Maximum Airflow Rate
 - 4. Value VAV Box Minimum Airflow Rate
 - 5. Analog Input Airflow Rate at each Airflow Measuring Station (See plans for quantity)
 - 6. Value Total Outdoor Air Supply Airflow Rate to Building
 - 7. Value Total Exhaust Airflow Rate from Building
 - 8. Value Pressurization Set Point

1.14 QUANTITATIVE CHEMISTRY MUFFLE HOOD EXHAUST CONTROL

- A. Whenever the local momentary contact ‘on’ pushbutton is pressed, the exhaust fan, EF-7, shall be energized. After a pre-programmed time period, the exhaust fan shall be de-energized until the next “on” command. Prior to time out, the exhaust fan may be de-energized through the local momentary contact “off” pushbutton.
- B. The fan operating status shall be fed back to the laboratory controller with an assigned exhaust cubic feet per minute value via programming (the exact value shall be determined via testing and balancing operations).
- C. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 - 1. Digital Output Start/Stop
 - 2. Digital Input Status
 - 3. Digital Input “On” Command Status
 - 4. Digital Input “Off” Command Status
 - 5. Value “On” Time-Out Period

1.15 REVERSE OSMOSIS (RO) SYSTEM MONITORING

- A. The DDC system shall monitor and display on the workstation the alarm status of each of the two (2) RO treatment system control panels and shall issue an alarm whenever either of the systems is in a fault status.

1.16 GREENHOUSE CONTROL AND MONITORING

- A. The DDC system shall monitor the space temperature in the greenhouse at a minimum of two locations (one approximately 8 feet above the floor and the second approximately 4 feet above the floor, at opposite ends of the greenhouse), and shall issue an alarm whenever the space temperature rises above the high or low limits.
- B. The two (2) heat pumps serving the greenhouse shall directly receive on-off (heating mode) signals from the greenhouse package temperature controller. These heat pumps shall be prevented from operating in cooling mode.
- C. The DDC system shall monitor the on-off operational status and the unit fault status of the two (2) heat pumps serving the greenhouse.

D. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:

1. Analog Input Greenhouse Temperature (2 required)
2. Value Greenhouse High Limit Alarm Set Point
3. Value Greenhouse Low Limit Alarm Set Point
4. Program Heat Pump Operating Status (2 required)
5. Analog Input Heat Pump (Kilowatt) (2 required)
6. Calculated Heat Pump (Kilowatt-hour) (2 required)
7. Digital Input Heat Pump Fault Status (2 required)

1.17 EXHAUST FAN/ELECTRICAL UNIT HEATER CONTROL

- A. Whenever the exhaust fan is called to run, the associated exhaust and outdoor air dampers shall be opened, and when both are confirmed open via end switches, the exhaust fan shall be energized. Whenever the exhaust fan is de-energized, the associated exhaust and outdoor air dampers shall be fully closed.
- B. Mechanical Room Temperature Control: the exhaust fan and the electric heat unit shall be controlled from a common thermostat (non-DDC control). On a rise in space temperature above the cooling set point (90 degrees Fahrenheit.), the exhaust fan shall be energized. On a fall in space temperature below the heating set point (55 degrees Fahrenheit.), the electric heat unit shall be energized.
- C. DDC System Monitoring: The DDC system shall monitor and display on the workstation the mechanical room space temperature and shall issue an alarm whenever the space temperature rises above or falls below the high and low limit alarm temperatures respectively.

1.18 ATOMIC ABSORPTION SPECTROMETER/INSTRUMENT ROOM EXHAUST CONTROL

- A. The exhaust air valve shall be modulated to maintain the room air balance (offset) at minimum of 50 cubic feet per minute negative or to provide no less than the exhaust airflow rate from the hood indicated on the drawings whenever the atomic absorption spectrometer is operating, whichever is greater. The spectrometer operating cycle shall be manually initiated with a pair of momentary contact 'on' and 'off' pushbuttons. Whenever the on button is pressed, the spectrometer shall be considered to be operating for a pre-programmed time period. After the pre-programmed time period ends, the exhaust air valve airflow control criteria shall revert solely to meeting the room offset requirement of 50 cubic feet per minute negative until the next 'on' command. Prior to time out, the spectrometer status may be manually set to 'off' by way of the local momentary contact "off" pushbutton.
- B. "When the fan is energized, the suction duct isolation motorized damper shall open, and when confirmed fully open by an end switch, the fan motor shall be energized. Whenever the fan is de-energized, the associated isolation damper shall be fully closed. The damper is not required to be a DDC output control point, but shall have a normally closed 120 volts actuator wired in parallel with the fan motor starter holding coil. The end switch may be wired as indicated in article 1.2, paragraph E of this section. The DDC system shall issue an alarm whenever the fan fails to operate".
- C. Minimum Display Points: the following points, at a minimum, shall be displayed on the system graphic:
 1. Digital Input "ON" Command Status
 2. Digital Input "OFF" Command Status

3. Analog Input Exhaust Valve Airflow Rate
4. Value “On” Time-Out Period
5. Value Valve Spectrometer Operating Mode Airflow Rate Set point
6. Analog Input Room Supply Airflow Rate
7. Calculated Current Room Offset

1.19 EXHAUST FANS

- A. Start/Stop: The DDC system shall monitor the status of these fans and shall have stop/start control. The DDC system shall issue an alarm whenever either fan fails to run. The fans shall operate in a duty-standby fashion (i.e. only one fan runs). If the duty fan fails to run, the DDC system shall automatically energize the standby fan. Whenever a fan is called to run, its suction duct isolation damper shall stroke and once stroked fully open (verified via end switch), the fan motor shall be energized. Whenever a fan is de-energized, the associated isolation damper shall be fully closed. The DDC system shall issue an alarm whenever the fan fails to operate.
- B. Duty-Standby Changeover Control: Every thirty (30) days, the DDC system shall energize the standby fan and de- energize the formerly operating fan. The new duty fan motor shall be energized and status verified prior to de- energizing the former duty fan’s motor.
- C. Minimum Display Points: The following points, at a minimum, shall be displayed on the building DDC system graphic:
 1. Digital Output Exhaust Fan Start/Stop
 2. Program Exhaust Fan Status
 3. Analog Input Exhaust Fan (Kilowatt)
 4. Calculated Exhaust Fan Run Time
 5. Calculated Exhaust Fan (Kilowatt-hour)
 6. Digital Output Exhaust Fan Damper
 7. Digital Input Exhaust Fan Damper End Switch

1.20 HEAT TRACE MONITORING

- A. The DDC system shall monitor the alarm contacts at each the heat trace control panel and shall issue an alarm if a fault is detected.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 230901

SECTION 231123 – NATURAL GAS PIPING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 Materials and methods for natural gas piping must follow the recommendations from the local natural gas distribution company, current International Plumbing Code, International Building Code and per applicable NFPA and local/municipality codes.

PART 2: PRODUCTS

- 2.1 Polyethylene pipe (PE) cannot be used if it has been longer than two (2) years since the pipe was manufactured. The manufactured date will be on the pipe.
- 2.2 Shop drawing submittals and O&M Material cut sheets must include date of manufacture.

PART 3: EXECUTION

- 3.1 A continuous length of PE pipe shall be used. Install insulated locator wire above PE pipe but not closer than 6 inches.
- 3.2 Plastic warning tape shall be installed no more than 6 inches below finished grade directly over PE pipe.
- 3.3 Minimum depth of burial shall be 24 inches unless noted otherwise.
- 3.4 Natural gas piping shall not share trench with any other utility.
- 3.5 Piping installed in trench shall have minimum 6 inches of limestone sand bedding above and below piping. Trenching cover shall be compacted to minimum 85 percent of maximum dry unit weight of soil material per ASTM D 698.
- 3.6 Contractor shall use only approved steel risers where applicable, and shall be installed per manufacturer's instructions.
- 3.7 Transitions, fittings and couplings are not re-usable and shall only be installed new.
- 3.8 Pipe transitions and connections for meter pits, valve pits, etc. shall be suitable for application, approved by pipe manufacturer for intended use, and installed per manufacturer's instructions.

END OF SECTION 231123

SECTION 232113 – HVAC PIPING

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 pipe, fitting materials, and joining methods, for the following above-grade piping systems:
 - 1. Hydronic piping (Abbreviations are as used on the drawings):
 - a. Geothermal Source Water System Piping (GSWS/GSWR)
 - 2. Domestic Water Makeup Piping
 - 3. Condensate-Drain Piping
 - 4. Blow-Down and Drain Piping
 - 5. Air-Vent Piping
 - 6. Pressure Relief Valve Inlet and Outlet Piping
- B. This section includes the following below grade piping systems: Geothermal Source Water System piping (GSWS/GSWR).
- C. This section also includes the following special-duty valves, piping appurtenances, and specialties:
 - 1. Pipe Sleeves
 - 2. Sleeve Seals
 - 3. Expansion Tanks
 - 4. Air Separators
 - 5. Automatic Air Vents
 - 6. Manual Air Vents
 - 7. Drain Valves
 - 8. Y-Strainers
 - 9. Pressure Reducing Valves
 - 10. Pressure Relief Valves
 - 11. Pipe Flashing Fittings

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D. Related sections include the following:

1. Division 23, Section 232123: Hydronic Pumps for pumps, motors, and accessories for hydronic piping
2. Division 23, Section 230500: Common Work for HVAC for piping welding and common piping system components for HVAC
3. Division 23, Section 230516: Expansion Fittings and Loops for HVAC Piping for accommodations for piping expansion
4. Division 23, Section 230548: Vibration Controls for vibration controls including flexible piping connections to all rotating HVAC equipment and where indicated on the drawings
5. Division 23, Section 230523: General Duty Valves for HVAC
6. Division 23, Section 230519: Meters and Gauges
7. Division 23, Section 232500: HVAC Water Treatment

E. Unless otherwise noted, where plumbing systems connect to equipment provided or installed under Division 23, work under Division 22 shall terminate the plumbing systems within 5 feet of final connection point of the equipment with a backflow preventer and a shutoff valve as specified in the plumbing valve specifications. Final connection to the HVAC equipment and/or hydronic systems provided or installed under Division 23 shall be provided as part of this section. Final connection shall include additional valves, strainers, control valves, check valves, miscellaneous connections, etc. as shown on HVAC details, HVAC drawings, or as specified herein.

1.3 HVAC PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, components, and equipment for the various HVAC piping systems shall meet the minimum pressure rating requirements.
- B. All piping, valves, and all other piping appurtenances, flanges, fittings, heat exchangers, coils, and other equipment connected to and a part of the system shall be suitable for the maximum system operating temperature and shall meet the minimum system pressure rating (at the maximum operating temperature) unless a more demanding criteria is specified elsewhere in this Division.
1. Exception: Air separators and expansion tanks shall be ASME stamped for 125 pounds per square inch gauge rating.

1.4 SUBMITTALS

- A. Product Data: For each type of the following:
1. Gasket Materials
 2. Grooved Mechanical Joints
 3. Plastic Pipe and Fittings with Solvent Cement
 4. Air Control Devices
 5. Drain Valves

6. Expansion Tanks
 7. Hydronic Specialties
 8. Mechanical Sleeve Seals
- B. Shop Drawings: Detail, at ¼" = 1'-0" scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. Indicated slopes of horizontal runs, locations of valves, fittings, and other pipeline appurtenances including manual and automatic air vents, and drain valves.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For air control devices, hydronic specialties, expansion tanks, and special-duty valves to include in emergency, operation, and maintenance manuals.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
1. High temperature hot water systems shall comply with ASME Standard B31.1 – Power Piping.
- B. Piping and fitting materials shall conform to the specification standards of the recognized standards listed herein. References shall be to the latest edition in force at the time of bidding.
- C. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- D. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.
- E. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components".

PART 2: PRODUCTS

2.1 PIPE AND TUBING MATERIALS

- A. Steel Pipe: ASTM A 53, Type S or ERW, Grade A or B, Schedule 40, plain ends
1. Pipe shall be manufactured in the United States.
 2. Standard weight is acceptable in lieu of schedule 40 above 12 inches size.
 3. Steel Pipe Nipples: Shall be ASTM A 733, made of ASTM A 53, Schedule 40 and Standard Weight, carbon steel, seamless for 2 inches NPS and smaller and electric-resistance welded for 2-½-inch NPS and larger.
- B. Drawn-Temper Copper Tubing:
1. ASTM B 88, Type L for water and drainage services

2.2 FITTINGS

- A. Wrought-Copper Fittings: ASME B16.22
- B. Wrought-Copper Unions: ASME B16.22
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150
- D. Malleable-Iron Unions: ASME B16.39; Classes 150 and 250
- E. Wrought-Steel Fittings: ASTM A 234, wall thickness matching the adjoining pipe (Only long radius elbows shall be used.)
- F. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1
 - 2. End Connections: Butt welding
 - 3. Facings: Raised face
- G. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- H. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- I. Grooved Mechanical-Joint Couplings and Fittings: Consist of two (2) ductile-iron housings, a synthetic rubber (EPDM) gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 1. Victaulic flexible Style 75 or 77 or rigid Style 07
 - 2. Application: 2-½ to 12 inches
 - 3. Rigid Type: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9
 - 4. Flexible Type: To be used only in locations where vibration attenuation and stress relief are required
 - 5. Manufacturers Victaulic (no exceptions)
 - 6. No ‘Vicolet’ or clamp-on type tee fittings will be acceptable

2.3 UNDERGROUND GEOTHERMAL SOURCE WATER PIPING

- A. General: Provide high density polyethylene pipe, fittings, and piping components for the underground portions of the ground heat exchanger. Use of polyvinyl chloride (PVC) or polybutylene pipe and fittings is not permitted. Provide high density polyethylene pipe coiled on reel, with U-end factory installed, pipe pre-marked for depth, and U-bend connections factory tested.

- B. Handling: Because of their size and weight, coiled PE piping requires appropriate equipment and procedures for safe handling, installation, and use. Reels and coiled pipe shall allow easy and thorough inspection of the pipe exterior for any shipping and handling damage. The reel shall be capable of securing the pipe coil while the pipe is being pressure tested. The reel and pipe coil shall allow easy access and handling while spooling the pipe coil off the reel and for insertion into the bore hole.
- C. High Density Polyethylene Pipe
1. Pipe shall be manufactured from virgin high density polyethylene extrusion materials in accordance with ASTM D 2513 with PE345434C or PE355434C cell classification and UV stabilizer of C, D, or E as specified in ASTM D 3350 with the following exception: this material shall exhibit zero failures (FO) when tested for 192 hours under ASTM D-1693, condition C as required in ASTM D3350.
 2. On-site (factory) re-processed resin is acceptable; however no off-site recycled resin shall be used.
 3. Dimensions: Provide ASTM D 3035 pipe with a standard dimension ratio (SDR) of 11.0.
 4. Acceptable Manufacturer:
 - a. Performance Pipe (Division of Chevron Phillips) – Driscoplex 5300 Series.
- D. Fittings
1. All plastic piping shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.
 2. Provide ASTM D 3261 butt and saddle fusion fittings and ASTM D 2683 socket fusion fittings manufactured in accordance with ASTM D 2513. Comply with ASTM F-1055 for electrofusion fittings. Barbed fittings, compression type fittings, mechanical joint fittings, groove fittings, hose clamps, etc. are not permitted in polyethylene pipe systems.
 3. Heat joining shall be performed in accordance with ASTM D 2657. Electrofusion joining shall be performed in accordance with ASTM F 1290. Heat fusion tests shall be conducted to verify the quality of the joints.
 4. All pipe fittings underground shall be fusion type joints. Flange joints and fittings shall not be provided on underground piping.
 5. Fitting wall thicknesses shall match the adjoining pipe.
- E. HDPE to Steel Pipe Transition Fittings
1. Threaded Type (for connections 2 inches and smaller): Provide ASTM D 2513 reinforced threaded steel to polyethylene fittings. The steel portion of the fittings shall have a factory applied external epoxy coating.
 2. Flanged Type (for connections larger than 2 inches): Consisting of butt fusion HDPE flange adapter with ductile iron back up ring. Back up ring shall have a factory applied external epoxy coating.
 3. Transition fittings are only permitted inside the building.

2.4 AIR CONTROL DEVICES

A. Manual Air Vents

1. Air vents for finned tube radiation and convectors shall be $\frac{1}{8}$ inch male screwdriver type manual air vents suitable for system pressure.
2. Air vents for air handling unit coils shall be $\frac{1}{4}$ inch petcocks.
3. All other manual air vents installed on the system piping for the purposes of purging the system completely of air shall be $\frac{3}{4}$ globe valves.

B. Automatic Air Vents

1. Automatic air vents shall vent automatically with float principle; bronze body and nonferrous internal parts; 150 pounds per square inch gauge working pressure (300 pounds per square inch gauge for chilled water system); 240 degrees Fahrenheit operating temperature; with NPS $\frac{1}{4}$ discharge connection and NPS $\frac{1}{2}$ inlet connection; equivalent to Spirax Sarco Model 13WS or 13WHS depending on system pressure.
2. Provide automatic air vents on air separators.
3. Provide automatic air vents at inaccessible locations requiring air purge. In such locations, the discharge of the automatic air vent shall be piped to the nearest acceptable indirect waste. Such locations are mechanical room floor and funnel drains and janitor's closet sinks. The discharge may terminate into the AC condensate drainage system provided the discharge is made with an air gap fitting located in a concealed, but accessible location. A shut off cock shall be provided on the vent discharge line at this location.
4. All accessible locations of air purge (other than air separators) shall be fitted with manual air vents.

C. High Capacity Air Vents

1. Provide float actuated high capacity air vents designed to purge free air from the system and provide shutoff at pressure up to 150 pounds per square inch gauge at a maximum temperature of 250 degrees Fahrenheit. The design of the high capacity air vents shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vents shall purge free air at pressures up to 150 pounds per square inch gauge during normal system operation. The high capacity air vents shall be constructed of cast iron and fitted with components of stainless steel, brass and EPDM.
2. Provide high capacity air vents on air separators.
3. High capacity air vents shall be ITT Bell & Gossett Model 107A or approved equivalent by Spriax Sarco or Armstrong International.

D. Air Separator

1. Air separation units shall be constructed of cast iron. The air separator shall have tangential inlet and outlet connections and an internal perforated stainless steel air collector tube designed to direct released air to an automatic air vent fitted at the top of the vessel. A blow-down connection shall be provided for routine cleaning and drain-down. No integral strainer shall be provided. Air separator shall be rated for 125 pounds per square inch gauge at 450 degrees Fahrenheit, constructed in accordance with ASME Section VIII, Division 1. Pressure shall be suitable for duty in selected system.

2. Size of air separator shall have a minimum piping connection size as indicated on the drawings. The size of the separator furnished shall also be such that the maximum flow rate recommended by the manufacturer exceeds the total design flow rate of all connecting duty pumps and the separator and that the pressure drop does not exceed 1 foot water gauge at that same flow rate. (The GPM of standby pumps does not need to be considered). If the separator connection size exceeds the system piping size as shown on the drawings, furnish reducer fittings to connect the separator to the piping system.
3. Acceptable Manufacturers:
 - 1) Bell & Gossett Rolairtrol
 - 2) Amtrol
 - 3) Taco

2.5 EXPANSION TANKS

- A. Diaphragm Vertical/Horizontal Expansion Tanks: Expansion tanks shall be ASME constructed and stamped suitable for a working pressure for duty in system intended. Tank shall be hydrostatically factory tested at a minimum of two times the working pressure. Tank shall have integral diaphragm. Size of the expansion tank shall be as scheduled on the drawings. Tank shall be of carbon steel construction and ASME Stamped for 125 pounds per square inch gauge. Tanks shall be pre-charged, but shall be fitted with a schrader valve for adjusting the air pressure.
- B. Acceptable Manufacturers:
 1. Bell & Gossett Series D Vertical/Horizontal
 2. Wessels
 3. Amtrol
 4. Taco

2.6 DRAIN VALVES

- A. Provide drain valve and cap at the bases of risers, downstream of flow shut off valves and as shown on drawings and specified herein.
- B. Drain valve shall be equivalent to Watts B-6000-CC ¾ inch boiler drain valve. Drain valve cap shall be brass gasketed cap capable of withstanding continuous full line pressure.

2.7 HYDRONIC PIPING SPECIALTIES

- A. Y-Strainers
 1. Strainers up to 4 inches for water and for steam shall be “Y” type, full pipe size and fitted with blow-off ball or globe valve. Basket screens shall be brass, with perforations suitable for intended service.
 2. Acceptable Manufacturers and models:
 - a. Mueller No. 11 or Mueller No. 758
 - b. Watts No. 77S or Watts No. 77F-D
 - c. Sarco Type IT or Sarco IF-125

B. Make Up Water Pressure Reducing Valve

1. Pressure reducing valve in water make-up piping shall be Watts Regulator Company No. U5 water reducing valve or approved equivalent. Maximum temperature: 160 degrees Fahrenheit; maximum initial pressure: 300 pounds per square inch gauge; reduced pressure range shall be from 25 to 75 pounds per square inch gauge.

C. Pressure Relief Valves

1. Pressure relief valves shall be ASME rated pressure safety relief valves of bronze body construction with test lever. Model number and size to be based upon pressure setting and relieving capacities as noted on the drawings.

2.8 PIPE SLEEVES

A. Provide sleeves for piping passing through roofs, floors, ceilings, walls, partitions, air handling equipment, structural members, and other building parts.

B. Sealant shall be equivalent to Dow Corning 795 Silicone Sealant for general purpose use and Dow Corning 786 Mildew Resistant Silicone Sealant for Kitchen, Food Preparation, Dining areas, and wet areas. Prime sleeves in accordance with manufacturer's recommendations.

C. Sealant in one-hour and two-hour walls and one-hour and two-hour floors shall be equivalent to Dow Corning Fire Stop System Sealants and Foams. Sealants and foams shall be UL listed and installed in accordance with manufacturer's recommendations.

D. Schedule of Sleeve Materials

1. Sleeve Type Sleeve Material:

- a. 18 gauge galvanized steel
- b. Standard weight galvanized steel pipe
- c. Standard weight galvanized steel pipe with a continuously welded water stop of ¼ inch steel plate extending a minimum of 2 inches from the outside of the sleeve. (F&S Mfg. Co. Figure 204 or approved equal.)
- d. Cast iron pipe sleeve with center flange. (James B. Clow & Sons No. F-1430 & F-1435, or approved equal.)
- e. Std. weight galvanized steel pipe with flashing clamp device welded to pipe sleeve or watertight sleeves. (Josam 1870-A2 with oakum and lead caulking as required, or approved equal.)
- f. Metal deck and wall sleeves.

E. Escutcheon Plates: Schedule of Escutcheon Plate Materials

1. Location Escutcheon Plate Materials:

- a. Finished spaces: Anodized aluminum or chrome-plated brass
- b. Unfinished spaces: Plain brass, cast iron or aluminum

2.9 MECHANICAL SLEEVE SEALS

- A. Provide a sealing element made of synthetic rubber material, compounded to resist aging, ozone, sunlight, water and chemical action, and having a low temperature flexibility and resistance to high temperature environments. Elements shall be suitable for temperature ranges of -100 to 600 degrees Fahrenheit.
- B. Bolts and metal parts shall be made of carbon steel and zinc phosphate plated to resist corrosion. Pressure plates shall be cathodic-type made of plastic.
- C. The seals shall be constructed so as to be air tight in aboveground installations, and to provide watertight sealing in below grade installations.
- D. Seals shall be manufactured by Thunderline Corporation or approved equivalent.

2.10 PIPE FLASHING FITTINGS

- A. Pipes passing through roof construction shall be provided with roof curb and piping portal.

PART 3: EXECUTION

3.1 GENERAL

- A. The drawings schematically indicate the size and location of piping. Piping system layout shall be modified as required to meet field conditions and facilitate coordination among Contractors at no additional cost. Piping shall conform to the referenced code for pressure piping. Unless otherwise noted, all piping, valves, and associated fittings shall be concealed behind walls, above ceilings, or below floors.
- B. Provide adequate provision for expansion and contraction in portions of the piping systems, to prevent undue strains on piping and connected equipment.
- C. Provide approved bolted, gasketed flanges for each piece of equipment to permit easy connection and disconnection. Screwed unions with steel faces may be used on piping 1 inch and smaller.
- D. Inlet/outlet piping connections to coils and equipment shall be provided with offsets and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- E. Converging and diverging bull-head tees will not be permitted in piping systems; only branch tee flow is permitted.
- F. ‘T-drill’, ‘Pro-Press’, and other mechanical joining systems not explicitly specified in this section will not be permitted in piping systems.
- G. The use of Contractor-fabricated branch weld “fish-mouth” assemblies (i.e. those made by welding a mitered pipe to the side of another pipe with a hole cut in the side) for branch connection to mains is only permitted when the size of the branch connection is two (2) or more nominal pipe sizes smaller than the size of the main pipe. Furthermore, branch weld assemblies shall utilize a reinforcing pad of a thickness no less than the main piping thickness where the branch size is larger than 6 inches.
- H. The use of weld-o-lets for branch connection to mains is only permitted when the size of the branch connection is three (3) or more nominal pipe sizes smaller than the size of the main pipe. Furthermore, weld-o-lets shall not be used for branches larger than 5 inches.

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- I. If, after systems are in operation, any coils or other apparatus become stratified or air-bound, they shall be re-piped with necessary fittings, air vents or vacuum breakers at no additional cost. If connections are concealed behind construction, the responsible Contractor shall bear the cost of any demolition and refinishing construction required.
- J. Pitch water piping up in direction of flow to ensure adequate flow without air binding and to prevent noise and water hammer. Branch connections to mains shall be made in such a manner as to prevent air trapping and prevent free passage of air. Mains shall be laid out to meet field conditions, maintain adequate headroom and clear work of other Contractors.
- K. Miscellaneous drains, vents, relief vents, equipment/tank overflows and similar devices shall be run to the nearest floor drain or roof drain, except for steam or refrigerant relief vents, which shall be routed to the exterior and terminated in a safe manner. Provide drain valves wherever required for complete drainage of water system piping, including the system side of pumps.
- L. Grooved Joint Installation: All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be manufactured by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved joints are only permitted in mechanical rooms and outside the building (above grade) and on non-glycol containing systems.
- M. Any piping passing through roof construction shall be arranged to provide a minimum of 12 inches clearance from walls or other obstructions so as to permit proper flashing. Set pipe flashing fittings at a suitable level above the roof to permit proper termination of flashing.
- N. Provide hose drain connections on water systems downstream of floor main shut off valves.
- O. Provide dielectric fittings equivalent to EPCO Sales at all ferrous to non-ferrous pipe connections.
- P. All grooved joint couplings, fittings, valves, and specialties shall be Victaulic. Grooving tools shall be of the same manufacturer as the grooved components. Assemble joints according to fitting manufacturer's written instructions. This option does not permit the substitution of valves, cocks, strainers, or other piping system specialties marketed by the mechanical joint manufacturer. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The Contractor's field personnel shall be adequately trained in the use of grooving tools, application of groove, and installation of grooved joint products.
- Q. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- R. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- S. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated on the drawings.
- T. Install piping free of sags and bends.
- U. Install fittings for changes in direction and branch connections.

- V. Select system components with pressure rating equal to or greater than the system pressure rating specified.
- W. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

3.2 PIPING AND FITTINGS MATERIAL APPLICATION SCHEDULE

- A. Piping systems shall be constructed of the following materials as scheduled below, subject to approval by authorities having jurisdiction:

- 1. Systems Pipe Fittings Remarks:

Pressure/temperature: Type L hard drawn Wrought copper: Provide dielectric relief valve discharge copper tubing with solder joints unions for ferrous to piping for water 95/5 tin antimony with copper tube non-ferrous pipe systems; air vent solder joints connections discharge piping, OR strainer blowdown drain OR piping Wrought Steel but ASTM A53 black welding fittings, steel pipe, Schedule ASTM A234, wall 40 thickness matching the adjoining pipe.

Cooling coil condensate: Type L hard drawn wrought copper piping and blow down copper tubing with solder joints drain piping. 95/5 tin antimony

Schedule 40 PVC not permitted; ASTM D1784 cell solvent welded in air plenums. Class of 12454 fittings, ASTM only copper tube D2466 shall be used in those areas.

- 2. Domestic Water Piping: In accordance with the applicable requirements of Division 22

3.3 HYDRONIC PIPING SYSTEM TESTS

- A. The following general procedures shall be observed for piping system pressure tests:

- 1. Preliminary testing, notification of inspectors and Contractor's responsibilities as specified elsewhere shall be observed.
- 2. Take all due precautions to prevent damage to the building and its contents that may be incurred by such tests; repair or make good any damage caused by the tests at no additional cost to the Owner.
- 3. Tests shall be conducted prior to the installation of any required fitting insulation. If delicate control mechanisms, not including control valves, are installed in the piping, they shall be removed to prevent shock damage.
- 4. The section of piping to be tested shall be brought up to the specified test pressure. If the test pressure falls more than the specified amount during the test period, the point of leakage shall be found, repaired and the test repeated. This procedure shall be repeated until the piping system has been proved absolutely tight.
- 5. Leaks shall be repaired by removing the valve, fitting, joint or section which is leaking and reinstalling new materials and joints as specified. Use of mastic, "no-leak" compounds or other temporary means of repairing leaks shall not be permitted.

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- B. The following specific procedures shall be observed for piping system pressure tests. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Test piping systems hydrostatically using water not exceeding 100 degrees Fahrenheit. Conduct tests in accordance with the requirements of ANSI B31.9 and as follows:
 2. Test the piping after the lines have been cleaned and prior to applying insulation and covers to fittings. Leave joints, including welds, uninsulated and exposed for examination during test.
 3. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 4. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
 7. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 8. Isolate expansion tanks and determine that hydronic system is full of water.
 9. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times “SE” value in Appendix A in ASME B31.9, “Building Services Piping”.
 - a. For all piping systems except high temperature hot water systems, test piping systems at a pressure equal to twice the system's peak operating pressure or 50 pounds per square inch gauge, whichever is greater.
 - b. For high temperature hot water piping systems, test at 600 pounds per square inch gauge.
 10. Remove or valve-off from the system gauges, traps, and other apparatus which may be damaged by the testing.
 11. Install calibrated test pressure gauge in the system to observe any loss in pressure.
 12. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 13. Tests shall be performed after installation of the piping systems and prior to acceptance of same.
 14. Prepare written report of testing.

3.4 HYDRONIC SYSTEMS FLUSHING AND CLEANING:

A. The following general procedures shall be followed:

1. After piping installation is complete but before final connections are made to the equipment, control valves, etc., thoroughly flush the supply and return piping with fresh water. Flushing shall continue until clear water flows from drains or for two hours, whichever is longer.
2. System pumps, coils, heat exchangers, and other equipment connected to the system piping until final flushing is completed and demonstrated to the Architect.
3. After clear water flushing, operate pumps (provide temporary pumps) for a minimum of eight (8) hours with a “start-up” fine mesh strainer. Clean strainer after 8 hours of operation then operate pump for twenty-four (24) hours. Remove start-up strainer, replace bypass filter, and clean remaining strainers.
4. Pump flow rate and head shall be equal to flow rate required for the installed system. Water systems (hot water and chilled water) shall not be connected until flushing is complete. Notify Architect five (5) days before temporary pumps are started.
5. The Contractor is prohibited to use the permanently installed hydronic pumps to clean/flush the hydronic system. The Contractor shall furnish and install a temporary pump for this purpose. After cleaning operations are complete, the Contractor shall remove the temporary pump and install the permanent pump. Damaged pump seals and pump shafts as a result of using the permanent system pumps for flushing and cleaning operations due to poor water quality shall be replaced at no cost to the Owner. All temporary electrical connections are the responsibility of the Division 23 Contractor.

B. The following specific procedures shall be followed:

1. Flushing: Screens/strainers shall be in place and chemical feed system installed before initial flushing begins. Flush hydronic piping systems with clean water. The flushing process shall continue until the inlet and outlet (including pH, conductivity and opacity) is equal, as demonstrated by visual and chemical testing.
2. The permanently installed pumps shall not be used until the system has been fully flushed and cleaned.
3. Cleaning:
 - a. Hydronic system piping, circulating pumps, equipment and water passages shall be cleaned by circulating mixtures of trisodium phosphate. Utilize (one) 1 pound of trisodium phosphate for each 50 gallons in the system.
 - b. Fill, vent and circulate system with the solution. Circulate water for 24 to 36 hours. Allow solution to reach design or operating temperatures if possible. After system has been circulated for four hours, system shall be drained completely and refilled with fresh water. The system shall be thoroughly vented of air.
4. Immediately after recirculation, so that removed and suspended foulants will not resettle, drain system.
5. After cleaning and flushing hydronic piping system, but before balancing, remove, clean and replace strainer screens.

6. Complete cleaning process and demonstrate system water quality to Architect prior to connecting coils, heat exchangers, chillers, or any other equipment to the hydronic piping system. Fouled heat exchangers or damaged control valves as a result of connections made to the system prior to cleaning or due to poor water quality shall be replaced at no cost to the Owner.

3.5 PIPE SLEEVES

- A. Install sleeves in time to permit construction progress as scheduled.
- B. Grout sleeves to building structure for watertight fit.
- C. Schedule of Sleeve Lengths
 1. Location Sleeve Length:
 - a. Floors: Equal to depth of floor construction and at least 1 inch above finished floor construction. In areas of waterproof floor construction (which includes mechanical equipment rooms), sleeves shall extend a minimum of 2 inches above finished floor construction
 - b. Roofs: Equal to depth of roof construction including insulation
 - c. Walls and Partitions: Equal to depth of construction and terminated flush with finished surfaces
- D. Schedule of Sleeve Caulking and Packing
 1. Caulking/Packing Type Caulking/Packing Requirements:
 - a. Space between pipe or pipe covering and sleeve shall be caulked with an incombustible permanently plastic waterproof, non-staining compound leaving a smooth, finished appearance.
 - b. Vermin-proofing: Space between pipe and sleeve shall be packed with industrial felt or fiberglass caulked at both ends with sealant according to manufacturer's recommendations. Vermin-proof insulation shall be minimum 1 inch thickness and shall be sections of foam glass as long as sleeves.

3.6 PIPE ROOF FLASHING FITTINGS

- A. Any pipe passing through roof construction shall be arranged to provide a minimum of 12 inches clearance from walls or other obstructions so as to permit proper flashing.

3.7 STRAINERS

- B. Strainers shall be installed such that they are accessible for maintenance and inspection.
- C. Strainers shall be installed in a horizontal (or vertical downward) run of pipe. Strainers shall be arranged so as to permit the blowing out of accumulated dirt, and to facilitate removal and replacement of strainer screen without disconnecting from piping system.
- D. Valved blow-down connections for strainers 2 ½ inches and larger shall be installed such that the valve is located 6 to 12 inches below the strainer. Blow-down connections shall be terminated in an approved manner, at a point where there shall be no risk of flooding or damage. Blow down connections in mechanical equipment rooms shall be routed to the nearest indirect waste.
- E. After the piping systems have been flushed and prior to releasing the system to the Owner, strainers shall be removed, cleaned, and reassembled.

3.8 AUTOMATIC AIR VENT

- A. Provide vent in accessible location at top of system to allow for maintenance. Pipe discharge of vent to the nearest indirect waste.

3.9 VALVE APPLICATIONS

- A. Install shut off duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install automatic balancing valves in the return pipe of each heating or cooling terminal.
- C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.10 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gauges and thermometers at coil inlet and outlet connections according to Division 23, Section 230519: Meters and Gauges.

3.11 FIELD QUALITY CONTROL

- A. Perform the following before operating the system:
 1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232123 – HYDRONIC PUMPS

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.
- B. Division 23, Section 23113: HVAC Piping including piping system component and equipment pressure ratings applies to this section.
- C. Division 23, Section 230513: Common Motor Requirements for HVAC Equipment for fan motor requirements.

1.2 SUMMARY

- A. This section includes the following:
 - 1. In-Line Pumps
 - 2. Suction Diffusers
 - 3. Triple Duty Valves
 - 4. AC Condensate Pumps
- B. Provide circulating pumps for HVAC service as shown on the drawings and specified herein. Pumps shall have the flow rate capacity and head characteristics indicated on the drawings.
- C. Maximum cataloged impeller size for pump submitted shall be capable of producing 10 percent over scheduled head at scheduled flow.
- D. Each pump shall be provided with gauges as specified and shown on the drawings.

1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Mechanical Seals: One mechanical seal for each pump

PART 2: PRODUCTS

2.1 REQUIREMENTS FOR PUMPS

- A. Pump rating curves shall be the result of testing and rating in accordance with the procedures of the hydraulic institute.
- B. Pumps shall be provided with suction and discharge gauge tappings and plugs.
- C. Impellers shall be dynamically balanced, keyed to the shaft and secured with a suitable locking cap screw or locknut arrangement.
- D. Pumps shall be factory tested, cleaned and painted with one coat of machinery enamel before shipment.

2.2 IN-LINE PUMPS

- A. Pumps shall be in-line type suitable for installation in the horizontal or vertical position. Pumps shall have a cast iron body and one-piece cast bronze impeller. Pumps shall be non-overloading and suitable for 125 pounds per square inch gauge working pressure and 225 degrees Fahrenheit water temperature. Pump shall have stainless steel or bronze sleeved shaft.
- B. Pump seal shall be carbon-ceramic seal suitable for 225 degrees Fahrenheit temperature and 175 pounds per square inch gauge working pressure.
- C. Split couplings required for pumps with motors larger than 10 HP. Close coupled pumps are acceptable for pumps with motors 10 horsepower and smaller.

D. Acceptable Manufacturers:

1. Grunfos and Taco
2. ITT Bell and Gossett

E. NOT Acceptable Manufacturers:

1. Armstrong Pump Inc.
2. FabFlow

2.3 SUCTION DIFFUSERS

- A. Suction Diffuser: Angle pattern, 175 pounds per square inch gauge pressure rating, cast-iron body and end cap, pump-inlet fitting, with bronze startup and bronze or stainless-steel permanent strainers, bronze or stainless-steel straightening vanes, drain plug, and factory-fabricated support

2.4 TRIPLE DUTY VALVES

- A. Triple duty valves shall consist of a non-slam check valve with a spring-loaded disc and a calibrated adjustment feature permitting regulation of pump discharge flow and shut-off. Triple duty valves shall be designed to permit repacking under full line pressure, and shall be designed for installation on the discharge side of the pump in a horizontal or vertical position. The valve body shall be constructed of cast iron, and the entire valve shall be designed for a working pressure of 250 pounds per square inch gauge at 110 degrees Fahrenheit.
1. Grooved or flanged ends are acceptable.
 2. Acceptable Manufacturers:
 - a. Bell and Gossett
 - b. Armstrong
 - c. Victaulic

2.5 AC CONDENSATE PUMPS

- A. AC Condensate Pumps: UL-listed packaged unit with corrosion-resistant pump impeller and stainless steel shaft, minimum ½ gallon high impact ABS tank with cover and three drain holes, and fully automatic controls including snap action float switch and thermal overload protection; suitable for up to 120 degrees Fahrenheit fluid (intermittent operation)
1. Minimum 25 gallons per hour at 15 feet of head; include factory- or field-installed barbed ¾ inch check valve
 2. Electrical: 1/30 horsepower motor at 120 volts, single phase, 60 hertz; minimum 72 inches long electrical power cord with plug
 3. Maximum dimensions: 11 inches by 5 inches by 7 inches tall
- B. Little Giant Model VCMA-20UL or approved equal
- C. Where clearances in the ceiling space demand a lower profile pump, the Little Giant Model 'VCC-20ULS' may be substituted.

PART 3: EXECUTION

3.1 PUMP INSTALLATION

- A. Install floor mounted in-line pumps vertically plumb on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - 1. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- B. Place the pump in operation and check for proper pump rotation and pressure drop.
- C. Measure motor current draw under normal operation to verify that pump is operating within the proper power limits and that the pump motor is not overloading.
- D. Check motor/pump alignment in the field. Correct any misalignments before operating pump.
- E. Provide suction diffusers on floor mounted pumps.
- F. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- G. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- H. Suspend pipeline mounted in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23, Section 230548: Vibration Controls.
- I. Automatic Condensate Pump Units: Furnish a condensate pump wherever a condensate pump is indicated on the drawings and wherever a pumped condensate drain piping is shown connected to a piece of cooling equipment. Install units for collecting condensate and extend to an open drain.

3.2 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with non-shrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 FLUSHING AND CLEANING OF THE HYDRONIC SYSTEM

- A. The Contractor is prohibited to use the permanently installed hydronic pumps to clean/flush the hydronic system. The Contractor shall furnish and install a temporary pump for this purpose. After cleaning operations are complete, the Contractor shall remove the temporary pump and install the permanent pump.

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Damaged pump seals and pump shafts as a result of using the permanent system pumps for flushing and cleaning operations due to poor water quality shall be replaced at no cost to the Owner. All temporary electrical connections are the responsibility of the Division 23 Contractor.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install check valve and gate or ball valve on each condensate pump unit discharge.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that pumps are installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- D. Perform the following preventive maintenance operations and checks before starting:
 - 1. Check piping connections for tightness.
 - 2. Lubricate bearings.
 - 3. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 - 4. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 - 5. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 - 6. Check suction piping connections for tightness to avoid drawing air into pumps.
 - 7. Clean strainers on suction piping.
 - 8. Verify that pump controls are correct for required application.
 - 9. Verify that pump is rotating in the correct direction.
- E. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
 - 1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
 - 2. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
 - 3. Open cooling water-supply valves if stuffing boxes are water cooled.

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4. Open sealing liquid-supply valves if pumps are so fitted.
 5. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
 6. Open circulating line valves if pumps should not be operated against dead shutoff.
 7. Start motors.
 8. Open discharge valves slowly.
 9. Check general mechanical operation of pumps and motors.
 10. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- F. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.
- G. Refer to Division 23, Section 230593: Testing, Adjusting, and Balancing for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

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

END OF SECTION 232123

SECTION 232213 – STEAM AND CONDENSATE PIPING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

- 2.1 The steam and condensate piping shall be designed around Perma-Pipe, Multi-Therm 500 and consist of an outer fiberglass jacket, polyurethane foam insulation, 10-gauge steel conduit, support assembly, mineral wool insulation, and a steel service pipe.
- 2.2 The supply service piping shall be Schedule 40, Type ASTM A53.
- 2.3 The return service piping shall be Schedule 80, Type ASTM A53.

PART 3: EXECUTION

- 3.1 Steam piping shall slope 1 inch in 40 feet and condensate shall slope 1 inch in 30 feet in the direction of flow.
- 3.2 Steam velocities shall not exceed 80 feet/second.

END OF SECTION 232213

SECTION 232223 – STEAM CONDENSATE PUMPS

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University.

1.2 Facilities Management Project Manager

PART 2: PRODUCTS

2.1 Use Spirax-Sarco, non-electric, steam pressure powered condensate pumps.

PART 3: EXECUTION

3.1 NOT AVAILABLE

END OF SECTION 232223

SECTION 232233 – STEAM SPECIALTIES

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

1.2 Steam Quality

A. Steam must meet the following criteria:

1. Steam must be free of harmful materials.
2. Must meet Food and Drug Administration, (FDA) requirements for use with food.
3. Exhibit a pH of between 8.8 and 9.2 standard pH units.
4. Exhibit conductivity of less than 10 microsiemens/centimeter ($\mu\text{S}/\text{cm}$) as measured at 25 degrees Celsius
5. Exhibit a cation conductivity of less than 1.0 microsiemens/centimeter as measured at 25 degrees Celsius
6. Exhibit a Silica concentration of less than 20 parts per billion.
7. Exhibit an Iron concentration of less than 15 parts per billion.
8. Exhibit a Sodium concentration of less than 10 parts per billion.

B. Condensate Quality: Condensate CANNOT be returned to MEA until it meets ALL of the following criteria.

1. Must be free of oil, grease and their harmful materials.
2. Exhibit a conductivity of less than 20 microsiemens/centimeter as measured at 25 degrees Celsius.
3. Exhibit a Silica concentration of less than 20 parts per billion.
4. Exhibit a pH of at least 7 pH units and less than 9 standard pH units.

PART 2: PRODUCTS

2.1 Use expansion loops and not expansion joints.

2.2 Use Spirax-Sarco, “Easi-Heat” instantaneous domestic water heaters.

2.3 Use Spirax-Sarco, “DIVA” saturated steam flow meters.

2.4 Use Spirax-Sarco UTD 52 traps with strainers on main lines and the F&T style trap on equipment.

PART 3: EXECUTION

3.1 Where design dictates a steam control valve larger than 2 inches, then two valves shall be used in parallel. Valves shall be sized for one-third, two-thirds capacity and be sequenced with positioners.

3.2 Provide double valving on steam lines 2 inches diameter and larger.

END OF SECTION 232233

SECTION 232243 – STEAM PIPING INSULATION

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

2.1 N/A

PART 3: EXECUTION

3.1 Piping

A. Steam Supply and Condensate Lines:

1. Aboveground or in Tunnels:

- a. Material: Shall be calcium silicate with a thermal conductivity (k) of 0.5 BTU/(hr·ft²·°F) at 400 degrees Fahrenheit mean temperature.
- b. Jacket: A layer of ¾ inch deadening felt shall be wrapped around the insulation. The felt on the elbows shall be pasted in place with a water based sealant/coating, equal to Foster Sealfas coating 30-36, as manufactured by the H.B. Fuller Co. The felt may be wired in place on straight runs of pipe.
- c. Thickness:

1) Supply:

Pipe Size	Insulation Thickness
0 – 2 inches nominal OD	1-½ inches
2 – 4 inches	2 inches
Over 6 inches	2-½ inches

2) Condensate: Use 1-½ inches thick on all pipe sizes.

2. Direct Buried:

- a. Pre-manufactured: Multi-Therm 500 by Perma Pipe. MT-500 consists of the following: steel service pipe, mineral wool insulation, support assembly, 10-gauge steel conduit, polyurethane insulation, and a fiberglass reinforced polyester outer jacket.

B. Other:

- 1. All valves 2 inches and larger shall have removable insulation blankets. These are machine sewn with velcro fasteners.
- 2. All fittings, flanges, and unions shall be insulated the same as its corresponding piping.

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3. Insulation shall continue unbroken through any hangers. The insulation shall rest on shields so as not to overly compress the insulation.

END OF SECTION 232243

SECTION 232253 – STEAM VAULTS

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

- 2.1 Steam vault lids shall be gray cast iron. Diameter shall be no less than 32 inches. All lids shall have the word “STEAM” cast into them, several vent holes, and include drop handles. Each vault shall have two lids.
- 2.2 All steam vaults shall have two integral ladders made of galvanized steel. The rungs shall be of a non-slip design. Each ladder shall lead to a different lid.
- 2.3 All pulling eyes shall be designed and reinforced to withstand an ultimate tension of 21000 pounds. All pulling eyes shall be designed and reinforced to permit lifting and setting of the vault.
- 2.4 Vaults shall have a minimum interior height of 7 feet.
- 2.5 Vault and lid shall be HS20 rated.

PART 3: EXECUTION

- 3.1 Use as few steam vaults as possible.
- 3.2 No plastic products shall be used in vault.
- 3.3 Each steam vault shall set on 12 inches of leveled limestone gravel which extends past the vault perimeter. Further, in damp areas, the vault shall be surrounded vertically by 6 inches of limestone gravel.
- 3.4 A bituminous mastic “rope” shall be used to form a gasket between each riser section. If possible use more than one rope.
- 3.5 Pipes shall not be mounted tight to the wall. No pipes shall impede ladder access.
- 3.6 All vaults shall be externally coated on the sides and base with a waterproof bituminous material. Further, if the vault is in a possibly damp area it shall have an internal gravity drain and an external French drain.
- 3.7 If a gravity drain is not possible then a high temperature sump pump shall be used. The pump shall be hardwired. The disconnect switches shall be in a separate box mounted outside the vault. A receptacle shall also be placed in this separate box.

END OF SECTION 232253

SECTION 232300 – REFRIGERANT PIPING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

- 2.1 Pipes and tubes: Only type ACR copper shall be used. Depending on the situation either annealed or hard drawn may be used. When the refrigerant line is in a visible location, only hard drawn shall be used.
- 2.2 Fittings: Shall be ASME B16.22, wrought-copper.

PART 3: EXECUTION

- 3.1 Double suction risers shall be employed on systems with capacity reduction and where required by lift.
- 3.2 Joints shall be made by brazing.

END OF SECTION 232300

SECTION 232301 – REFRIGERANT

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

- 2.1 If the pertinent type and size equipment is available with zero ozone depletion refrigerants, then that is what shall be specified. It shall also be noted in the drawing schedules. If not, then the most environmentally friendly refrigerant shall be specified.

PART 3: EXECUTION – NOT USED

END OF SECTION 323301

SECTION 232500 – HVAC WATER TREATMENT

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 GENERAL

- A. The following work consists of providing all labor, material and equipment for cleaning and flushing piping systems and providing water treatment chemicals and miscellaneous equipment for piping systems.
- B. Provide the work which is outlined and which will be performed by an independent water treatment company. Perform all work required for the installation but is not specifically outlined to be performed by the water treatment company.

1.3 SUMMARY

- A. This section includes the following HVAC water-treatment systems:
 1. Glycol Solution Makeup Units
 2. Propylene Glycol
 3. Chemical Treatment Test Equipment
 4. Water-Treatment Chemicals

1.4 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Obtain water samples at job site to determine required treatment. Provide thermal and hydrodynamic review of the proposed treatment system piping routing and equipment characteristics, to preclude thermal degradation of materials excessive chemical feed pump discharge or suction pressure and siphoning of chemicals. Provide report outlining water analysis with shop drawing submission.
- D. Provide all chemicals and testing equipment, as described in the following paragraphs.
- E. Provide all chemicals required for cleaning and flushing the systems affected by the construction, for initially filling these systems, and for maintaining these systems at proper concentration levels required for effective, efficient operation of the mechanical equipment for a period of one year after the acceptance of the project by the Owner. Fouling factors shall be maintained at 0.0005 on all heat exchange surfaces and algae shall be maintained at levels of no appreciative build-up.

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- F. Provide all water chemical treatment equipment as required to implement the chemical treatment programs specified. All chemical treatment equipment shall become the property of the Owner.
- G. Instruct HVAC Contractor on installation of feeding equipment.
- H. Provide services by an experienced chemical engineer to: direct flushing, cleaning and/or disinfection, pretreatment, metal passivation, startup and debugging operations; direct and perform chemical control tests during construction period.
- I. Provide the Architect with three (3) sets of complete written instructions in shop manual format for chemical feeding and test procedures.
- J. Demonstrate to the Owner the proper application of the written instructions.
- K. Obtain samples from all systems, at least once every two months, analyze these samples and furnish written report and recommendations to the Architect.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
 - 1. Solution Makeup Units
 - 2. Injection Pumps
 - 3. Chemical Test Equipment
 - 4. Chemical Material Safety Data Sheets
- B. Shop Drawings: Treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For sensors, injection pumps, water softeners, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.
- E. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the “Performance Requirements” article above.
 - 2. Water Analysis: Illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this section.
- 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.

1.7 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping, heating, snow-melt piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one (1) year from date of Substantial Completion, and shall include the following:
1. Initial water analysis and water-treatment recommendations
 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation
 3. Periodic field service and consultation
 4. Customer report charts and log sheets
 5. Laboratory technical analysis
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations

PART 2: PRODUCTS

2.1 GENERAL

- A. Refer to Section 232113: HVAC Piping for component and equipment ratings. All components, fittings, equipment, coils, specialties, etc., shall meet the component pressure rating listed.

2.2 GLYCOL SOLUTION MAKE-UP UNIT – GLYCOL SYSTEMS

- A. The Contractor shall furnish and install a prefabricated, automatic make-up unit for the glycol/water system.
- B. The package shall be designed to occupy a minimum amount of floor space to operate on a standard 110 volts, 60 hertz electrical circuit, and to maintain the desired fill pressure in the glycol system. The set point shall be adjustable. Pump shall start based on falling pressure. Green light shall indicate power supplied to unit
- C. The unit shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate an audible (which can be silenced) and a visual alarm. A 110 volts signal shall also be available for a remote alarm.
- D. A 50 gallons translucent polyethylene solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shutoff valve. The container shall have a visible solution level scale in gallons and liters. A $\frac{3}{4}$ inch NPT glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.
- E. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a 1.8 gallons per minute at 50 pounds per square inch gauge pump, a $\frac{1}{3}$ horsepower ODP motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, y-strainer, pressure reducing valve, check valve, balancing valve, shutoff valve, and a pressure gauge. It shall be connected to the system with a $\frac{3}{4}$ inch NPT connection.

F. Acceptable Manufacturers:

1. Wessels Model ‘GMP’
2. Bell and Gossett ‘GMU’

2.3 PROPYLENE GLYCOL/WATER SOLUTION

- A. Provide a sufficient quantity of commercial inhibited propylene glycol in the hydronic system to provide a solution which is 25 percent propylene glycol by volume. Glycol shall meet the requirements of ASTM D-2695. Conduct refractometer tests initially and periodically over the warranty period to assure that a proper mixture is maintained. Advise the Owner in writing of the type of glycol, total amount provided and guaranteed lowest outdoor ambient temperature at which freezing and bursting will be prevented.
1. The solution should be dyed red for easy leak detection.
 2. The solution should contain an industrial grade inhibitor to limit corrosion.
 3. The solution should be easily analyzed and re-inhibited.
- B. Glycol/water solution shall be premixed with water conforming to all recommendations of the glycol manufacturer (maximum 25 parts per million of each of chloride and sulfate ions; maximum 50 parts per million total hardness; unless more restrictive requirements are set by the glycol manufacturer).
- C. The pre-mixed solution shall be pumped into the system by the Contractor. The Contractor is responsible for ensuring the entire system, including the well field, is filled with the correct solution concentration.
- D. Propylene Glycol:
- a. Dow Chemical Co. (Dowfrost HD)
 - b. Ohio Chemical Services (Protocol NT)
 - c. Interstate Chemical Company

2.4 CHEMICAL TREATMENT EQUIPMENT – EVAPORATIVE COOLER SPRAY WATER SYSTEMS

- A. Provide a complete electronic monitoring package complete with feed pumps, water meters, blowdown valve, wiring, piping, and accessories.
- B. Evaporative Cooler Spray Water Monitoring and Control System
1. System shall be packaged self-contained, factory assembled, fully automatic, chemical feed system with an integral electric/electronic monitoring control system to continuously monitor, control, and alarm system variables within specified limits. All controllers, timers, and pumps shall be mounted on a single frame or structure for installation. System shall be equal to Dexter Mogul Towertrol.
 2. Only one 115 volts AC power supply shall be furnished to this system as part of the work under the electrical sections, all other electrical work necessary to provide a complete functioning system shall be provided as part of the work under this section, except as otherwise indicated for external to unit remote functions. All work shall conform to the provisions outlined in Division 26.
 3. Control unit shall be factory tested and pre-calibrated to assure reliability of operation. Unit shall be of modular construction for easy trouble shooting and repair.

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4. Control unit shall have a back plate of formed aluminum, epoxy painted; NEMA 3 enclosure. Power source (1) shall be 120 volts AC, 60 hertz, 20 amps.
5. Sample line shall be Schedule 80 CPVC complete with conductivity sensor and flow switch and may be located locally or remotely from the control panel.

C. System Description

1. System continuously monitors and controls inhibitor chemical feed, biocide additions, and conductivity.
2. Conductivity: OF-OFF control of bleed valve. Purged high total dissolved solids (TDS) water is replaced with low TDS make-up water by tower level control.
3. Inhibitor/dispersant level: Proportional to make-up by a water meter activating a counter-timer.
4. Alarms: Audible and visual alarm activated with manual alarm silence. Also provide auxiliary relay contact for remote alarm.
5. Electrical/Electronic Components:
 - a. The controller circuitry shall be individually housed in a weather-tight enclosure with a key-locked, windowed door. The electrode signal from the sensor assembly shall be conditioned and linearly displayed on a 4-½ inches mirrored scaled meter. The analyzer electronics shall be mounted on a plug-in printed circuit board. A run-test switch shall be provided for the electrode signal to isolate the electrode during trouble shooting and to simulate readings during control adjustments.
 - b. All bleed and feed control functions shall have a manual OFF and ON as well as automatic operating mode. All control lights shall be long life neon to minimize bulb failure.
 - c. The conductivity analyzer shall have one (1) control set point, adjustable 100 percent across the range with a variable hysteresis, as well as one HI and one LO alarm, also adjustable 100 percent across the range. Powered control contacts shall be provided for ON/OFF control of chemical treatment feed, bleed, and an alarm including an alarm contact for remote readout and an audible alarm. All control relays will be 10 amps resistive to permit the direct connection of the bleed valve and fractional horsepower feed pumps.
 - d. The timer-counter shall be provided with a continuous time adjustment between 0 and 60 seconds. The counter included in the timer circuit shall have an adjustment range of 1 to 15 counts per timer cycle.
 - e. The conductivity analyzer and timer-counter shall meet the following operating requirements.

<u>Conductivity Controller</u>	Sensitivity:	0.1 percent of full scale
	Stability:	0.2 percent of full scaler per day
	Scale:	0 to 5000 microhms/centimeter (switch selectable)
<u>Timer-Counter</u>	Span:	0 to 60 seconds
	Counter Span:	1 to 15 counts
	Minimum Count Contact Time:	0 to 25 seconds
 - f. The conductivity cell electrodes shall be manufactured from inert titanium-palladium alloy, never requiring replanization. All conductivity signals shall be automatically temperature compensated. The conductivity components are completely encapsulated, eliminating the need of O-ring seals, air pressure, or other sealing devices.

D. Algaecide/Biocide Feed

1. An algaecide/biocide timer shall be mounted on the pre-assembled control panel to automatically add biocide per the chemical treatment company's instructions and have the capability of automatically alternating formulations. The timer shall be minimum 7-day programmable-type capable of starting chemical feed pumps at 15-minute intervals of the day. Programs shall be easily adjusted by hand without tools to obtain or to change the desired programmed schedule. The unit shall be powered by a 120 volts source.
2. The switch mechanism shall be self-contained unit rated at not less than 20 amps, 120 volts, single pole, double throw, and shall be readily replaceable in the field.
3. An omitting device shall be furnished as an integral part of the time switch, to enable switching operation to be skipped for any pre-selected day or days of the week.

E. Fail-safe Control (Flow Switch)

1. A flow switch shall be provided in the sample stream to lock out chemical feed in a “no flow” condition. Flow switch cleaning shall require no tools.

F. Contacting (Contact Head) Water Meter

1. Provide a contacting water meter in the make-up water line. The register shall read directly in gallons and be sealed. See drawings for requirements.

G. Solenoid Bleed Valve and Strainer

1. The bleed valve capable of blowing down sufficient condenser water to maintain recommended concentrations at 70 tons shall be part of the centrifugal separator. A cast iron strainer of the pipe size equal to the solenoid bleed valve shall be provided. The strainer element shall be 20-mesh stainless steel.

H. Chemical Feed Pumps

1. The chemical metering pumps for corrosion inhibitor and/or pH control shall be positive displacement, liquifram type pumps. Output volume shall be adjustable from 0.15 to 14.4 gallons/day. To eliminate need for pressure relief valve, liquifram shall automatically stop pulsating when discharge pressure exceeds pump pressure rating by no more than 35 percent. The pump shall be capable of injecting chemicals against pressures up to 80 pounds per square inch gauge.
2. Each pump shall be provided with the following:
 - a. Sufficient lengths of $\frac{3}{4}$ inch nylobrade hose for connecting feed pump with condenser water piping
 - b. Sufficient lengths of $\frac{3}{8}$ inch polyethylene tubing with check valve and tee for hookup to chemical drum/pail suction wand
 - c. Ten (10) drum/pail suction wands with $\frac{3}{4}$ inch bung plugs
 - d. Drum/pail release assembly
 - e. Three (3) corporation stop injector assemblies

I. Testing Equipment

1. Testing equipment shall be provided which shall include the following:
 - a. Reagents and apparatus for determination of pH and alkalinity levels
 - b. Reagents and apparatus for determination of treatment levels
 - c. Any special equipment required for proper control or test of chemical treatment
 - d. Test procedure manuals and test result plates

PART 3: EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Refer to Division 23, Section 230548: Vibration Controls for seismic restraints.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Mount sensors and injectors in piping circuits.

3.3 INITIAL CHEMICAL TREATMENT PROGRAM – GLYCOL WATER SYSTEMS

- A. Chemical feed system shall be installed before system flushing and cleaning procedures begin. Refer to Division 23, Section 232113: HVAC Piping for detailed flushing and cleaning requirements.
- B. Immediately after piping system flushing and cleaning procedures are complete, so as to prevent corrosion from taking place on empty piping, fill the system adding $\frac{1}{4}$ the theoretical dosage of the selected treatment, recirculate for a minimum of (four) 4 hours, maximum of twenty-four (24) hours. Then drain or purge system.
- C. Immediately after the above step, refill system while adding total required dosage of selected treatment equal to Nalco 2536. Continue to recirculate for a minimum of twenty-four (24) hours to allow total film formation.
- D. Immediately after the above step, refill system with premixed solution of 25 percent propylene glycol. Circulate solution for at least twenty-four (24) hours to insure complete mixing with any residual water left in the system. Check solution concentration.
- E. Drain system of volume required and add 100 percent concentrate of propylene glycol to insure correct mixture. Circulate solution for at least twenty-four (24) hours to insure complete mixing. Recheck solution concentration. Repeat step until compliance with specification is obtained.
- F. Provide certification by the chemical treatment representative that the system is properly cleaned and ready for startup.

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3.4 WATER TREATMENT PROGRAM – EVAPORATIVE COOLER SPRAY WATER SYSTEMS

- A. Provide initial fill chemical plus an approximate one-year supply of chemicals and biocides for the condenser water.
- B. In the cost breakdown for chemical treatments, the chemical supplier shall include costs for equipment, cleanout, and chemical costs for each treatment program.
- C. The chemical supplier shall maintain at the site, two extra containers (which are not in use) of each material during the first three months of operation and one extra container thereafter for the remainder of the year.
- D. Inhibitor/Dispersant:
 - 1. Provide a liquid non-chromate/zinc or other heavy metal formulation containing no organics such as lignin or tannins or any other material to contribute to color, COD, or BOD. Material must be thermally stable at maximum system heat exchanger surface temperatures not to exceed 200 degrees Fahrenheit suitable for all system metals. Treatment shall be equal to Nalco 2523.
 - 2. pH Control:
 - a. No formulation of acid, 66 degrees Baume sulfuric or any other acid product, whether or not formulated in a given product, shall be used. Corrosion control shall be alkaline and be provided by natural pH climbs as the “Open Loop” water concentrates in “cycles of concentration”.
 - 3. Cycles of Concentration:
 - a. Not less than six. Automatic control range, 0 to 10. Final control points determined by the Water Treatment Company.
 - 4. Algaecide/Biocide:
 - a. Use concentrated non-phenol and oxidizing products fed in sufficient quantities, at time intervals per water treatment company's recommendations, to effectively “kill” micro-organisms and algae. Two formulations shall be provided and added, per water treatment company's recommendations, at different intervals. Pails shall be distinctly marked “for rotation”. Algaecide shall be equal to Nalco 2504 or 2599; biocide shall be equal to Nalco 2532.
 - 5. Guarantee
 - a. Protect various dissimilar materials of construction.
 - b. Corrosion rate of ferrous metals shall not exceed 50 mils penetration per year.
 - c. Treatment system shall not permit fouling to cause equipment capacity reduction beyond the allowed 0.0005 “fouling factor”.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

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- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23, Section 230500: Common Work for HVAC.
- D. Refer to Division 22, Section 221319: Domestic Water Piping Specialties for backflow preventers required in makeup water connections to potable-water systems.
- E. Confirm applicable electrical requirements in Division 26 sections for connecting electrical equipment.
- F. Ground equipment according to Division 26.
- G. Connect wiring according to Division 26.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 pounds per square inch gauge (345 kilopascals) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.

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- E. At eight (8) weeks intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 “Performance Requirements” article.
- F. Comply with ASTM D 3370 and with the following standards:
 - 1. Silica: ASTM D 859
 - 2. Steam System: ASTM D 1066
 - 3. Acidity and Alkalinity: ASTM D 1067
 - 4. Iron: ASTM D 1068
 - 5. Water Hardness: ASTM D 1126

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232500

SECTION 233113 – HVAC DUCTS

PART 1: GENERAL

1.1 GENERAL

- A. References to SMACNA-HVAC shall be “SMACNA HVAC Duct Construction Standards, Metal and Flexible” latest edition unless otherwise noted. References to SMACNA-Industrial shall be “SMACNA Industrial Duct Construction Standards” latest edition, unless otherwise noted.
- B. When the specifications refer to SMACNA Standards, they shall be considered as minimum standards; if local codes or requirements specified herein require more restrictive standards than described in SMACNA, the local codes and requirements specified herein shall govern.
- C. Ductwork indicated on drawings is schematic; therefore, changes in ductwork sizes and/or location shall be made when necessary to conform to space conditions. Changes shall be made at no additional cost to the Owner. Duct size changes shall always be in equivalent free area dimensions read off a manual ductulator or ASHRAE or SMACNA equivalent free area duct tables. The Engineer shall be consulted for approval of duct size changes which cannot maintain the same equivalent free area dimensions or which require an aspect ratio greater than 4 to 1. Change in duct sizes shall be made with transitions. Transitions shall have not more than a 30 degrees angle parallel to the airflow for a one sided transition or 15 degrees angle for a two sided transition.
- D. Duct dimensions indicated on drawings shall be the clear inside dimensions. Provide hat section at turning vanes, dampers, etc., as indicated in SMACNA, Figure 2-24.
- E. Ductwork shall be constructed true to sizes indicated and shall be airtight with a smooth appearance.
- F. Coil frames, damper frames, louver frames, etc., shall be bolted and sealed to ductwork.
- G. Provide additional bracing and reinforcing as necessary to prevent buckling and bulging of ductwork.
- H. The Contractor shall be responsible for control of duct cleanliness to reduce contamination during duct installation.
- I. Reinforcing, bracing, etc. shall be designed in accordance with SMACNA standards for the pressure classification listed.

PART 2: PRODUCTS

2.1 GENERAL

- A. Ductwork, fittings, reinforcement, hangers, etc., shall be in accordance with SMACNA-HVAC or SMACNA-Industrial.
- B. Material Applications:
 - 1. Supply, return, and transfer air ductwork shall be constructed of galvanized steel.
 - a. Exception: All ductwork in the Potting Room and Greenhouse (Rms. 101A and 101B) shall be aluminum.

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2. Interior exhaust ducts associated with EF-2, 4C, 5, and 6 shall be galvanized steel.
 3. Exhaust ducts associated with EF-1C shall be stainless steel.
 4. Laboratory exhaust ductwork associated with EF-1A, 1B, 3A, 3B, 4A, and 4C shall be constructed of 316 stainless steel, G90 galvanized steel, or PVC as indicated on the drawings.
 - a. Exhaust risers concealed in shafts shall be stainless steel.
 - b. Individual Branch run-outs to fume hoods and miscellaneous process exhausts (snorkels, canopy hoods, furnaces, etc.) shall be stainless steel, with the exception of the two (2) hoods in Quantitative Chemistry, where PVC duct shall be utilized.
 - c. Exhaust ductwork between the ERUs and the respective EF's, and the exterior ducts associated with EF-1C and 4C shall be constructed of either of the following:
 - 1) Fully welded 304 or 316 stainless steel. No insulation required.
- OR
- 2) G90 galvanized steel with board insulation and EPDM roofing membrane covering as described in the Division 23 Section, "HVAC Insulation".

2.2 PRESSURE CLASSIFICATION

A. Duct construction for the various duct systems shall have the following pressure ratings:

- | | |
|--|----------------------------|
| 1. ERU-1, 2, and 3 Supply Air Ductwork upstream of supply air valves | plus 4 inches water gauge |
| 2. ERU-1, 2, 3 Supply Air Ductwork downstream of supply air valves | plus 2 inches water gauge |
| 3. ERU-4 Supply ductwork | plus 2 inches water gauge |
| 4. ERU-4 Exhaust Ductwork from space to ERU | minus 4 inches water gauge |
| 5. HP Supply Air Ductwork | plus 1 inch water gauge |
| 6. HP Return Air Ductwork | minus 1 inch water gauge |
| 7. ERU-1, 2, and 3 Exhaust Air Ductwork upstream of exhaust air valves | minus 2 inches water gauge |
| 8. ERU-1, 2, and 3 Exhaust Air Ductwork downstream of exhaust air valves | minus 3 inches water gauge |
| 9. EF-4C ductwork | minus 2 inches water gauge |
| 10. Exhaust Ductwork between ERU-1 and 3 and their respective EFs | minus 6 inches water gauge |
| 11. Exhaust ductwork between ERU-2 and 4 and their respective EFs | minus 4 inches water gauge |
| 12. Exhaust ductwork on the discharges of the EF's | plus 2 inches water gauge |
| 13. Other Exhaust Air Ductwork not listed above | minus 2 inches water gauge |
| 14. Transfer air ductwork | plus ½ inch water gauge |
| 15. Outdoor air ductwork | minus ½ inch water gauge |

2.3 ELBOWS

- A. Elbows shall be of radius construction with throat radius equal to or greater than the width of the duct unless otherwise indicated. Square construction with turning vanes may be used where space limitations prohibit radius construction.
 - 1. Radius elbows with square throats are not permitted.
- B. Size changes in ductwork should not occur at elbows.
- C. Offsets in ductwork shall be 30 degrees unvaned radius elbows.
- D. Segmented round elbows shall have a minimum of 5 sections.

2.4 GALVANIZED STEEL DUCTWORK

- A. Ductwork shall be G90 galvanized steel ductwork. Duct system pressure rating shall be 2 inches unless otherwise indicated above.
- B. Rectangular Ductwork: Pressure rating from plus ½ inch water gauge to plus 1 inch water gauge, and from minus ½ inch water gauge to minus 1 inch water gauge:
 - 1. Galvanized construction including sheet metal hangers and miscellaneous materials.
 - 2. Construction shall be in accordance with SMACNA-HVAC.
 - 3. Duct sealing shall meet SMACNA duct sealing requirements as listed in SMACNA Table 1-2 (reprinted below).
 - 4. Metal gauge for duct sides shall be the same thickness.
 - 5. Final connections from sheet metal ductwork to diffusers, registers and grilles shall be made with either insulated flexible duct, round ductwork, or rectangular ductwork.

TABLE 1-2 DUCT SEALING REQUIREMENTS

Seal Class	Sealing Required Static Pressure Construction Class
A	All transverse joints, longitudinal seams and duct wall penetrations 4 inches water gauge thru 10" water gauge
B	All transverse joints and longitudinal seams 3 inches water gauge
C	Transverse joints 2 inches water gauge thru ½ inch water gauge

Flexible ductwork shall not be used behind inaccessible hard-surface ceilings or sidewalls. Insulated flexible duct shall be Flexmaster Type 3M or approved equivalent. Interior liner shall be tri-laminated aluminum foil, fiberglass, and aluminum polyester with a helix encapsulated in the fabric. Insulation shall be 1-½ inches fiberglass, compressed to 1 inch thick, and exterior jacket shall be a fire retardant, reinforced aluminum vapor barrier material. Duct shall be UL listed for Class 1 air duct and shall be suitable for operation at up to 12 inches water gauge and velocities to 4500 feet per minute. Flexible ducts shall be joined to rigid ducts and box inlets by metal or flexible drawband and duct mastic equivalent to "Ductmate". Flexible ductwork shall conform to SMACNA "Duct Performance Standards for Flexible Duct". Maximum flexible duct length shall be 5 feet.

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6. Leakage Class: Duct leakage shall meet SMACNA applicable leakage classes as listed in SMACNA Table 4-1 (reprinted below).
- C. Rectangular Ductwork – Pressure Rating from plus 2 inches water gauge to plus 10 inches water gauge, and from minus 2 inches water gauge to minus 10 inches water gauge. Note: The use of slip and drive joints outside the pressure ratings shown is permitted if in accordance with SMACNA standards:
1. Galvanized construction including sheet metal hangers and miscellaneous materials.
 2. Construction shall be in accordance with SMACNA-HVAC for supply ductwork and return/exhaust ductwork to minus 3 inches water gauge Construction shall be in accordance with SMACNA-Industrial for return/exhaust ductwork from minus 4 inches water gauge to minus 10 inches water gauge
 3. Duct sealing shall meet SMACNA duct sealing requirements as listed in SMACNA Table 1-2 (reprinted below).
 4. Metal gauge for duct sides shall be the same thickness.
 5. All traverse duct joints shall be constructed with “Ductmate” rectangular duct connector system or equivalent. System type shall depend on joint class required. Connector system shall have leakage ratings and deflection ratings submitted during shop drawing phase. TDC/TDF connection system is not permitted.
 6. Final connections from sheet metal ductwork to terminal units shall be made with either insulated flexible duct, round ductwork or rectangular ductwork.
 Flexible ductwork shall not be used behind inaccessible hard-surface ceilings or sidewalls. Insulated flexible duct shall be Flexmaster Type 3M or approved equivalent. Interior liner shall be trilaminated aluminum foil, fiberglass, and aluminum polyester with a helix encapsulated in the fabric. Insulation shall be 1-½ inches fiberglass, compressed to 1 inch thick, and exterior jacket shall be a fire retardant, reinforced aluminum vapor barrier material. Duct shall be UL listed for Class 1 air duct and shall be suitable for operation at up to 12 inches water gauge and velocities to 4500 feet per minute. Flexible ducts shall be joined to rigid ducts and box inlets by metal or flexible drawband and duct mastic equivalent to “Ductmate”. Flexible ductwork shall conform to SMACNA “Duct Performance Standards for Flexible Duct”. Maximum flexible duct length: 5 feet.
 7. Leakage Class: Duct leakage shall meet SMACNA applicable leakage classes as listed in SMACNA Table 4-1 (reprinted below):

TABLE 4-1 APPLICABLE LEAKAGE CLASSES

Duct Class	Leakage Class – Rectangular	Leakage Class – Round
½ thru 2 inches water gauge	24	12
3 inches water gauge	12	6
4 inches thru 10 inches water gauge	6	3

8. Leakage Test: Ductwork from plus 2 inches water gauge to plus 10 inches water gauge, and from minus 2 inches water gauge to minus 10 inches water gauge pressure rating shall be leak tested in accordance with SMACNA HVAC “Air Duct Leakage Test Manual, First Edition, 1985”. Ductwork for section tested shall be tested at duct pressure rating. At this test pressure, the allowable system leakage shall meet the specified Leakage Class. When duct system is broken into convenient segments, allowable leakage must be apportioned to each segment.

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9. Reseal ductwork until satisfactory test results are obtained. Demonstrate to Engineer the leakage test after satisfactory test results are obtained.
 10. Regardless of test, audible leaks must be repaired.
 11. Leak tests shall include flexible ducts, connections to terminal boxes, air handling units, etc.
- D. Round Ductwork: Pressure rating from plus ½ inch water gauge to plus 1 inch water gauge, and from minus ½ inch water gauge to minus 1 inch water gauge:
1. Galvanized construction including sheet metal hangers and miscellaneous materials.
 2. Construction shall be in accordance with SMACNA-HVAC.
 3. Duct sealing shall meet SMACNA duct sealing requirements as listed in SMACNA Table 1-2 (reprinted below).
 4. Final connections from sheet metal ductwork to diffusers, registers, and grilles shall be made with either insulated flexible duct or round ductwork. Flexible ductwork shall not be used behind inaccessible hard-surface ceilings or sidewalls. Insulated flexible duct shall be Flexmaster Type 3M or approved equivalent. Interior liner shall be tri-laminated aluminum foil, fiberglass, and aluminum polyester with a helix encapsulated in the fabric. Insulation shall be 1-½ inches fiberglass, compressed to 1 inch thick, and exterior jacket shall be a fire retardant, reinforced aluminum vapor barrier material. Duct shall be UL listed for Class 1 air duct and shall be suitable for operation at up to 12 inches water gauge and velocities to 4500 feet per minute. Flexible ducts shall be joined to rigid ducts and box inlets by metal or flexible drawband and duct mastic equivalent to “Ductmate”. Flexible ductwork shall conform to SMACNA “Duct Performance Standards for Flexible Duct”. Maximum flexible duct length: 5 feet.
 5. Leakage Class: Duct leakage shall meet SMACNA applicable leakage classes as listed in SMACNA Table 4-1 (reprinted below).
- E. Round Ductwork: Pressure rating from plus 2 to plus 10 inches water gauge, and from minus 2 to 10 inches water gauge:
1. Galvanized construction including sheet metal hangers and miscellaneous materials.
 2. Construction shall be in accordance with SMACNA-HVAC for supply ductwork and return/exhaust ductwork to minus 3 inches water gauge Construction shall be in accordance with SMACNA-Industrial for return/exhaust ductwork from minus 4 inches water gauge to minus 10 inches water gauge
 3. Duct sealing shall meet SMACNA duct sealing requirements as listed in SMACNA Table 1-2 (reprinted below).

TABLE 1-2 DUCT SEALING REQUIREMENTS

Seal Class	Sealing Required Static Pressure Construction Class
A	All transverse joints, longitudinal seams and duct wall penetrations 4 inches water gauge thru 10”water gauge
B	All transverse joints and longitudinal seams 3 inches water gauge
C	Transverse joints 2 inches water gauge thru ½ inch water gauge

In addition to the above any variable air volume system duct of 1 inch and ½ inch water gauge construction class that is upstream of the VAV boxes shall also meet Seal Class C.

4. All duct joints shall be constructed with “Ductmate” round duct connector system.
5. Final connections from sheet metal ductwork to terminal units shall be made with either insulated flexible duct or round ductwork.
 Flexible ductwork shall not be used behind inaccessible hard-surface ceilings or sidewalls. Insulated flexible duct shall be Flexmaster Type 3M or approved equivalent. Interior liner shall be trilaminated aluminum foil, fiberglass, and aluminum polyester with a helix encapsulated in the fabric. Insulation shall be 1-½ inches fiberglass, compressed to 1 inch thick, and exterior jacket shall be a fire retardant, reinforced aluminum vapor barrier material. Duct shall be UL listed for Class 1 air duct and shall be suitable for operation at up to 12 inches water gauge and velocities to 4500 feet per minute. Flexible duct shall be joined to rigid ducts and box inlets by metal or flexible drawband and duct mastic equivalent to “Ductmate”. Flexible ductwork shall conform to SMACNA “Duct Performance Standards for Flexible Duct”. Maximum flexible duct length: 5 feet.
6. Leakage Class: Duct leakage shall meet SMACNA applicable leakage classes as listed in SMACNA Table 4-1 (reprinted below).

TABLE 4-1 APPLICABLE LEAKAGE CLASSES

Duct Class	Leakage Class – Rectangular	Leakage Class – Round
½ thru 2 inches water gauge	24	12
3 inches water gauge	12	6
4 inches thru 10 inches water gauge	6	3

7. Leakage Test: Ductwork from plus 2 inches water gauge to plus 10 inches water gauge, and from minus 2 inches water gauge to minus 10 inches water gauge pressure rating shall be leak tested in accordance with SMACNAHVAC “Air Duct Leakage Test Manual, First Edition, 1985”. Ductwork for section tested shall be tested at duct pressure rating. At this test pressure, the allowable system leakage shall meet the specified Leakage Class. When duct system is broken into convenient segments, allowable leakage must be apportioned to each segment.
8. Reseal ductwork until satisfactory test results are obtained. Demonstrate to engineer the leakage test after satisfactory test results are obtained.
9. Regardless of test, audible leaks must be repaired.
10. Leak tests shall include flexible ducts, connections to terminal boxes, air handling units, etc.

2.5 ALUMINUM DUCTWORK

- A. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts. Minimum thickness permitted shall be 22 gauge.
- B. Hangers, supports, reinforcements, etc. shall be constructed of aluminum or isolated from the aluminum with an epoxy paint finish.
- C. All other aspects of aluminum ductwork construction, etc. shall meet the requirements of Articles 2.1 through 2.4 above as described for galvanized steel construction.

2.6 STAINLESS STEEL LAB EXHAUST DUCTWORK

- A. Laboratory exhaust ductwork, where indicated on the plans, shall be minimum 16 gauge, Type 316 stainless steel with continuously welded joint and seam construction. Hangers, reinforcing, and flange angles shall be Type 304 stainless steel.
- B. Turning vanes, dampers, and other accessories exposed to the airstream shall be Type 316 stainless steel.

2.7 PVC LAB EXHAUST DUCTWORK AND FITTINGS

- A. Duct Sizes 4 inches diameter and larger: Trovidur Series 250, Type II, Grade I, PVC Class 14333-D, ASTM D- 1784. Compound shall include a UV inhibitor.
 - 1. All joints shall be welded using a hot gas method using PVC filler rod as manufactured for this purpose. All finished joints shall be completely air and water tight.
 - 2. Ducts shall be rated for minus 4 inches water gauge pressure and temperatures up to 140 degrees Fahrenheit.
 - 3. All changes in direction shall be made with factory fabricated fittings.
 - a. Elbows shall be continuous radius type with a centerline radius no less than 1.5 the duct diameter, or may be segmented type with a minimum of 5 sections per 90 degrees change in direction.
 - b. Branches shall enter mains at angles no exceeding 45 degrees.
 - c. Connections to metallic duct shall be made with flanged connections fitted with gaskets and stainless steel fasteners.
 - 4. Ducts and fittings shall be approved by the Facilities Manager. Flame spread rating not exceeding 14 when tested in accordance with ASTM E-84.
 - 5. Duct shall be fabricated, reinforced, installed, and sealed in accordance with the requirements and recommendations of the SMACNA Thermoplastic Duct Construction Manual, latest edition.
 - 6. Hangers and supports shall not cut, gouge, or otherwise damage the ductwork.
 - 7. Acceptable Manufacturer Viron International Corporation or approved equal.
- B. Duct sizes 3 inches diameter and smaller: PVC piping used for exhaust ductwork shall be PVC Schedule 40 pipe shall be Iron Pipe Size (IPS) conforming to ASTM D 1785. PVC Schedule 40 DWV fittings shall conform to ASTM D 2466. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer. Installation shall comply with the latest installation instructions published by the manufacturer. Solvent cement joints shall be made in a two-step process with primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D 2564. Connections between PVC and metal ductwork shall be made with flanged fittings. Changes in direction shall be made with large radius ell fittings.
- C. PVC duct materials shall not be installed in an air plenum unless provided with a 2-hour rated, UL-listed blanket insulation system. Fire rated blankets are specified in other Division 23 sections.

2.8 DUCT SEALANT

- A. Duct sealant shall be provided to meet seal class requirements listed elsewhere in this sections.
- B. Sealant shall be Childers CP 146 or approved equivalent by Foster or Carlisle.

2.9 SLEEVES

- A. Provide sleeves for ducts passing through roofs, walls, floors and partitions.
- B. Sleeve material shall be 20 gauge galvanized steel except for fire walls and smoke barriers which shall be 16 gauge galvanized steel.
- C. Sealant shall be equivalent to Dow Corning 795 Silicone Sealant for general purpose use. Prime sleeves in accordance with manufacturer's recommendations.
- D. Sealant in one-hour and two-hour walls shall be equivalent to Dow Corning Fire Stop System Sealants and Foams. Sealants and foams shall be UL listed and installed in accordance with Manufacturer's recommendations.

PART 3: EXECUTION

3.1 GENERAL

- A. Ductwork construction shall be in strict accordance with the SMACNA-HVAC Standards including ductwork gauges, bracing, reinforcement, joints, seams, hanging, and construction.
- B. The drawings schematically indicate the size and location of ductwork. Ductwork system layout shall be modified as required to meet field conditions and facilitate coordination at no additional cost. Unless otherwise noted, ductwork, dampers and associated fittings shall be concealed behind walls or above ceilings.
 - 1. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09, Section 099100: Painting.

3.2 HANGING AND SUPPORTING

- A. Unless otherwise indicated or specified, install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards–Metal and Flexible".
 - 1. Supporting ductwork and associated equipment from roof and floor decking is prohibited. All ductwork and associated equipment shall be supported from building structural system.
- B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 2 feet.
- D. Install upper attachments to building structural system. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- E. Install concrete inserts before placing concrete.
- F. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3.3 PRESSURE TESTING

- A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.
- B. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.
- D. Maximum Allowable Leakage: As per SMACNA standards and Part 2 of this specification.
- E. Remake leaking joints and retest until leakage is less than maximum allowable.
- F. Leakage Tests: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual" except where these specifications exceed SMACNA requirements.
 - 1. Outdoor air supply and exhaust ductwork, and heat pump supply ductwork shall be leak pressure tested. The duct wall square footage of the amount tested shall be no less than 50 percent of the total installed duct wall area of these types of ducts, except that 100 percent of exterior ductwork shall be tested.

3.4 INDOOR AIR QUALITY MANAGEMENT DURING CONSTRUCTION

- A. The Contractor shall protect duct interiors from moisture, construction debris and dust, and other foreign materials. The Contractor shall comply with "Advanced Level" duct cleanliness procedures as defined by SMACNA "Duct Cleanliness for New Construction Guidelines", 2000 edition. The Contractor shall take great care to thoroughly clean and wipe-down all HVAC system components and ductwork above prior and during installation. Where duct systems have not been wiped down before and during installation or where visual contaminants are found from a duct wipe-down inspection by the Owner or Architect after installation, the Contractor shall clean the entire ductwork system with a vacuum cleaning method in compliance with the latest NADCA Standard "Mechanical Cleaning Methods of Non-Porous Air Conveyance System Components".
- B. Delay the start-up of permanent ductwork systems until construction activities that generate large amounts of indoor or exterior airborne particulates have been completed.
- C. During ductwork system installation, keep open ends of ductwork and terminations at registers, grilles, and diffusers sealed off and closed to prevent entrance of dirt and debris.
- D. Operation of the permanent systems shall not occur prior to the duct systems being fully insulated and sealed.
- E. Operation of the permanent systems prior to completion of final cleaning of the building by the General Contractor shall only occur with minimum ASHRAE 52.2 – MERV 8 filter media secured and sealed to each return or exhaust air grille or register.
 - 1. Outdoor air intakes require an equivalent treatment if outdoor construction activities involve site work generating airborne dust and dirt.

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3.5 START UP

- A. Air Balance: Comply with requirements in Division 23, Section 230593: Testing, Adjusting, and Balancing.
- B. Testing and Balancing shall not occur until the construction environment is free air airborne particulate, and final cleaning operations are completed by the General Contractor, such that all temporary filters installed on return grilles for the purpose of complying with indoor air quality management provisions can be removed.

3.6 DUCT CONNECTOR SYSTEM

- A. Except for lab exhaust ductwork, on ductwork having pressure ratings from plus 2 inches water gauge to plus 10 inches water gauge and from minus 2 inches water gauge to minus 10 inches water gauge, the duct connector system installed at all transverse duct joints shall be applied in full conformance with the system manufacturer's installation instructions and with all required sealants, gaskets, bolts and spring clips. Substitution of zip screws for spring clips will not be permitted.

3.7 SLEEVES

- A. Provide ½ inch clearance between duct or duct insulation and sleeve. Install sleeves in time to permit construction progress as scheduled. Grout sleeves to building for watertight fit.
- B. Schedule of Sleeve Lengths
 - 1. Location Sleeve Length:
 - a. Walls and Partitions Equal to depth of construction and terminated flush with finished surfaces.

C. Schedule of Sleeve Caulking and Packing Type

- 1. Caulking/Packing Type Caulking/Packing Requirements:

A	Caulking not required.
B	Space between duct or duct covering and sleeve shall be vermin proof sealant.
C	Space between duct and sleeve shall be packed with industrial felt or fiberglass caulked at both ends with sealant according to manufacturer's recommendations. Vermin proofing for ducts with insulation shall be minimum 1 inch thick sections of foam glass as long as sleeve with space between foam glass and sleeve packed with industrial felt or fiberglass caulked at both ends with sealant in accordance with manufacturer's recommendations.

D. Schedule of Sleeve Applications

Sleeve Caulking and Packing Location Type

3.8 DUCT HANGERS AND SUPPORTS

- A. Duct Hanger Support Schedule Building Construction Duct Support Method:

Concrete slabs “Phillips” or “Hilti” expansion bolts and shields with main supports welded to structural steel at maximum 20 feet on center 4 inches by 4 inches by ¾ inch thick clip knee angles with ¾ inch expansion bolt in shear (horizontal) or supporting rod at 90° from anchor bolt attached to concrete beams or columns

- B. Duct supports shall be spaced in accordance with SMACNA guidelines. Submit shop drawings of support type and spacing.

3.9 STAINLESS STEEL DUCTWORK

- A. Weld seams, joints, etc., to provide a watertight seal. Welding process shall be suitable for stainless steel. Provide means to prevent warpage during and after welding.
- B. For exposed ductwork, remove weld discoloration and deposits on ductwork using cleaner intended for this purpose. Do not wire brush or steel wool. Grind and polish welds to provide a smooth appearance.
- C. Watertight bolted gasket connections shall be provided at connections to fans, hoods and other equipment (only). Flange gaskets shall be butyl rubber or EPDM polymer with polyisobutylene plasticizer.

3.10 FLEXIBLE DUCTWORK

- A. Seal insulation at both ends to maintain insulation and vapor barrier continuity. Do not kink flexible ducts. Supports ducts with galvanized hangers to avoid sagging.
- B. Flexible connections shall not be used on lab exhaust systems. All exhaust system connections shall be hard duct connections.
- C. Exposed supply ductwork spaces shall have hard duct connections. Flexible connections are only permitted above acoustical ceilings.

END OF SECTION 233113

SECTION 233300 – DUCT ACCESSORIES

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.

1.1 SUMMARY

A. Section includes:

1. Acoustic Duct Liner
2. Backdraft Dampers
3. Manual Volume Dampers
4. Fire Dampers
5. Smoke Dampers
6. Combination Fire and Smoke Dampers
7. Flange Connectors
8. Supply Duct Silencers
9. Stainless Steel Packless Silencers
10. Laboratory Stacks with Silencers
11. Turning Vanes
12. Duct-Mounted Access Doors
13. Flexible Connectors
14. Flexible Ducts
15. Louvers
16. Fume Arms (Snorkels)
17. Duct Accessory Hardware
18. Remote Cable Damper Operators

B. Related sections:

1. Division 26 for duct-mounted fire and smoke detectors
2. Division 25 for control dampers

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated:
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories, include plans, elevations, sections, details and attachments to other work:
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings
 - b. Manual volume damper installations
 - c. Control damper installations
 - d. Fire-damper, smoke-damper, combination fire-and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems,” and with NFPA 90B, “Installation of Warm Air Heating and Air Conditioning Systems”.
- B. Comply with AMCA 500-D testing for damper rating.

1.4 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.
 - 2. Combination Fire-Smoke damper and Smoke damper actuators: One (1) of each type/model installed.

PART 2: PRODUCTS

2.1 GENERAL MATERIALS

- A. Comply with SMACNA's “HVAC Duct Construction Standards – Metal and Flexible” for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90 for materials not exposed to the weather; G115 for materials installed outdoors
 - 2. Exposed-Surface Finish: Mill phosphatized
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Stainless Steel: Comply with ASTM A 480/A 480M, Type 316.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel or stainless steel to match the associated ductwork
 - 1. ¼-inch minimum diameter for lengths 36 inches or less
 - 2. ⅜-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

- A. Acoustic duct lining shall consist of glass fiber blanket of 1-½ pound per cubic foot density. The airstream surface shall be protected against erosion with reinforced coating or mat-facing. Insulation edges shall be treated with a factory-applied coating to prevent surface flaring. Duct dimensions given on the drawings for lined ductwork are inside clear dimensions. Sheet metal sizes must be increased to allow for the thickness of the insulation.
- B. Minimum Thickness: 1 inch for return ducts, ½ inches for transfer ducts, and 1 ½ inches for supply ducts.
- C. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B, FHC 25/50 and Limited Combustibility. The airstream surface shall be treated with an EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22. The duct lining should be rated for air velocities up to 6000 feet per minute and air temperatures up to 250 degrees Fahrenheit.
- D. Acoustic duct lining shall have a maximum thermal conductivity (k) of .25 BTU/(hr·ft²·°F) at 75 degrees Fahrenheit mean temperature, and an NRC not less than 0.70 as tested per ASTM C 423 using Type “A” mounting.
- E. Acoustic duct lining shall be installed in strict accordance with SMACNA Duct Construction Standards and NAIMA Duct Liner installation Standards. The liner shall be adhered to the sheet metal with full coverage of an approved adhesive conforming to ASTM C 916. All cut edges shall be field coated with a factory supplied edge treatment. Seams are to be neatly butted and fitted without gaps. Duct liner shall be additionally secured with mechanical fasteners spaced per the manufacturers’ recommendations. Metal nosing shall be provided over transversely oriented liner edges facing the airstream at fan discharges, access doors, and any other exposed edge conditions.

F. Manufacturers:

1. Knauf Duct Liner EM
2. Manville Linacoustic RC
3. Certainteed ToughGard R.

2.3 BALANCING DAMPERS

- A. Balancing dampers for rectangular ductwork shall be opposed blade type, and shall be Ruskin Model MD35 Manual Balancing Damper with Locking Quadrant or equivalent for duct pressure ratings 2 inches water gauge or less, and Ruskin Model CD30AF1 with Locking Quadrant or equivalent for duct pressure ratings greater than 2 inches water gauge
- B. Balancing dampers for round ductwork shall be Ruskin Model MDRS25 Round Manual Balancing Damper with Locking Quadrant, or equivalent.

2.4 FIRE DAMPERS

- A. Fusible link dampers shall be of the folding blade type, shall meet the requirements of NFPA Bulletin 90A, and shall be UL listed and tested in accordance with UL 555 test criteria. Provide fire dampers UL listed for installation in 1-½ hour or 2-hour fire separations or divisions.
- B. Fire dampers for vertical installation shall be gravity operated. Fire dampers for horizontal installation shall have closure springs and latches.
- C. Fire dampers shall have re-settable reusable fire link rated at 165 degrees Fahrenheit.
- D. Fire dampers installed in ductwork shall be Ruskin Model IBD2, Style C, CR, or CO to match duct shape, or equivalent. Maximum pressure drop: 0.05 inches water gauge at 1500 feet per minute face velocity.
- E. All small combination fire dampers (under 16 inches in height) shall be oversized by 2 inches in height and transitioned down to duct size to maximize free area. Openings in fire and smoke separations shall be oversized accordingly to accommodate larger duct work. Where it is impossible to oversize the duct/opening, then a flat top and bottom frame style shall be used on all small combination fire/smoke dampers.
- F. Fire dampers shall be constructed for 350 degrees Fahrenheit temperature rating, dynamically rated for a velocity of 3000 feet per minute (minimum), and pressure levels of 6 inches water gauge or 4 inches (minimum) to match duct system static pressures and velocities in which they are installed. Acceptable Manufacturers Ruskin, Prefco, National Control Air, Safe-Air, Greenheck, Pottorff.

2.5 DUCT ACCESS DOORS

- A. In general, access doors shall be at least 18 inches by 18 inches where physically possible; access doors for fire dampers shall be sized in accordance with the fire damper size.
- B. Access doors shall be of double construction and shall be gasketed around the entire perimeter to minimize air leakage between door and frame. Access doors in insulated ducts or casings, and fire damper access doors, shall be fully insulated with rigid fiberglass insulation between the metal panels.
- C. In no case shall access to any items of equipment require the removal of nuts, bolts, screws, wedges or any other loose devices.

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- D. Access doors installed in ductwork 2 inches water gauge class and below shall be Ruskin Model ADH22, or equivalent.
- E. Access doors installed in ductwork above 2 inches water gauge class shall be Ruskin Model ADHP-3 High Pressure Access Doors, or equivalent.
- F. Acceptable Manufacturers:
 - 1. Ruskin
 - 2. Nailor
 - 3. Louvers and Dampers (Division of Mestek Inc.)

2.6 FLEXIBLE CONNECTIONS

- A. Flexible connections shall be a minimum of 8 inches long.
- B. Flexible connection shall be fabricated from approved flame-proofed fabric in accordance with the applicable sections of the NFPA overall fire codes. Asbestos cloth is not permitted.
- C. Flexible connections on EF-1A, 1B, 2, 3A, 3B, 4A, and 4B shall have a pressure rating of at least plus/minus 2 pounds per square inch gauge. Such flexible connections shall be Proco Style 520, U-design, Neoprene material.

2.7 BACKDRAFT DAMPERS

- A. Dampers shall be pressure activated, vertical air flow with face linkage and an adjustable counter weight, with a range of positive pressure from .02 to .25 inches water gauge
- B. For the backdraft dampers installed on the inlet ducts of EF-1A, 1B, 3A, 3B, 4A, and 4B: 6063 T6 extruded aluminum hat channel frame, .080 inches thick. Teardrop shaped extruded aluminum blades (6063 T6 AL) with silicone rubber blade edge seals. ½” diameter aluminum shafts pin-locked to frame and positively locked to blades. Construction shall be suitable for 6 inches water gauge differential pressure and 3500 feet per minute velocity. Static pressure drop at 2000 feet per minute shall not exceed 0.13 inches water gauge
- C. Damper shall be Arrow United Industries Model ‘850 feet or approved equal.
- D. For all other applications: The damper frame shall be constructed of .090 inch thick extruded aluminum. Blades shall be formed from .025 inch aluminum. Blades shall have overlapping edges with extruded vinyl edge seals.
- E. Damper shall be Ruskin Model CBD2, or equivalent.
- F. Backdraft dampers associated with EF-8A and EF-8B shall be of type 304 stainless steel construction (including the frame, blades, axles, and linkage) with polyurethane blade seals and suitable for no less than 1500 feet per minute and 2 inches water gauge differential pressure, equal to Arrow Model Series 503. Dampers shall have an adjustable counterbalance to assist opening.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Maximum pressure drop for damper assembly shall be 0.05 inches water gauge at 1500 feet per minute duct face velocity.

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- B. Dampers shall be UL listed and tested in accordance with UL 555 test criteria and shall be further qualified under UL 555S as a leakage rated damper for use in smoke control systems. The leakage rating shall be no higher than Class 1 (4 cubic feet per minute/square feet at 1 inch water gauge) at 250 degrees Fahrenheit elevated temperature category. UL leakage ratings shall apply to sizes of dampers required herein, and elevated temperature ratings shall apply to operators as well as dampers.
- C. Each combination fire and smoke damper shall be equipped with a UL classified firestat which shall function to close damper when duct temperature exceeds 165 degrees Fahrenheit. Firestat package shall include two (2) damper position indicator switches, both linked directly to a damper blade, to provide capabilities of remotely indicating damper position. Firestat and damper position indicators shall have capability of interfacing electrically with smoke detectors, building fire alarm systems and remote indicating/control stations. Motor operator shall be 120 volts electric actuated normally closed.
- D. Motor damper and firestat assembly shall have maximum draw of 30 watts under opening conditions.
- E. Furnish a switch package to remotely monitor damper position.
- F. Firestat position indicator shall have capabilities of electrically locking damper in a closed position whenever duct temperatures exceed 165 degrees Fahrenheit and the capability of permitting appropriate authority to override the smoke detector and re-open damper as may be required to permit desired smoke control functions only. Damper shall remain closed when firestat temperature is above 165 degrees Fahrenheit.
- G. All small combination fire/smoke dampers (under 16 inches in height) shall be oversized by 2 inches in height and transitioned down to duct size to maximize free area. Openings in fire and smoke separations shall be oversized accordingly to accommodate larger duct work. Where it is impossible to oversize the duct/opening, then a flat top and bottom frame style shall be used on all small combination fire/smoke dampers.
- H. Combination motor/fire dampers shall be Ruskin FSD60 or equivalent.
- I. Firestat shall be Ruskin Model TS150 or equivalent.
- J. Equivalent Manufacturers Ruskin, Prefco, National Control Air, Safe-Air, Greenheck.

2.9 SMOKE DAMPERS

- A. Maximum pressure drop for damper assembly shall be 0.05 inches water gauge at 1500 feet per minute duct face velocity.
- B. Dampers shall be UL listed and tested in accordance with UL 555 test criteria and shall be further qualified under UL 555S as a leakage rated damper for use in smoke control systems. The leakage rating shall be no higher than class 1 (4 cubic feet per minute/square feet at 1 inch water gauge) at 250 degrees Fahrenheit elevated temperature category. UL leakage ratings shall apply to sizes of dampers required herein, and elevated temperature ratings shall apply to operators as well as dampers.
- C. Motor operator shall be 120 volts electric actuated normally closed.
- D. Motor damper assembly shall have a maximum draw of 30 watts under opening conditions.
- E. Furnish a switch package to remotely monitor damper position.
- F. All small smoke dampers (under 16 inches in height) shall be oversized by 2 inches in height and transitioned down to duct size to maximize free area. Openings in fire and smoke separations shall be oversized accordingly to accommodate larger duct work. Where it is impossible to oversize the duct/opening, then a flat top and bottom frame style shall be used on all small smoke dampers.

- G. Smoke dampers shall be Ruskin SD60 or approved equivalent.
- H. Equivalent Manufacturers Ruskin, Prefco, National Control Air, Safe-Air, Greenheck.

2.10 SUPPLY AIR DUCT SILENCERS

- A. Provide duct silencers as shown and scheduled on the drawings.
- B. Supply Duct Silencers:
 - 1. Sound attenuator casing shall be minimum 22 gauge galvanized steel outer casing, minimum 26 gauge galvanized steel inner partitions. Seams shall be lock formed and mastic filled.
 - a. If sound attenuators are located in a duct system specified as stainless steel, the sound attenuator shall also be stainless steel.
 - 2. Filler material shall be of inorganic mineral or glass fiber of density sufficient to obtain the specified performance. Filler material shall be packed under not less than 5 percent compression to eliminate voids due to vibration and settling. Materials shall be inert, vermin and moisture proof.
 - 3. Combustion rating for acoustical fill when tested in accordance with ASTM 84, NFPA 255 or UL No. 723 shall not be less than the following:

Flame Spread Classification	25
Smoke Development Rating	15
Fuel Contribution	20
- C. Stainless Steel Rectangular Packless Silencers:
 - 1. Sound attenuator casing shall be minimum 22 gauge 304 stainless steel outer casing, minimum 26 gauge 304 stainless steel inner partitions. Seams shall be lock formed.
 - 2. The silencer elements shall not contain absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- D. Elbow Silencer Special Requirements: All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48 inches shall have at least two half splitters and one full splitter.
- E. Sound attenuators shall not fail structurally when subjected to a differential static pressure of 8 inches water column.
- F. The manufacturer shall provide certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance for reverse and forward flow conditions with submittals. Test data shall be for a standard product.
- G. Manufacturers IAC, Vibro-Acoustics, Semco, or Gale.

2.11 LABORATORY EXHAUST STACKS WITH SILENCERS

- A. All circular stacks with silencers shall be constructed of minimum 16 gauge type 316 or 304 stainless steel outer casings. Casings shall be internally reinforced as required for a wind loading of 120 miles per hour with 316 stainless steel materials. Guy wires and shall be attached to the building structure.

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1. Manufacturer shall provide structural calculations to demonstrate that the stack, curb base support, and guy wire design is sufficient for the specified design conditions.
- B. The stack/silencer assembly shall consist of a structural base section, a lower support section with side breeching connection to receive the fan discharge, and a curb cap. Stack silencer shall be supplied with a companion roof curb and flexible seal. The stack and roof curb interface shall be designed to accommodate normal stack deflections. The stack silencer assembly shall extend a minimum of 15 above the finished roof surface.
- C. The stack shall be complete with a 316 or 304 stainless steel breeching duct extension which shall be site welded to the breeching opening and is flanged for bolting to the fan discharge ducting.
- D. Stack shall have internal tapering outlet to provide minimum 3000 feet per minute outlet velocity. Exterior of stack shall be maintained flush to the top of stack
- E. The assembly shall be supplied with factory drilled 316L stainless steel connection flanges, reinforced as required to meet wind loading requirements, and lifting lugs. All external casing seams and joints shall be continuously welded using butt welds.
- F. The stack and silencer exterior finish shall be a 2B mill finish with all welds ground smooth. After fabrication, the exterior shall receive a white metal blast with sand or glass beads, as selected by the Engineer. Finish samples shall be provided to the Engineer for review and selection. Silencers shall be factory packaged to prevent damage and marring of the exterior finish during shipment and handling.
- G. Silencer elements shall incorporate fiberglass absorptive media protected by mylar or teldar encapsulation.
 1. No media splitters shall be full height with panel-type construction. Splitter framing shall be 16 gauge, type 316 stainless steel with supplemental structural reinforcement as required to meet the specified wind loading. Perforated liner shall be minimum 26 gauge, perforated 316 stainless steel. Splitters shall span the full diameter of the silencer without internal gap partitions or spacers.
 2. Splitters must be oriented perpendicular to the fan shaft.
 3. All perforated steel shall be adequately stiffened to insure flatness and form.
 4. Stack silencer dynamic insertion loss shall not be less than that listed in the silencer schedule.
 5. Stack silencer generated noise shall not be greater than 68 decibels A-scale.
 6. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
 7. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
 8. Noise level at top of stack, including airborne noise and radiated noise, shall not exceed 75 decibels A within a 1 meter sphere centered on the midpoint of the stack outlet.
 9. Silencer pressure drops shall not exceed those listed in the silencer schedule. Silencer pressure drop measurements shall be made in accordance with the ASTM E477-06a test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

2.12 TURNING VANES

A. Manufacturers:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Metalaire, Inc.
4. SEMCO Incorporated
5. Ward Industries, Inc., a division of Hart & Cooley, Inc.

B. Turning Vanes for Metal Ducts shall be curved blades of sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Materials shall match those specified for the ducts.

C. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows".

D. Vane Construction shall be single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.13 FLEXIBLE DUCTS

A. Insulated, flexible duct shall be UL 181, Class 1; multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylenized vapor-barrier film.

1. Pressure Rating: 10 inches water gauge positive and 1 inch water gauge negative
2. Maximum Air Velocity: 4000 feet per minute
3. Temperature Range: Minus 20 to plus 210 degrees Fahrenheit

B. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action to suit duct size and adhesive mastic.

C. Acceptable Manufacturers:

1. Flexmaster U.S.A.
2. McGill AirFlow LLC
3. Hart and Cooley
4. The Wiremold Company

2.14 REMOTE DAMPER OPERATORS

- A. Manufacturers subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff; a division of PCI Industries, Inc.
 - 2. Ventfabrics, Inc.
 - 3. Young Regulator Company
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass
- D. Cable: Stainless steel

2.15 LOUVERS

- A. Louvers shall be stationary drainable blade type constructed of extruded aluminum. Louver frame shall be 6 inches deep box type, constructed of 0.125 inch (minimum) thick aluminum. Louver blades shall be 0.125 inch thick aluminum.
- B. Louvers shall have an integral color anodized finish. Color shall be selected and approved by Architect.
- C. Provide aluminum bird screen.
- D. Provide extended sill and clip angles for each louver.
- E. Manufacturers Ruskin, National Control Air, American Warming.

2.16 EXHAUST FUME ARMS (SNORKELS):

- A. Fume arms shall be constructed of three sections of anodized aluminum tubing connected to glass fiber reinforced polypropylene elbows with aluminum rivets. Elbows shall have friction-adjustable knobs and a stainless steel threaded shaft and internal spring. Anodizing on tubing shall be no less than 10 microns thick. Provide integral balancing damper, wall or ceiling support bracket (as indicated on the drawings), and clear plastic rectangular inlet hood.
- B. Snorkel arm shall be Nederman 'FX-CHEM' series (with a 3 inches or 4 inches diameter connection as indicated on the drawings) with 'combination' hood, or approved equal.

2.17 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.18 CUSTOM FABRICATED CANOPY HOOD

- A. Where indicated on the drawings, provide custom fabricated exhaust hoods constructed of a continuously welded, minimum 18 gauge Type 304 or 316 stainless steel with a No. 3 finish. All welded seams and joints shall be ground smooth. The seams on the canopy shall be welded liquid-tight. Each hood shall be constructed to the dimensions indicated on the drawings and provided with a round or rectangular duct collar connection as indicated. Provide a brace near the bottom of the hood secured to the wall to provide lateral stability of the hood. Exposed hangers, brackets, and braces shall be Type 304 Stainless steel. Provide chromed steel escutcheons at the ceiling penetration of the connecting duct and support hangers.

PART 3: EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for metal ducts.
- B. Install flexible duct with a maximum of one 90 degree bend. Install in accordance with Air Diffusion Council (ADC) Publication "Flexible Duct Performance and Installation Standards", 4th Edition.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and aluminum accessories in aluminum ducts.
- D. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated.
- H. Install fire, smoke, and combination fire-smoke dampers according to UL listing.
- I. Connect ducts to duct silencers rigidly.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils
 - 2. Downstream from manual volume dampers, control dampers, turning vanes, and equipment
 - 3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links (Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.)
 - 4. At each change in direction and at maximum 50 feet spacing

5. Upstream of turning vanes
 6. Elsewhere as indicated
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
1. Provide duct access doors not smaller than 18 inches by 18 inches. Provide ducts smaller than 18 inches in width with access doors two inches less in width than the width of the duct. Minimum dimension of one side to be 18 inches.
- M. Label access doors according to Division 23, Section 230553: Identification for HVAC to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5 inches water gauge and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Connect terminal units to supply ducts directly.
- Q. Connect diffusers to low-pressure ducts with maximum 72 inches lengths of flexible duct clamped and sealed in place. If a shorter, upper limit on the allowable length of flexible duct is noted on the drawings, the limit noted on the drawing shall take precedence over the herein described 72 inches limit.
- R. Connect flexible ducts to metal ducts with worm gear clamps and adhesive mastic.
- S. Install duct test holes where required for testing and balancing purposes.
- T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of ¼-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233416 – HVAC FANS

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 the following:
 1. Housed Centrifugal Fans
 2. Square In-Line Centrifugal Fans
 3. Power Roof Ventilators

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan performance ratings on sea level.
- B. Operating Limits: Classify according to AMCA 99.
- C. Catalog rated for 15 percent greater static pressure than specified at air volume, selected so that the specified air volume is greater than that at the apex of the fan pressure volume curve, and selected to provide stable operation down to 85 percent of design volume operating at the required speed for the specified conditions.
- D. Brake horsepower for backward inclined bladed centrifugal fans shall not exceed 78 percent of motor nameplate horsepower times the NEMA service factor, and for forward curved bladed centrifugal fans shall not exceed 70 percent at specified duty.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 1. Certified fan performance curves with system operating conditions indicated
 2. Certified fan sound-power ratings
 3. Motor ratings and electrical characteristics, plus motor and electrical accessories
 4. Material thickness and finishes, including color charts
 5. Dampers, including housings, linkages, and operators
- 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.

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1. Wiring Diagrams: Detail power, signal, and control wiring.
 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
- C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- D. Field quality-control test reports
- E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals

1.5 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Belts: Two sets for each belt-driven unit

PART 2: PRODUCTS

2.1 GENERAL

- A. Fan performance data shall be AMCA certified for sound and air performance.
- B. Fans shall be provided complete with motors and drives. Belt drive fans shall be provided with belt guards meeting OSHA requirements. Belt guards shall allow speed measurement at both fan and motor without removing guard. Each fan shall include an allowance for one pulley and belt change during balancing procedures.
- C. Provide appropriate weather covers for motors and belts where fans are exposed to weather.
- D. Fans shall be balanced statically and dynamically for maximum rated speed.
- E. Submit fan volume-pressure-horsepower curves for approval as indicated under shop drawings.

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- F. Bearings shall be ball or roller anti-friction type with minimum L10 life of 80000 hours.
- G. Where internal coating is indicated, factory apply the coating to all interior surfaces including dampers, screens, curbs, in contact with air stream. Use Type 316 stainless steel in lieu of coating at supplier's option or where required for component operation. Utilize one of the following coatings:
 - 1. Baked Heresite Phenolic P413, minimum 7 mils thickness. Prepare steel surfaces according to SSPC-SP10.
 - 2. Glidden SP24-CE double built epoxy, minimum 10 mils thickness. Prepare steel surfaces by sandblasting per Steel Structure Painting Council Std. SP10-63 (near white).
- H. Lubricate bearings for extended shutdown or storage and rotate shafts every four weeks until fans are put into permanent operation.
- I. Fans with motor operated dampers shall have access doors for access to both damper and motor.
- J. Drives shall be selected for a 1.5 service factor. Drives for motors over 3 horsepower shall be a minimum of two belts. Provide an allowance of one sheave change for balancing.

2.2 PRESSURE RATING

- A. Refer to Division 23, Section 233113: HVAC Ducts for component and equipment ratings. All components, equipment, and specialties, etc., shall meet the component pressure rating listed.

2.3 CENTRIFUGAL FANS

- A. Backwardly inclined or airfoil blade single inlet type as scheduled equivalent to Greenheck Series 41. Fan shall be single width or double width as indicated on the drawings. Scroll and housing shall have fully welded seams. Structural fan base with vibration isolation provided between the base and the roof support rails.
 - 1. Equip fan with scroll access door (provide means to raise door for insulated fan), scroll drain, and extra set of drive belts.
 - 2. Stainless steel shaft and extended lube lines for bearings.
 - 3. Unit mounted combination magnetic motor starter/disconnect switch (except where VFDs control is indicated, only provide unit mounted disconnect switch).
- B. Exterior fans shall be provided with a weather hood over motor and drive.
- C. AMCA spark resistant construction as scheduled.
- D. Fan shall be Arrangement 10, Class II or III as required by the scheduled conditions. Refer to drawings for fan configuration and pattern.
- E. Drives shall be selected for a 1.5 service factor.
- F. Approved Manufacturers:
 - 1. Greenheck
 - 2. Buffalo Forge

3. Twin City Fan
4. New York Blower

G. No Loren Cook fans are to be used.

2.4 SQUARE IN-LINE CENTRIFUGAL VENTILATORS

- A. Description: In-line, direct or belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories
- B. Fan Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting
- C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing with wheel, inlet cone, and motor on swing-out service door
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent
(Provide for direct drive fans only.)
 2. Companion Flanges: For inlet and outlet duct connections.
 3. Fan Guards: ½ by 1 inch mesh of galvanized steel in removable frame
(Provide guard for inlet or outlet for units not connected to ductwork.)
 4. Motor and Drive Cover (Belt Guard): Epoxy-coated or galvanized steel
 5. Non-fused NEMA 1 manual disconnect switch. Single-pole rocker switch assembly with cover and pilot light

2.5 POWER ROOF VENTILATORS

- A. Centrifugal power roof ventilator with single inlet riveted aluminum fan wheel, belt or direct drive as scheduled, and downblast or upblast as scheduled, equal to Greenheck G/GB and CUE/CUBE series
- B. Spun aluminum or fire resistant molded reinforced fiberglass housing, removable for access to fan and drive with wiring channel; motor and drive in ventilated compartment, out of main air stream, integral discharge damper
- C. Non-overloading fan, screw or automatic adjustment of belt tension, shaft seal, disconnect switch factory wired to motor, integral fan and motor vibration isolators
- D. Prefabricated 18 gauge galvanized steel roof curb with built-in cant strip, 2 inches minimum thickness internal insulation, inside vapor barrier cover, isolation pads to be provided

E. Manufacturers:

1. Cook
2. Twin City
3. Greenheck

2.6 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, “Methods for Calculating Fan Sound Ratings from Laboratory Test Data”. Factory test fans according to AMCA 300, “Reverberant Room Method for Sound Testing of Fans”. Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, “Laboratory Methods of Testing Fans for Rating”.

PART 3: EXECUTION

3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Support roof-mounting units using isolation specified in Division 23, Section 230548: Vibration Controls.
- C. Install units with clearances for service and maintenance.
- D. Label fans according to requirements specified in Division 23, Section 230553: Identification for HVAC.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23, Section 233300: Duct Accessories.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- D. Ground equipment according to Division 26.
- E. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

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3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Refer to Division 23, Section 230593: Testing, Adjusting, and Balancing for testing, adjusting, and balancing procedures.
 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 01.

END OF SECTION 233416

SECTION 233600 – AIR TERMINAL UNITS

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 the following:
 - 1. Single Duct Variable Volume Terminal Units

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01.
- 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. NFPA Compliance: Install air terminal units according to NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems”.
- D. All performance ratings (including pressure drop, sound levels, fan and heating coil performance) shall be shall be ARI certified.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound- power ratings, and accessories.
 - 1. Air terminal units
 - 2. Liners and adhesives
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring
 - 3. Hangers and supports, including methods for duct and building attachment and vibration isolation
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members
2. Size and location of initial access modules for acoustic tile
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings

D. Operation and Maintenance Data including:

1. Instructions for resetting minimum and maximum air volumes
2. Instructions for adjusting software set points

1.5 COORDINATION

- E.** Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2: PRODUCTS

2.1 GENERAL

- A.** Unit size, capacities, and minimum and maximum settings are as indicated on the drawings. All performance data will be certified in accordance with ARI Standard 880.
- B.** Terminal unit discharge sound power levels shall not exceed NC 35 in the room when delivering design cubic feet per minute at 1 inch water gauge static pressure across the unit. Discharge sound power level indicated is based on 10 decibels room minus 12 absorption, RE 10 watts and 5 feet long internally insulated discharge duct.
- C.** Terminal unit radiated sound power levels shall not exceed NC 35 in the room when delivering design cubic feet per minute at 1.0 inches water gauge static pressure across the unit. Sound power level indicated is based on a 10 decibels room minus 12 absorption, RE 10 watts and a ceiling sound transmission Class 35-39.
- D.** At 1.5 inches water gauge static pressure, unit casing leakage shall not exceed 1 percent of nominal terminal unit air volume for units below 800 cubic feet per minute and .5 percent for remaining terminal units.
- E.** At 1.5 inches water gauge static pressure, unit damper leakage shall not exceed 2 percent of nominal terminal unit air volume for units below 800 cubic feet per minute and 1 percent for remaining terminal units.

2.2 SINGLE DUCT VARIABLE VOLUME TERMINAL UNIT

- A.** Single duct variable or constant volume terminal unit shall be pressure independent. Maximum pressure drop for any size unit shall be the lesser of 0.20 inches water gauge static pressure or as indicated on the drawings.
- B.** Unit shall be complete with inlet flow sensor which shall compensate for flow conditions. Unit casings shall be galvanized steel, internal rigid fiberglass insulation which complies with NFPA-90A and UL 181; all cut edges of insulation shall be sealed from the airstream using metal brackets to meet the erosion protection requirements of NFPA-90A. Terminal unit fiberglass insulation shall be protected with foil laminated to the fiberglass.

- C. Volume regulator damper shall be heavy gauge metal with self-lubricating bearings. Damper shall have built-in stop to prevent over-stroking and shall seal against a low leakage gasket. Unit shall be capable of full shutoff.
- D. Controls: Unit mounted DDC controller and actuator shall be supplied by the DDC system supplier/sub-Contractor to the terminal unit manufacturer for factory mounting. Boxes shall be factory furnished complete with a controls enclosure, an isolation transformer, and a multi-point center-averaging sensor with flow measurement and balancing taps to amplify velocity pressure signals and provide accurate flow sensing regardless of air inlet duct configuration. Coordinate control component and isolation transformer requirements with the Building DDC System Supplier/sub-Contractor. Pneumatic tubing shall be UL listed flame retardant (FR) type. Unit shall be capable of full shutoff. Controller shall be suitable for control sequences indicated on the drawings.
- E. Acceptable Manufacturers:
 - 1. Titus ESV
 - 2. E.H. Price
 - 3. Kreuger
 - 4. Tuttle and Bailey

2.3 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3: EXECUTION

3.1 INSTALLATION

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air terminal units to allow service and maintenance.
- C. Make connections to air terminal units with flexible connectors complying with requirements in Division 23, Section 233300: Duct Accessories.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 4, "Hangers and Supports".
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

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1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.

C. Hangers Exposed to View: Shell have threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pullout, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23, Section 230553: Identification for HVAC for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections of components, assemblies, and equipment installations, including connections.
1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Complete installation and startup checks according to manufacturer's written instructions.
 6. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 7. Verify that controls and control enclosure are accessible.
 8. Verify that control connections are complete.
 9. Verify that nameplate and identification tag are visible.
 10. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

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SECTION 233713 – DIFFUSERS, REGISTERS, AND GRILLES

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:
 - 1. Ceiling- and Wall-Mounted Diffusers
 - 2. Registers
 - 3. Grilles

1.3 GENERAL

- A. Provide diffusers, registers and grilles as scheduled on the drawings and specified herein. Refer to architectural reflected ceiling plans for exact locations of diffusers, registers and grilles and the neck sizes required for each installation. Make minor modifications to ductwork as required.
- B. Diffusers, registers and grilles shall be tested and rated in an ADC Certified Laboratory in accordance with ADC requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members
 - 2. Method of attaching hangers to building structure
 - 3. Size and location of initial access modules for acoustical tile
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings
 - 5. Duct access panels

PART 2: PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Titus
- B. Krueger
- C. Tuttle & Bailey
- D. E.H. Price

2.2 DIFFUSERS, REGISTERS, AND GRILLES

A. Low Velocity Radial Pattern Diffusers:

1. Equivalent to Titus Radiatec
2. High volume, low velocity displacement air diffuser with uniform radial pattern in 1 or 2-way throw configuration (Internal baffles and perforated face not extending below finished plane more than 6.25 inches. Top of duct collar shall not extend more than 7-¼ inches above the finished ceiling plane.)
3. Aluminum construction with baked enamel paint finish.
4. 24 inches by 24 inches and 24 inches by 48 inches module sizes with border compatible with lay in T-bar ceilings (Provide plaster frame for hard ceiling installations.)

B. Ceiling Supply Diffusers:

1. Equivalent Titus Model OMNI and OMNI-AA
2. Steel or aluminum as noted, plaque face diffuser (Furnish neck baffles to provide with one-, two-, three-way blow patterns where indicated on the drawings. Diffuser shall have a removable core and louver blades. Unit shall be complete with opposed blade damper D-75, square to round transition, equalizing grid, and a baked enamel finish with color selected by the Architect. Frame shall be suitable for tee-bar lay-in or gypsum board ceilings with 24 inches by 24 inches or 12 inches by 12 inches module size as indicated on the drawings.)
3. Coordinate diffuser type with ceiling type (Refer to the Architectural drawings the locations of various ceiling types. Each diffuser shall be provided with removable factory fabricated opposed blade, gang operated, volume regulator with accessible operator.)

C. Supply Registers:

1. Equivalent to Titus Model 300 RL
2. Steel bar register. Double deflection with bars on ¾ inch centers (Bars shall be individually adjustable. Face bars shall be oriented with the longer dimension of rectangular devices. Register have a foam gasket and countersunk screw holes. Unit shall be complete with model AG-15 gang operated opposed blade damper white finish. Frame shall be suitable for surface mounting in sidewall applications unless otherwise indicated.

D. Return and Exhaust Registers:

1. Steel Construction:

- a. Equivalent to Titus Model 355 RL
- b. Square or rectangular louvered register with 35 degrees fixed deflection, ¾ inch spacing, steel construction, and AG-15 opposed blade damper. Register shall be painted. Color shall be selected by the Architect.

E. Aluminum Construction:

- a. Equivalent to Titus Model 355 FL
- b. Square or rectangular louvered register with 35 degrees fixed deflection, ¾ inch spacing, aluminum construction, and AG-15-AA opposed blade damper (Register shall be painted. Color shall be selected by the Architect.)
- c. Furnish aluminum construction registers where indicated on the drawings.

F. Transfer Grilles:

1. Steel Construction:

- a. Equivalent to Titus Model 355 RL
- b. Square or rectangular louvered register with 35 degrees fixed deflection, ½ inch spacing, and steel construction (Grille shall be painted. Color shall be selected by the Architect.)

2. Aluminum Construction:

- a. Equivalent to Titus Model 355 FL
- b. Square or rectangular louvered register with 35 degrees fixed deflection, ½ inch spacing, and aluminum construction (Register shall be painted. Color shall be selected by the Architect.)
- c. Furnish aluminum construction grilles where indicated on the drawings.

G. Linear Continuous Slot Diffuser>Returns with Plenums:

1. Equal to Titus FL series

2. Provide all materials and equipment required for a complete installation of linear continuous slot air distribution systems as shown on the drawings. The systems shall be complete in every respect and shall include all required appurtenances. The slot diffusers shall integrate into the ceiling system. The linear slot diffusers shall have the number and width of slots in overall lengths indicated on the drawings and shall be capable of being used for supply air, return air, exhaust air, or any combination thereof.
3. The linear slot diffusers shall be capable of supporting the ceiling system. For lay-in ceiling, provide hanger wire support clips that are integral with the linear slot diffusers allowing the linear slot diffusers to be supported from the building structure with ceiling wire. For hard ceilings, provide clips that are integral with the linear slot diffusers allowing the diffusers to be secured directly to the ceiling framing without the requirement for hanger supports without visible fasteners. Provide spline clips to secure joints and ceiling tees to the diffusers.

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4. Provide ends and corners as required. Ends shall be butt type, field installed, or mitered picture frame type factory installed, as indicated herein or shown on the drawings. Corners shall be mitered one piece unit. For longer installations, utilize the longest length sections manufactured for the fewest possible butt joints.
5. Pattern controllers shall be one-piece extruded aluminum, 24 inches long, positioned between spring loaded spacers. Pattern controllers shall allow the air stream to be directed flat against the ceiling in either direction or downward as well as allowing throw reduction every two feet along the entire length of the linear slot diffusers. The air stream shall be maintained at the ceiling plane and shall not dump when volume is reduced. Where shown or noted pattern controllers shall be designed to allow the air stream to be jetted into the occupied space and be adjustable to vector the air stream as required.
6. Provide Titus “Jetflow” accessories (or equal) for sidewall installations.
7. Material shall be minimum wall thickness .062 extruded aluminum. Spring steel retainers shall be used under the spacers to hold the slot diffusers assembly tightly together and allow the slot diffusers to be disassembled easily for field trimming.
8. Flanges exposed to view shall be furnished with an anodized finish, custom color as selected by the Architect. All other surfaces shall be painted flat black. Provide samples to the Architect.
9. For sections used for supply, provide shop or factory fabricated supply air plenums. Plenums shall be minimum 10 inches tall and fabricated of 24 gauge galvanized steel. Plenums shall be lined with ½ inch thick, 1-½ pounds per cubic foot density glass fiber liner type insulation with black colored facing. Duct collar connector shall be provided on side of box. Plenum boxes shall be provided with sheet metal extensions.
10. For sections used for return, provide uninsulated return hoods/light shields. Hoods shall be 51 percent free area and constructed of 24 gauge perforated sheet metal painted flat black.
11. Provide a volume control damper at each slot diffuser for balancing the air distribution system. Where diffusers are located in inaccessible ceilings, a flexible cable type operator shall be connected to the damper and extended down to the diffuser face to provide manual adjustment of the damper through the diffuser face with a common screw driver.
12. Air test and balance of linear and modular slot diffusers systems shall be in accordance with the testing and balancing section of the specifications. Position all pattern controllers in their normal operation positions and perform all air testing and balancing of all slot diffuser systems in full accordance with manufacturer's recommendations.

PART 3: EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.

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- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, and fire dampers.
- D. Paint interiors of metal ducts that do not have duct liner, for a minimum distance 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9, Section 099100: Painting.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 234100 – PARTICULATE AIR FILTRATION

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

- 2.1 If an air handler regularly brings in more than 50 percent outdoor air, it shall be supplied with Airguard “Mist-Defier” filters. Their Minimum Efficiency Reporting Value (MERV), is 7. These are highly resistant to moisture which is necessary on foggy or rainy days.
- 2.2 Kitchens/food prep areas shall have two banks of disposable filters. The pre-filter shall be the same type noted in Paragraph 2.1. The second filter bank shall also be moisture resistant with a MERV of 11 and an efficiency of 55 to 65 percent. Filters shall be a minimum of 2 inches thick.
- 2.3 All other air handlers shall have at least one filter bank with a minimum MERV of 7 and an efficiency of 25 to 30 percent. Filters shall be a minimum of 2 inches thick.
- 2.4 A differential pressure gauge is required for each set of filter banks.
- 2.5 Manometer style gauges shall be installed with integral leveling gauge, 0 to 3 inches water gauge, and accurate to within plus/minus 3 percent of full scale range.

PART 3: EXECUTION

- 3.1 Upon substantial completion of the project, all of the filters will be removed and replaced with new.
- 3.2 Angle filter system shall be used.
- 3.3 All equipment having filters shall have adequate space to maintain filters and change filters, filters shall be of standard size and available through any supplier.

END OF SECTION 234100

SECTION 236416 – CHILLERS

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

1.2 When a project needs cooling the first choice shall be to connect to the pertinent campus's main chilled water loop.

1.3 For a multiple chiller installation, the primary chiller shall be selected on full load efficiency. Secondary and stand-alone chillers shall be selected on their IPLV rating.

1.4 Calculation of Integrated Part Load Value, (IPLV):

A. Refrigerant chiller, (kilowatt/ton): $IPLV = 1/((0.01/A) + (0.42/B) + (0.45/C) + (0.12/D))$ B.

B. Absorption chiller, (MBH/ton): $IPLV = 1/((0.01/A) + (0.42/B) + (0.45/C) + (0.12/D))$

C. For water cooled chillers:

A = kilowatt/ton at 100 percent load at 85 degrees Fahrenheit of ECWT

B = kilowatt/ton at 75 percent load at 75 degrees Fahrenheit of ECWT

C = kilowatt/ton at 50 percent load at 65 degrees Fahrenheit of ECWT

D = kilowatt/ton at 25 percent load at 65 degrees Fahrenheit of ECWT

D. For air cooled chillers:

A = kilowatt/ton at 100 percent load at 95 degrees Fahrenheit of EDB

B = kilowatt/ton at 75 percent load at 80 degrees Fahrenheit of EDB

C = kilowatt/ton at 50 percent load at 65 degrees Fahrenheit of EDB

D = kilowatt/ton at 25 percent load at 55 degrees Fahrenheit of EDB

E. ECWT: Entering Condenser Water Temperature

F. EDB: Entering Dry Bulb Temperature

PART 2: PRODUCTS

2.1 Allowable brands:

A. Carrier

B. Trane

2.2 Efficiency, IPLV, for each type of compressor system must be at least as good as noted in ASHRAE Standard 90.1 – 2004.

2.3 Centrifugal Chiller Requirements

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A. General: All chillers selected shall be identical products from the same manufacturer and meet the criteria specified below. Chillers shall be capable of unloading down to 15 percent of the full load capacity.

B. Evaporator performance:

1. Entering Chilled Water Temperature: 55 degrees Fahrenheit
2. Leaving Chilled Water Temperature: 41 degrees Fahrenheit
3. Design Chilled Water gallons per minute/ton: 1.7
4. Maximum Evaporator Pressure Drop: 30 feet H₂O
5. Variable evaporator flow (if variable frequency drive motors selected)
6. Fouling Factor: 0.00025

C. Condenser performance:

1. Entering Condenser Water Temperature Range: 85 to 65 degrees Fahrenheit
2. Leaving Condenser Water Temperature Range: 95 to 55 degrees Fahrenheit
3. Design Condenser Water gallons per minute/ton: 3.0
4. Maximum Condenser Pressure Drop: 30 feet H₂O
5. Fixed Condenser Water Flow
6. Fouling Factor: 0.00025

2.4 Use water cooled condensers for all systems over 300 tons.

2.5 It is understood that not all types and sizes of chillers are compatible with zero ozone depletion refrigerant. However, designers must specify the most environmentally friendly refrigerants where possible. The brand and model of chiller detailed in the Drawing Schedules must reflect this decision.

2.6 Chiller features

- A. Building management system interface capability with full graphics. See Section 230900, Controls, in the Design Guidelines for details.
- B. Variable frequency drives (VFD) shall be considered if available. If a VFD is available, an economic analysis shall be conducted and presented to Baldwin Wallace University to show payback period.
- C. Capability for extended operation with 55 degree F entering condenser water temperature
- D. Marine water boxes shall be installed on condensers on large centrifugal chillers. The boxes shall have either hinged ends or lifting lugs to facilitate removal.
- E. Surfaces with an operating temperature lower than 65 degrees Fahrenheit shall be covered with a minimum of ¾ inch insulation at $k = 0.28 \text{ BTU}/(\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F})$.
- F. Refrigerant isolation valves.

- G. If a chiller can be installed without being broken down, it shall be shipped pre-charged with refrigerant and oil.
- H. Tap on oil system to draw samples for testing

PART 3: EXECUTION

- 3.1 Machines with multiple compressors shall have at least two separate refrigerant circuits.
- 3.2 If connected to outdoor piping, chillers shall be capable of utilizing a water/ethylene glycol mixture consisting of 35 to 40 percent concentration by weight, with deionized water, corrosion inhibitors effective for water based fluids, and additional additives to buffer and neutralize acidic glycol degradation. This shall be supplied and installed by the on-site mechanical Contractor. This mixture will protect the equipment down to minus 5 to minus 10 degrees Fahrenheit. Only polyethylene glycol will be used in a coolant mixture around food processing.
- 3.3 Large process cooling requirements shall be met by a dedicated cooling system.
- 3.4 Chillers shall be equipped with an internal flow sensor to ensure flow prior to start and after shutdown. The condenser water flow on steam chillers must continue for 30 minutes after chiller shutdown.
- 3.5 Use multiple same size chillers in centralized chilled water plants.
- 3.6 Chiller controls must be able to interface with Siemens, Invensys, and Automated Logic building management systems. These are the only three building management systems allowed at Baldwin Wallace University. See Section 250900 in the Design Guidelines for details.

END OF SECTION 236416

SECTION 236500 – CLOSED CIRCUIT COOLING TOWERS

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 GENERAL

- A. Provide factory-assembled evaporative coolers of induced draft design with vertical air discharge as shown on the drawings and specified herein. Evaporative coolers shall have the capacities indicated on the drawings at design conditions.

1.3 THERMAL CAPACITY

- A. The evaporative coolers shall be warranted by the manufacturer to have capabilities as scheduled on the drawings. The performance shall be certified by the Cooling Technology Institute (CTI) in accordance with CTI Certification Standard STD-201 or, lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by the CTI, or other qualified independent third party testing agency. Manufacturers' performance guarantees or performance bonds without CTI Certification of water ratings shall not be accepted.

1.4 SUMMARY

- A. Section includes:
 1. Closed-Circuit, Induced-Draft Cooling Towers

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
 1. Maximum flow rate
 2. Minimum flow rate
 3. Drift loss as percent of design flow rate
 4. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed
 5. Performance curves for the following:
 - a. Varying entering-water temperatures from design to minimum
 - b. Varying ambient wet-bulb temperatures from design to minimum
 - c. Varying water flow rates from design to minimum
 - d. Varying fan operation (off, minimum, and design speed)

6. Fan airflow, brake horsepower, and drive losses
 7. Pump flow rate, head, brake horsepower, and efficiency
 8. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower
 9. Electrical power requirements for each cooling tower component requiring power
- B. Shop Drawings:** Complete set of manufacturer's prints of cooling tower assemblies, and control panels, sections and elevations. Include the following:
1. Assembled unit dimensions
 2. Weight and load distribution
 3. Required clearances for maintenance and operation
 4. Sizes and locations of piping and wiring connections
 5. Wiring Diagrams: For power, signal, and control wiring
- C. Coordination Drawings:** Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Structural supports and vibration isolation
 2. Piping roughing-in requirements
 3. Wiring roughing-in requirements, including spaces reserved for electrical equipment
 4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances
- D. Certificates:** For certification required in “Quality Assurance” article
- E. Startup service reports**
- F. Operation and Maintenance Data:** For each cooling tower to include in emergency, operation, and maintenance manuals
- G. Warranty:** Sample of special warranty

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications:** Certified by CTI
- B. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application
- C. ASME Compliance:** To fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1
- D. CTI Certification:** Cooling tower thermal performance according to CTI STD 201, “Certification Standard for Commercial Water-Cooling Towers Thermal Performance”

1.7 COORDINATION

- A. See Division 23, Section 230000: General HVAC Provisions.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
 1. Fan assembly including fan, drive, and motor: five years from date of substantial completion.
 2. Stainless steel basin shall have a 5 year leak proof warranty from the date of substantial completion.
 3. All other components 1 year from date of substantial completion.

PART 2: PRODUCTS

2.1 GENERAL

- A. Refer to Section 232113, HVAC Piping, for component and equipment ratings. All components, fittings, equipment, coils, specialties, etc., shall meet the component pressure rating listed.

2.2 CONSTRUCTION

- A. All steel panels and structural elements shall be constructed from heavy-gauge, G-235 hot-dip galvanized steel, with cut edges given a protective coat of zinc-rich compound.

2.3 BASIN

- A. The cold water basin shall be constructed of Type 304 stainless steel. All factory seams in the cold water basin shall be welded, leak tested at the factory to ensure watertight assembly and shall be warranted against leaks for five (5) years.
- B. The basin shall include a depressed section with drain/clean-out connection.
- C. A large area, lift-out, hot-dip galvanized steel strainer with perforated openings and an integral anti-vortexing hood to prevent air treatment shall be provided.
- D. Provide the sump with a float-actuated brass water make up valve. The float shall be adjustable.
- E. Provide sump covers with lifting handles.
- F. Electric Basin Heaters: To maintain 40 degrees Fahrenheit, water with minus 20 degrees Fahrenheit, ambient conditions, the heater shall have an integral low water cut out switch and controlling thermostat wired back to the remote control panel.

2.4 FANS

- A. Fans shall be heavy-duty, axial flow, with aluminum alloy blades. Air shall discharge through a fan cylinder designed for streamlined air entry and minimum fan blade tip clearance for maximum fan efficiency.

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- B. Fans and shafts shall be supported by heavy-duty, self-aligning, grease-packed ball bearings with moisture-proof seals and integral slinger rings, designed for minimum L50 life of 280000 hours. Fans shall be driven by a one-piece, multi-groove neoprene/polyester belt designed specifically for evaporative cooling service. Fan and motor sheave(s) shall be fabricated from cast aluminum.
- C. Fan motors shall be totally enclosed air over (TEAO), reversible, squirrel cage, ball bearing type with 1.15 service factor, designed specifically for evaporative cooling duty and suitable for the scheduled electrical service. The motor shall be furnished with special moisture protection on windings, shafts, and bearings. Each motor shall be mounted on an easily adjusted, heavy-duty motor base.

2.5 COIL SECTION

- A. The heat transfer section of the evaporative cooler shall be enclosed with removable heavy-gauge galvanized steel panels.
- B. The coil shall be constructed of continuous serpentine all prime surface steel, be pneumatically tested at 375 pounds per square inch gauge, and be hot-dip galvanized after fabrication. The coil shall be designed for free drainage of fluid and shall be ASME B31.5 compliant. Maximum allowable working pressure shall be 300 pounds per square inch gauge.

2.6 WATER DISTRIBUTION SYSTEM

- A. Spray Pump: Close-coupled, bronze fitted centrifugal pump with mechanical seal. Complete with suction and discharge piping connected to the water distribution system. TEFC motor. The system shall include a metering valve and bleed line to control the bleed rate from the pump discharge to the overflow connection.
- B. Water shall be distributed evenly over the coil at a flow rate of sufficient to ensure complete wetting of the coil at all times. The system shall consist of Schedule 40 PVC spray branches with large diameter, non-clog, 360 degrees plastic distribution nozzles. The branches and spray nozzles shall be held in place by snap-in rubber grommets, allowing quick removal of individual nozzles or complete branches for cleaning or flushing. Nozzles shall utilize a two-stage diffusion pattern to provide overlapping, umbrella spray patterns.
- C. The distribution systems shall be installed so that it shall drain freely when the unit basin pan is drained.

2.7 AIR INLET LOUVERS AND ELIMINATORS

- A. Air inlet louvers shall be wave-formed, fiberglass-reinforced polyester (FRP) with UV resistant finish spaced to minimize air resistance and prevent water splash-out.
- B. Provide wire mesh air inlet screens to help prevent debris from entering the unit.
- C. The wet deck surface and integral drift eliminators shall be formed from polyvinyl chloride (PVC) and shall be impervious to rot, decay, fungus and biological attack. The surface shall be manufactured and performance tested by the evaporative cooler manufacturer to provide single source responsibility and assure control of the final product. Drift eliminators shall be removable in easily handled sections for quick access to the coil. Eliminators shall have a minimum of three changes in air direction.

2.8 MAINTENANCE ACCESS

- A. Large, hinged access doors shall be provided on each end wall for access to the coil, drift eliminators, and fan plenum section. The basin make up water valve and float and suction strainer shall be immediately accessible from this access point.

2.9 VIBRATION ISOLATION

- A. Provide spring type vibration isolators with vertical restraints with a minimum of 4 inches static deflection at the support points required by the cooling tower manufacturer. Provide plate steel between the top of the isolator and the cooling tower base of the dimensions recommended by the cooling tower manufacturer. The isolators shall be suitable for a maximum wind speed of 80 miles per hour. The isolator manufacturer shall verify the isolator sizing and capacity via calculations by a qualified professional engineer licensed in the State of Ohio.

2.10 CONTROLS AND POWER CONNECTION PANEL

- A. Provide a remote mounted control panel in a NEMA-3R enclosure mounted where indicated on the drawings. Panel to include a main unit disconnect switch, magnetic motor starter for the spray pump motor, magnetic motor starter for fan motor, control contactor for basin heater, step down control transformer, adjustable phase protection, and wired terminal strip for controls interface with tower-installed control devices.
- B. Control panel shall be configured for a single point three phase power connection. Wiring from the panel to the individual loads (fan motor, pump motor, basin heater, etc.) shall be field-provided by the Division 26 Contractor.
- C. See Division 23, Section 230901: Control Sequences of Operation for control sequences. A representative from the evaporative cooler supplier and the Controls Contractor shall cooperate in the integration of the evaporative cooler controls, and the building controls system.

2.11 OPTIONAL EQUIPMENT

- A. Provide the following optional equipment:
 1. Whisper quiet fan design
 2. Wire-mesh air inlet screens
 3. Extended lubrication lines for fan shaft bearings (Grease fittings shall be located near the access door.)
 4. Vibration cut-out switch with adjustable trip point between 0.2 and 2.0 g's, wired to shut down the fan motor to prevent damage to the tower due to imbalance
 5. Intake hood with positive closure dampers and actuators on the unit top air intake with side access doors (The hood shall have 1 inch thick PVC nitrile rubber blend insulation.)
 6. 1 inch thick PVC nitrile rubber blend thermal insulation on the intake hood and casing panels surrounding the water coil
 7. Stainless steel internal maintenance walkway
 8. Internal ladder to access the fan drive and motor
 9. External maintenance platform and fixed ladder at each exterior access panel (Provide ladder extension to 8 inches above the finished roof surface.)

2.12 SOUND

- A. To maintain the quality of the local environment, the evaporative cooler shall be furnished with a whisper quiet fan. The thermal performance of the evaporative cooler shall be certified by the CTI in accordance with paragraph 1.2 of this specification when furnished with these options.
- B. Maximum sound pressure levels (decibels) shall not exceed the levels scheduled on the drawings. Units not meeting these sound performance requirements will not be accepted.

2.13 MANUFACTURERS

- A. Basis of design: Baltimore Air Coil 'FXV' Series
- B. Alternate: Evapco or Marley provided that the specification and performance criteria are met

PART 3: EXECUTION

3.1 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Obtain performance data from manufacturer.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Clean entire unit including basins.
 - b. Verify that accessories are properly installed.
 - c. Verify clearances for airflow and for cooling tower servicing.
 - d. Check for vibration isolation and structural support.
 - e. Lubricate bearings.
 - f. Verify fan rotation for correct direction and for vibration or binding and correct problems
 - g. Adjust belts to proper alignment and tension.
 - h. Measure current draw of fan motors and verify that motors are not overloaded.
 - i. Check controls for proper operation through complete control sequence.
 - j. Verify water level in remote tower sump. Fill to proper startup level. Check makeup water-level control and valve.
 - k. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
 - l. Replace defective and malfunctioning units.

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- D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
- E. Prepare a written startup report that records the results of tests and inspections.

3.2 ADJUSTING

- A. Set and balance water flow to each tower inlet.
- B. Adjust water-level control for proper operating level.

3.3 DEMONSTRATION

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

END OF SECTION 236500

SECTION 237313 – MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Project Manager.

PART 2: PRODUCTS

2.1 All units shall come equipped with mixing boxes for outside and return air. Dampers will be provided for outside, mixed, and exhaust air ducts. Damper leakage rate shall be less than 2 cubic feet per minute/square feet at 1 inch water gauge pressure differential.

2.2 Where units are large enough to be entered, internal lighting will be provided. Luminaries shall be long life, rough service, incandescent lamp type in a vapor tight housing.

2.3 All air handlers shall have inspection ports at each component.

2.4 Allowable equipment brand names:

- A. Carrier
- B. Trane
- C. McQuay
- D. Aeon
- E. York

2.5 Hot water coils shall have entrances on the bottom with exits and air vents on the top.

2.6 Coils shall be made of seamless copper tubes with aluminum tube sheets, and fins of aluminum. Coil headers shall be extra heavy wall seamless copper tubing.

2.7 All 100 percent outdoor air units shall consider energy recovery. Calculations shall be provided at Schematic Document phase that predicts economic payback.

2.8 Air handlers shall have solid double wall panels internally insulated with R-13 insulation. Panels to be made from G90 galvanized steel.

2.9 Stainless steel drain pans shall be insulated and sloped in at least two planes. Drain shall be on bottom of pan. Provide pans under coil, fan, and humidifier sections. Pans shall be drained by a trapped, insulated drainpipe that remains the full size of the drain pan connection and indirectly connects to drain.

2.10 Air handlers shall be internally covered with an anti-microbial coating.

2.11 Air handlers that typically use more than 35 percent outdoor air shall have air blenders installed to minimize stratification.

2.12 Equipment shall be provided with a single power point connection.

2.13 Fan bearings shall have a minimum life L50 of 200000 hours.

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- 2.14 UV lights shall be installed at each cooling coil and have their own external manual disconnect switch plus a door interlock safety switch.
- 2.15 All air handlers shall be supplied with G90 galvanized base rails.
- 2.16 Air handlers shall be supplied with hinged, insulated, double wall access doors on at least one side.
- 2.17 All units shall have the capability for an economizer/free cooling cycle.
- 2.18 All air handlers shall come with a GFI receptacle.
- 2.19 If the air handler has external grease fittings, the fitting shall be connected to the bearing with metallic tubing.

PART 3: EXECUTION

- 3.1 No air handler will be installed on the roof unless in a penthouse.
- 3.2 Manufacturer recommended vibration isolators will be installed on every unit.
- 3.3 Flexible membranes will be installed between the air handler and the ductwork.
- 3.4 All zones shall be clearly marked on supply ducts at multizone air handling units. A laminated chart shall also be installed in the mechanical room which indicates what rooms each zone serves.
- 3.5 Equipment shall be installed on 4 inches concrete housekeeping pads.
- 3.6 Equipment shall be installed in such a position to allow for removal of coils, fan shafts, and filters, etc.
- 3.7 A lockable electrical disconnect shall be provided at each air handler for lock-out/tag-out.
- 3.8 A laminated chart shall be installed in all mechanical rooms that show the air handler and a list of rooms served.
- 3.9 Any air handlers using concrete as the interior floor shall have the concrete sealed.
- 3.10 A vibration analysis shall be performed at the manufacturing stage and as installed. This shall be done on any motors over 3 horsepower and their corresponding pumps and fans.
- 3.11 Air intakes shall be mounted at least 18 inches above the ground or roof.

END OF SECTION 237313

SECTION 238146 – WATER SOURCE UNITARY HEAT PUMPS

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:
 - 1. Water-to-Air Pumps
 - 2. Water-to-Water Heat Pump Units for Geothermal (Extended Range) Applications

1.3 GENERAL

- A. Provide geothermal heat pump units including all the required piping, fittings, valving, controls, extended range options, and accessories as hereinafter specified or shown on the drawings, and as required for a completely operational system.
- B. Units shall be ARI Standard 320 Performance Certified and Underwriter Laboratories (UL) listed for safety on all models. Each unit shall be run tested at the factory.

1.4 SUBMITTALS

- A. Submit shop drawings and product data sheets indicating cross section of cabinets, general assembly, and materials used in fabrication.
- B. Submit product data indicating typical catalog of information including arrangements.
- C. Indicate mechanical and electrical service locations and requirements, specifically indicating deviations from indicated products.
- D. Submit manufacturer's installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include Manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, including filter replacement and unit lubrication.

PART 2: PRODUCTS

2.1 WATER TO AIR HEAT PUMPS

A. Unit Construction

1. The cabinet shall be fabricated from heavy-gauge galvanized steel. The interior shall be insulated with ½ inch thick, multi-density, coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air. Blower compartment and compressor compartment access panels shall be provided and shall be removable with supply and return ductwork in-place. The internal component layout shall provide for major service with the unit in-place.
2. A stainless steel drain pan shall extend the full length of the air coil. The condensate drain connection shall be externally trapped and extend beyond the unit case as shown on the drawings. A condensate overflow switch shall be provided conforming to UL508 that will shut off the heat pump in the event that the condensate drain is blocked. The switch shall be installed in the primary drain line, the overflow drain line connection, or the drain pan, located at a point no higher than the primary drain line connections and below the overflow rim of the pan.
3. Units shall be factory supplied with 2 inches, 4-sided filter racks with removable doors which can accommodate either 1 inch or 2 inches filters. Standard-size 2 inches (30 percent efficiency) filters shall be provided with each unit.
4. The units shall have an insulated divider panel between the air handling section and the compressor section to minimize the transmission of the compressor noise, and to permit operational service testing without air bypass. Provide units with optional sound attenuation package (compressor blankets).
5. Hanger Kit: The hanger kit shall consist of galvanized steel brackets, bolts, lock washers, and isolators and shall be designed to fasten to the unit bottom panel for suspension from the ¾ inch threaded rods.

B. Refrigeration System

1. The units shall utilize R-410a refrigerant.
2. Units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, bidirectional thermal expansion valve, finned tube air-to-refrigerant heat exchanger, reversing valve, coaxial tube water-to-refrigerant heat exchanger, and service ports to allow reading of refrigerant pressures at the suction and discharge of the compressor.
3. Compressors shall be high-efficiency reciprocating or scroll type designed for heat pump duty and mounted on vibration isolators. Compressor motors shall be single or three-phase with internal overload protection. Provide an acoustical wrap sound package on each compressor.
4. The air-to-refrigerant heat exchanger shall be constructed of staggered copper tubes with aluminum fins bonded to the tubes. The air-to-refrigerant heat exchanger shall have a working pressure rating of 400 pounds per square inch gauge.
5. The coaxial water-to-refrigerant heat exchanger shall be designed for close approach temperatures and be construction of a convoluted copper inner tube and a steel outer tube, and capable of and 450 pounds per inch working pressures. The heat exchanges shall be insulated on geothermal applications.

- a. Unit shall have a low leaving source (geothermal) water temperature (freeze stat) safety switch. The trip point shall be below 32 degrees Fahrenheit to permit operation without nuisance trips using source water containing 25 percent propylene glycol.

C. Fan and Motor

1. The fan shall be direct drive centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet, low outlet velocity operation. The fan housing shall be of galvanized steel construction and shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor.
2. The fan motor shall be a multi-speed type and isolated from the housing by rubber grommets. The fan motor and control box shall be harness plug-connected for easy removal. The motor shall be permanently lubricated and have thermal overload protection.

2.2 WATER TO WATER HEAT PUMPS (NOT A PREFERRED SOURCE OF HEATING DOMESTIC WATER)

A. General:

1. The water source (ground-source closed loop) heat pumps shall be a single packaged reverse cycle heating/cooling unit. Each unit shall be computer run-tested at the factory. Each unit shall be shipped in a corrugated box.
2. The liquid source heat pump units shall be designed to operate with entering liquid temperature between 20 degrees Fahrenheit and 110 degrees Fahrenheit.
3. Units shall be certified in accordance with ARI standard 330.
4. Units shall be mounted on structural steel framework. Refer to Section 230548: Vibration Controls for requirements on vibration isolation.

B. Casing and Cabinet:

1. The cabinet shall be fabricated from heavy-gauge steel and finished with corrosion-resistant textured epoxy coating. The interior shall be insulated with ½ inch thick, multi-density, coated glass fiber with edges sealed and tucked under flanges.
2. Units shall have ⅞ inch knockouts for entrance of low and line voltage wiring.

C. Refrigerant Circuit:

1. Units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, bidirectional capillary tube/thermal expansion valve assembly, reversing valve, coaxial tube water-to-refrigerant heat exchanger, factory-installed high-and low-pressure safety switches and service ports for connection of high and low pressure gauges. The heat exchangers shall be double wall stainless steel on the load side suitable for domestic water heating service.
2. Compressors shall be designed for heat pump duty and mounted on vibration isolators. Compressor motors shall have overload protection and will be three-phase or single-phase PSC type as scheduled on the drawings.

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3. The water-to-refrigerant heat exchangers shall be a coaxial type constructed of a convoluted copper inner tube and a steel outer tube capable of withstanding 450 pounds per inch gauge working pressure on the refrigerant side. The parallel capillary tube/thermal expansion valve assembly shall provide proper superheat over the 20 to 110 degrees Fahrenheit liquid temperature range with minimal “hunting”. The assembly shall operate bi-directionally without the use of check valves.
4. The water-to-refrigerant heat exchanger, desuperheater coil, and refrigerant suction lines shall be insulated to prevent condensation at low liquid temperatures.

2.3 MANUFACTURER

- A. Basis of Design: Florida Heat Pump ‘EC/EV’ Series for water to air units, Florida Heat Pump ‘WW’ Series.
- B. Alternate: Water Furnace International, Inc. ‘Envision’ Series for water to air units, “EW” Series for water to water units, provided the specification and performance criteria are met.

2.4 PIPING

- A. Supply, return water, and condensate, drain connections shall be brass pipe thread fittings mechanically mounted to cabinet exterior. Water piping shall be insulated to prevent condensation at low liquid temperatures. Provide stainless steel, braided hose kit with swivel connectors.

2.5 ELECTRICAL AND CONTROLS

A. Electrical – General:

1. Components, controls and safety devices shall be factory wired and mounted within the unit. Controls shall include fan relay, compressor contactor, 24 volts transformer, reversing valve coil and reset relay.
2. A terminal block with screw terminals will be provided for field control wiring.
3. To prevent short cycling, the reset relay shall provide a lockout circuit when the safety controls are activated which requires resetting at the thermostat or main circuit breaker. A lockout indicting signal shall be provided on the low voltage terminal block.
4. Controls and safety devices will be factory wired and mounted within the unit. Controls shall include fan relay, compressor contactor, 24 volts transformer, reversing valve coil and solid state lockout controller.

B. Controls – General:

1. The Heat Pump DDC Controller shall consist of a high speed microprocessor with 1 megabyte flash memory and 1 megabyte of battery-backed RAM. An on-board lithium battery shall hold Controller time clock settings. The controller shall be factory mounted.
2. The DDC controller supplied by the unit manufacturer shall be a standard product with a guarantee of ongoing parts availability and factory trained field support for five (5) years after system acceptance.
3. The equipment manufacturer shall make available to the DDC Contractor the read/write capability necessary to accomplish functional integration with the DDC system and achieve the sequences as specified. The unit manufacturer shall coordinate with the DDC Contractor, prior to bid time, to insure that the units are supplied with the proper I/O configuration required by the sequence of operations and associated DDC Points List in Division 23, Section 230900: Integrated Automation Control System. Such coordination may result in the DDC Contractor providing a portion of the requirement as part of the DDC system as necessary. Equipment submittals shall include proof of this coordination during bidding.

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4. As part of the unit DDC controller acceptance, the unit manufacturer shall turn over to the Owner copies of configuration files, databases, and programming for this project on suitable media. In addition, at the completion of the warranty period, the unit manufacturer shall repeat this process to account for updates made during the first year of operation.
 5. The unit manufacturer shall provide, as part of this project, any tool sets (hardware and/or software) that the Owner will require in order to support normal daily operation of the DDC controller provided.
 6. The equipment manufacturer shall be responsible for start-up and warranty service associated with the control hardware and software they provide.
 7. The controller shall include built-in protocol support for BACnet (MS/TP) open protocol.
 8. The units shall be run tested through all modes of operation while at the factory.
 9. A representative from the heat pump unit supplier and the DDC subcontractor shall cooperate in the integration of the unit operation and the building control system during field installation. The heat pump unit supplier shall provide one (1) hour of on-site factory technician time per unit supplied to assist in problem solving and integration.
- C. DDC Controller: The Heat pump DDC Controller shall be programmed with water to air application software and installed in the unit to be job site ready to run. The unit shall operate in 100 percent stand-alone control mode or connected to the Building Automation System (BAS).
1. The unit shall run according to a timed local override from zone temperature sensor or via the BAS start command (software point). When commanded to run the unit will operate in the following modes:
 - a. Occupied Mode: The unit will maintain adjustable room cooling and heating set points.
 - b. Unoccupied Mode (night setback): The unit will maintain adjustable setback room heating and cooling set points.
 - c. In the occupied mode, the fan shall run continuously. In the unoccupied mode, the fan shall cycle as required to maintain unoccupied heating and cooling set points.
 - d. An override control will allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time (presets at 1, 2, 4, or 6 hours). At the expiration of this time, control of the unit will automatically return to the current BAS control mode.
 2. The controller will stage the compressor(s) to maintain its room temperature set point. To prevent short cycling, there shall be a 5-minute delay between compressor stages if equipped with two (2) compressors. Additionally, there shall be a 1 minute delay when transitioning between heat and cool modes. The compressor shall run subject to internal safeties and controls.
 3. The condensate overflow sensor in the drain pan shall prevent heat pump operation if condensate overflow is eminent.
 4. Controller Inputs:
 - a. Room temperature
 - b. Room temperature set point
 - c. Room occupancy override
 - d. Discharge air temperature

- e. Unit Disable Alarms:
 - 1) High and Low Pressure per Circuit
 - 2) Freeze Alarm
 - 3) Condensate Overflow Alarm
 - 4) Brownout Alarm
 - f. Unit Enable from building DDC system
5. Controller Outputs.
- a. Unit Fan status
 - b. Reversing Valve
 - c. Compressor Stage(s)
 - d. General Alarm

2.6 WARRANTY

- A. The complete heat pump unit shall be guaranteed against defects by the manufacturer. Any defective parts developing during the guarantee period shall be supplied by the manufacturer and replaced by the Contractor at no cost to the Owner.
 - 1. A one-year warranty shall be provided by the Contractor for furnishing parts and labor for replacing any part of the heat pump which becomes defective in normal operation.
 - 2. The hermetically sealed motor compressor assembly and all components of the refrigerating circuit not readily separable there from shall be warranted to the original Owner for five (5) years, parts and labor.

PART 3: EXECUTION

3.1 UNIT INSTALLATION AND START-UP.

- A. Comply with Manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Install units in accordance with manufacturer's instructions.
- C. Protect units from site damage. Leave factory shipping covers in place until installation.
- D. Contractor shall install new filter in each heat pump before attempting to start up. Unit shall have filter installed during construction.
- E. Construction debris and dirt in or on heat pump shall be vacuumed or removed.
- F. Open all valves to full position and turn on line power to all heat pumps.
- G. Voltage and current shall be checked to be in accordance with data plate furnished on equipment.
- H. Check to see if supply and return piping is properly connected to inlet and outlet connections on machine.

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- I. Contractor shall check to see that fan wheel turns freely, that it is tight on shaft and that motor operates on either heating or cooling.
- J. Contractor shall operate each heat pump first on cooling cycle and then on heating cycle. Room temperature should be in normal range (minimum 70 degrees Fahrenheit). Loop water temperature entering water source heat pumps shall be between minimum 50 degrees Fahrenheit and maximum 90 degrees Fahrenheit. Check for cool air delivery at unit grille after a few minutes. Contractor shall list room identification of any machines that do not function. Contractor shall operate each heat pump on heating cycle immediately after checking cooling cycle operation. Check for warm air delivery at unit grille after a few minutes. Contractor shall list room identification of any machines that do not function.

END OF SECTION 238146

SECTION 238147 – ENERGY RECOVERY HEAT PUMPS

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 SUMMARY

- A. Section includes:

- 1. Rooftop Energy Recovery Units for Geothermal (Extended Range) Applications.

1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with CAN/CSA C22.2 No. 236 and/or UL 1995 (Heating and Cooling Equipment).
- B. Unit shall carry the label of a Nationally Recognized Testing Laboratory (NRTL) or a Standards Council of Canada (SCC) approved lab (Testing Organization and Certifying Body).
- C. Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
- D. Airflow data shall comply with AMCA 210 method of testing.
- E. Cabinet and exterior components shall be tested and certified as being weatherproof.
- F. Energy recovery component effectiveness data shall be certified by the ARI 1060 certification program directives.
- G. Unit components selected for this project shall conform to the following standards:
 - 1. AFBMA 9: Load Ratings and Fatigue Life for Ball Bearings
 - 2. AMCA 210: Laboratory Methods of Testing Fans for Rating Purposes
 - 3. AMCA 300: Test Code for Sound Rating Air Moving Devices
 - 4. AMCA 500: Test Methods for Louvers, Dampers and Shutters
 - 5. ARI 410: Forced Circulation, Air Cooling and Air Heating Coils
 - 6. ARI 1060: Air-to-Air Energy Recovery Ventilation Equipment
 - 7. ASHRAE 84-91: Method of Testing Air-to-Air Heat Exchangers
 - 8. ASHRAE 52.2: Procedures for Testing Air Cleaning Devices Used for Removing Particulate Matter
 - 9. IEEE 112-B: Standard Test Procedures for Polyphase Induction Motors and Generators
 - 10. NEMA MG-1: National Electrical Manufacturers Association Motor Standards
 - 11. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
 - 12. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
 - 13. UL 900: Test Performance of Air Filter Units

H. Units shall be factory-tested.

1.4 COORDINATION

- A. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.
1. The Contractor's attention is directed to the limited space available and units shall be arranged for access and removal of components. Equipment must be suitable for installation in the space available, with equipment, conduit and piping located in such a manner that parts are accessible for future maintenance, repair or replacement. The units shall be provided with removable panels and access doors to accomplish the above.
 2. Submit shop drawings. Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: One (1) complete set for each unit
 2. Fan Belts: One (1) set for each air-handling unit fan

1.6 GENERAL REQUIREMENTS

- A. Provide rooftop units of type, quantity, and duty as indicated on the drawings. Units shall have components and sections arranged as indicated on the drawings. Units shall have components and overall dimensions as indicated on the drawings and shall fit into space available with adequate clearance for servicing.
1. The units shall not have an operating weight exceeding that scheduled.
- B. Rooftop unit components, including but not limited to, vibration isolation, bases, sheet metal accessories, and controls are specified elsewhere in Division 23 unless otherwise indicated.
- C. Submit for review pressure, volume and horsepower curves and sound power information for each unit fan in addition to all other performance data. Fan performance data shall be AMCA certified. Fan selections shall include the following criteria:
1. Catalog rated for 15 percent greater static pressure than specified at air volume
 2. Selected so that the specified air volume is greater than that at the apex of the fan pressure volume curve
 3. Selected to provide stable operation down to 85 percent of design volume operating at the required speed for the specified static pressure conditions
- D. Provide an allowance for one sheave and one belt change for each unit during balancing procedures.
- E. Fan systems over 7.5 horsepower shall have a drive assembly with a minimum of two belts. Drive assembly shall be properly tensioned and aligned at the factory. Belt drives shall include removable belt guards.

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- F. Construction of unit components including but not limited to intake plenums, discharge plenums, and access sections shall be the same construction as the air handling unit casing.
- G. Submit overall sound information including discharge and radiated sound levels for each air handling unit.
- H. Prior to startup, provide final cleaning of air handling units to remove road debris from interior and exterior of unit.

PART 2: PRODUCTS

2.1 UNIT FRAME AND CASING CONSTRUCTION

- A. Unit base shall be constructed from 5 inches structural steel. Base frame deflection shall be less than $\frac{1}{360}$ of the unit length. All major components shall be supported by the base without sagging. Base shall be designed to accommodate curb installation.
- B. Unit panels shall be double wall construction using 2 inches thick mineral wool insulation or flexible elastomeric insulation (minimum R8.4),
 - 1. Exterior sheet shall be G90 galvanized steel factory painted exterior panels, minimum 16 gauge.
 - 2. The interior liners of the outdoor air supply portion of the unit shall be 22 gauge galvanized steel except as noted otherwise for ERU-4 (in humidifier section and downstream of humidifier in fan section).
 - 3. The interior liner of the exhaust air portion of the unit shall be 22 gauge, Type 304 or 316 stainless steel on ERU-1, 2, and 4. Galvanized steel is acceptable for ERU-2.
- C. Unit panels shall be attached with zinc plated hexagonal-head type screws or pop rivets complete with washer and rubber gasket for weatherproof assembly. All panel seams shall be caulked and sealed for an airtight unit.
- D. The unit frame shall be constructed to allow for panel removal without affecting the unit integrity.
- E. Internal partitions shall be double wall insulated and constructed in the same manner as the unit exterior panels.
- F. Unit casing floors in walk in sections shall be fabricated with 14 g. (2.0 millimeters) galvanized floor with rust resistant non-skid coating. Provide reinforcing channels under floor to minimize deflection.
- G. Provide stainless steel drain under complete fan section where fan is downstream of humidifier. (ERU-4).
- H. Compressor compartment shall be insulated with 2 inches thick nominal 3 pounds/cubic feet density acoustic insulation.
- I. Unit shall have a 1 percent minimum roof pitch to prevent water accumulation. Rain gutters shall be provided above access doors. All roof joint seams shall be “T” shape construction, minimum height of 1 inch, metal strip sealed and encapsulated. The unit shall be designed to resist snow, ice and wind loads.
- J. Double-sloped IAQ drain pans shall be made of formed sections of stainless steel. Drain pans shall be minimum 2 inches deep and sloped at a minimum of 1.5 percent with a drain pipe connection of 1- $\frac{1}{4}$ inches MPT. All drain pan corners shall be welded. Pans shall extend a minimum of 6 inches downstream of the cooling coil face.
- K. Air intakes shall be through louvers or intake hoods as indicated on the drawings.

2.2 ACCESS DOORS

- A. Provide full size access door(s) allowing for periodic maintenance and inspections for all serviceable components. Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, compressors, heat exchangers, coils, access plenums and humidifiers, electrical control panels and compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
- B. Units shall be provided with hinged access doors in welded steel frames. Doors shall be fully lined, complete with bulb trim seal gasket and Leverlok handles, operable from both sides. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label and safety chain must be affixed.
- C. Doors shall be double wall construction (same construction as unit panels). Door insulation shall be the same as unit panels. Door frames shall be extruded aluminum with a built-in thermal break barrier.
- D. Provide hold-open device on access doors.
- E. Door openings shall be flush with all surrounding panels.

2.3 FANS

- A. Fans shall be factory-tested and performance ratings shall comply with AMCA 210.
- B. Fans shall be statically and dynamically designed and balanced for continuous operation at the maximum rated fan speed and motor horsepower in accordance with AMCA 300.
- C. Fans shall be of single width, single inlet plug/plenum centrifugal type, AMCA arrangement 3, with airfoil wheels, rigidly braced and reinforced to help prevent vibration or pulsation. Wheel diameters shall be in accordance with the sizes adopted by AMCA.
- D. Fan and motor assemblies shall be mounted inside the unit casing with 2 inches (90 percent minimum efficiency) static deflection spring vibration isolators and supplied with flexible neoprene connections. Thrust restraint isolators shall be provided to minimize axial movement.
- E. Removable shipping restraints shall be provided to protect the fan, motor and base during shipment.
- F. Fan shaft shall be solid steel, turned, ground, polished and finished off with a corrosion resistant coating. Fan wheels shall be keyed to the shaft.
- G. Bearings shall be heavy duty, grease-lubricated, self-aligning ball or pillow block type, selected for a L10 life in excess of 80000 hours at maximum operating speed in accordance with AFBMA 9 Standards. Provide extended lube lines near to the fan section access door.
- H. Fan drives shall be designed for a minimum 1.3 service factor. Drives shall be factory-mounted with final alignment and belt adjustment completed before unit start-up.
- I. Motors and fan pulleys shall be of fixed pitch. Provide for at least one sheave change out during testing and balancing operations.
- J. Provide open mesh bent guards and inlet screens.

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- K. Variable frequency drives: Provide variable volume control for the units via an adjustable frequency drive. Refer to Division 23, Section 230530: Adjustable Frequency Drives for requirements. The drives shall be factory mounted.
 - 1. The unit refrigeration design shall permit the supply airflow to be as low as 35 percent of the peak (scheduled) unit cubic feet per minute while maintaining stable operation.
- L. Dual Supply Fans (ERU-4): ERU-4 shall be furnished with dual supply fans and independent variable frequency drives. The fans shall normally operate simultaneously, however each fan shall be capable of lone operation. Provide backdraft dampers to prevent unintended reverse flow through an idle fan.

2.4 FAN MOTORS

- A. Motors shall be enclosed in the unit casing and mounted on adjustable bases that allow for belt alignment and tensioning.
- B. Fan motors shall be heavy duty, 1800 revolutions per minute, provided per specification Division 23, Section 230513: Common Motor Requirements for HVAC.
- C. Fan motor torque shall efficiently accelerate the drive loads.

2.5 FILTERS

- A. Filters shall be of UL 900 Class II. Filter sections shall be equipped with galvanized universal holding frames with upstream access. Filters change out shall be side service.
- B. Outdoor air supply side filters shall be flat orientation, with the filter air velocity not exceeding 500 feet per minute. Exhaust side filters shall be angled to produce a filter velocity not exceeding 370 feet per minute.
- C. Unit shall include 2 inches thick pleated media disposable-type air filters on both the supply and exhaust sides of the unit, upstream of the heat pipe heat exchanger:
 - 1. Filters shall be constructed of non-woven cotton and synthetic media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the entering air and exiting side of each pleat. The filter media shall have an approximate 30 percent Dust spot efficiency (ASHRAE Standard 52.1-92) and minimum MERV 8 rating (ASHRAE 52.2-1999).
 - 2. ERU-4 shall have a second 4 inches pleated media filter bank just downstream of the supply pre-filters rated at 65 percent efficiency/MERV-11.
- D. Unit shall include filter gauges at each filter bank:
 - 1. Filter gauges shall be equal to Dwyer 3000 Photohelic air gauge with single pole double throw switch for control system alarm signal. Provide complete with static pressure taps and aluminum tubing. Filter gauge to have a range of 0 to 1 inch for the 30 percent filters and 0 to 1-½ inches for the 65 percent filters.

2.6 DAMPERS

- A. Unit shall be equipped with outside air and exhaust air isolation dampers. Dampers shall be parallel blade type suitable for operating between minus 40 and 212 degrees Fahrenheit. The outdoor air damper shall be located at the unit outdoor air intake. The exhaust air damper shall be on the building exhaust (return) air inlet.

- B. Operation: Dampers shall be motorized. Damper Control shall provide a two-position, normally closed electric damper operator. This damper operator shall be interlocked so that when the unit is shut down, or on a power failure, the damper shall return to the closed position. The supply fan shall not be permitted to run until the Outside Air damper is confirmed open.
- C. Leakage: Air leakage through a 48 inches by 48 inches damper shall not exceed 10.3 cubic feet per minute /square feet against 4 inches water gauge differential static pressure at standard air condition. Standard air leakage data to be Burt Hill Project 08082.00 June 26, 2009 Baldwin Wallace University, Thomas Family Center for Science and Innovation – Renovation and Addition, rated in accordance with AMCA certified rating program. Dampers shall be certified low leak dampers tested to AMCA Standard 500-89 by an accredited test laboratory.
- D. Construction: Dampers blades shall be 18 gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall “nest” in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 48 inches. Damper linkage brackets shall be constructed of galvanized metal.

2.7 INTEGRATED WATER SOURCE HEAT PUMP

- A. Unit shall have a sealed refrigerant circuit(s) including a reversing valve, evaporator coil, coaxial water-to-refrigerant condenser coil, thermostatic expansion valve, scroll compressors, hot gas bypass valve on lead compressor, high and low side access valves and safety controls. The system shall be specifically designed to utilize refrigerant R410A or R-407C.
 - 1. The unit shall have a minimum of two independent refrigerant circuits, and no fewer than four (4) compressors total. The unit shall have a minimum of five (5) capacity steps, not including off. The use of hot gas bypass on the lead circuit as a stage of capacity control (only) is acceptable.
- B. Reversing Valve (if required by the specific unit design):
 - 1. A reversing valve shall reverse the refrigerant flow through the water and air coils in the heating mode. Valve shall have an accessible steel body with a full port pin guided spool for low refrigerant pressure drop. The solenoid valve shall be UL approved for continuous operation in all temperature and humidity conditions.
 - 2. Check valves shall allow reverse refrigerant flow to bypass the opposite cycle expansion valve and filter drier.
 - 3. A suction accumulator and receiver tank shall be used for refrigerant management. The receiver tank shall be specially designed for reverse flow operation.
- C. Evaporator Coil:
 - 1. Coil shall have ARI Standard 410 certification and bear the ARI symbol.
 - 2. Coil shall be tested to be leak-free with nitrogen at 500 pounds per square inch gauge underwater. The entire refrigerant piping circuit shall be leak-tested at 150 pounds per square inch gauge air pressure.
 - 3. Coil tube size and wall thickness is $\frac{5}{8}$ inches by 0.020 inches. Fins shall be made of 0.0075 inches thick aluminum and mechanically bonded to copper tubes.
 - 4. Casings and endplates shall be made of 16 gauge stainless steel. Double flanged casings on the top and bottom of finned height shall be provided to allow for coil stacking.

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5. Distributor shall be designed to have a removable nozzle to allow for installing an auxiliary side connection for hot gas bypass.

D. Hot Gas (Condenser) Heating Coil: The condenser heating coil shall be located downstream of the cooling coil and capable of providing modulating reheat for dehumidification, and meeting the winter heating loads.

Supplementary electric heat to meet this requirement is not acceptable.

1. ERU-4 does not require a hot gas re-heat coil.

E. Condenser:

1. Condenser shall be of coaxial tube-in-tube type, be provided with cupronickel inner tubes and steel outer tubes (shells), and be selected with 15 degrees Fahrenheit sub-cooling;
2. The condenser shall have maximum working pressures of 400 pounds per square inch gauge on the water side and 620 pounds per square inch gauge on the refrigerant side, and be UL and CSA approved.

F. Compressors:

1. Compressor shall be hermetically sealed scroll type with a forced-feed lubrication system and oil charge.
2. Compressor motor shall be refrigerant gas-cooled with inherent internal line break protection and mounted on rubber grommet isolators.
3. Compressor shall include internal pressure relief valve, gas sensor and device to limit the shut-down noise caused by scroll reversal.
4. One stage of capacity reduction scheduled may be provided by hot gas bypass on lead compressor.
5. Compressor shall have discharge, hot gas bypass and liquid service valves. Each compressor shall have a crankcase heater that is independently fused and will remain energized at all times unless unit is disconnected at the main power source.
6. Scroll compressors shall be provided with rubber in shear vibration isolators.
7. System shall include discharge service valves.

G. Refrigeration Circuit:

1. Entire refrigerant piping circuit shall be leak-tested at 150 pounds per square inch gauge air pressure.
2. The complete refrigerant piping shall be dehydrated, factory-charged with R410a refrigerant, and then factory-tested in both the heating and cooling modes with full water flow.
3. Refrigerant circuit components shall include: thermal expansion valve, distributor, liquid line filter drier, sight glass and charging valve.
4. Safety controls shall include a high and low refrigerant pressure switch on each circuit for protection against loss of charge.
5. Refrigerant piping shall be type L or ACR copper.

6. Safety controls shall include a high and low refrigerant pressure switch on each circuit for protection against loss of charge.

H. Provide the following water source heat pump options:

1. Unit shall include a water regulating valve and shall include an additional refrigerant pressure access port for the water regulating valve equalizer line. The water regulating valve operate shall prevent condenser freezing during cold start-up.
2. Unit shall have refrigerant, condenser water and condensate piping insulated with $\frac{3}{8}$ inches thick elastomeric pipe insulation.
3. Unit shall have a low leaving source (geothermal) water temperature (freeze stat) safety switch. The trip point shall recognize entering water temperatures as low as 40 degrees Fahrenheit. and a propylene glycol percentage of 15 percent, while preventing nuisance trips.

2.8 ELECTRIC PRE-HEAT (ERU-1, 2, AND 3 ONLY)

- A. Electric resistance heaters shall be provided in the capacities, voltage, and steps of control as noted in the schedules and shall bear a listing or certification mark from an authorized agency.
- B. Heater elements shall be installed a minimum of 12 inches downstream from air filters. Insulation in heating sections shall be fiber-reinforced foil faced. Should discharge air exceed 105 degrees Fahrenheit, employ motors in air stream with Class F insulation. Over 150 degrees Fahrenheit discharge air temperature, mount motors out of the heated air stream.
- C. Heater element wiring shall terminate in a full height enclosure at one end of the heater. All internal wiring shall terminate on clearly identified terminal blocks. A wiring diagram shall be provided on the enclosure cover.
- D. Heaters shall be equipped with an automatic reset disc type thermal cut-out. Heaters rated at 30 kilowatts and less shall be equipped with an additional manual reset disc type thermal cut-out.
- E. Heater elements shall be open type nickel-chromium construction, ($\frac{2}{3}$ nickel, $\frac{1}{3}$ chromium) with a maximum of 22.5 kilowatts/foot (Sheathed coils shall be a maximum of 13 kilowatts/foot). Coil terminal pins shall be mechanically secured and insulated from the frame by means of non-rotating ceramic bushings.
- F. Electric heater elements mounted in a corrosive air stream, as indicated in the schedules, shall be encased in an electrically isolated protective metal sheath, specially selected for the environment, and filled with magnesium oxide, fully compacted.
- G. Heating coil casings shall be corrosion resistant and made of galvanized steel of suitable gauge as required by approval agency.
- H. Electric Heat Control shall be complete with solid state discharge air control with Silicon Controlled Rectifier (SCR) performing time based sine wave phase control. The SCR shall be controlled by a factory installed solid-state proportional integral controller.
 1. Sequencer capable of reset from a Building Management System (BMS) using a 0 to 10 volts DC or 4 to 20 milliamps signal as coordinated with the Temperature Controls Contractor.
 2. The heaters will provide pre-heat only upon sensing the beginning of a frost condition and will be controlled to maintain a discharge temperature just above the frost temperature to minimize the energy consumption of the electric heaters.

2.9 DIRECT USE SOURCE WATER PRE-HEAT COIL (ERU-4 ONLY)

- A. Provide an outdoor air pre-heat coil upstream of the heat pipe constructed of seamless copper tubes mechanically expanded into flat-plate extended aluminum fins and galvanized steel casings. Tubes, headers, connection nipples and copper return bends shall be brazed into an integral assembly with a high silver brazing alloy.
 - 1. The fluid shall be the source water supply. All piping and valving required to divert a portion of the source water provided to the unit shall be internal and part of the ERU package. The controls and automatic control valves for this coil shall also be factory provided.
 - 2. Coils shall have capacities scheduled on the drawings.
 - 3. Elements shall be completely drainable, with individual drain headers to insure positive drainage of tubes and return bends.
 - 4. Coils shall be guaranteed for operating pressures up to 125 pounds per square inch gauge and shall withstand hydrostatic tests of 250 pounds per square inch gauge.

2.10 ELECTRIC HUMIDIFIER (ERU-4 ONLY)

- A. The humidifier shall be tested and approved by ETL/ETL-C Testing Laboratories, Inc
- B. The humidifier shall have an evaporating reservoir with a gasket sealed cover which is capable of operating at pressures of at least 19 inches water gauge without steam or water leaks. The reservoir shall be made of type 304 stainless steel with welded joints.
- C. The humidifier shall be designed to facilitate easy removal of the heater assembly for periodic scale removal and inspection. The cover and heater assembly shall be secured to the unit by the use of quick release clamps. The heater assembly shall be removable from the side of the humidifier without disturbing the cover or injection tube system's steam supply piping.
- D. An adjustable surface water flusher shall be included to drain away a portion of the water upon each refill cycle. This is to allow mineral deposits produced by earlier evaporation cycles to be removed. Flusher height should be adjustable for minimal water waste and efficient flushing.
- E. The immersion heater(s) shall be incoloy clad and designed for 80 watts per square inch. Expansion and contraction of the heater(s) sheath allows mineral build-up to flake off.
- F. Water Level Control: A brass body, solenoid operated water fill valve shall be factory mounted on the top near the front of the humidifier reservoir. A bottom fill system shall be utilized to prevent any collapse of the steam head during the fill process. The fill valve shall be located to allow a minimum water gap of 1 ½ inches (3.81 centimeters). An inline strainer shall be factory provided Burt Hill Project 08082.00 June 26, 2009 Baldwin Wallace University, Thomas Family Center for Science & Innovation – Renovation & Addition, mounted upstream of the fill valve to remove any water born particulate matter before the humidifier fill valve. The water strainer shall have a removable screen to permit periodic inspection and cleaning.
- G. The humidifier shall incorporate a condensate cooler using domestic water to temper the discharge to no greater than 140 degrees Fahrenheit.
- H. Automatic Controls (factory provided):
 - 1. The humidifier shall have a manual reset over-temperature switch factory installed on the humidifier reservoir. The temperature switch shall provide humidifier over-temperature protection.

2. A programmable microprocessor control module shall be factory mounted on the cover of the control panel and shall electronically control the automatic refilling, low water cutoff, high water cut-off, manual surface water flushing and safety switch interlock functions. When in the flush mode the water fill valve shall stay open for five (5) minutes, then close.
 3. The control module shall control all water level control functions through a Tri-Probe sensor with stainless steel shield mounted on the top front of the humidifier reservoir. The Tri-Probe sensor shall electrically sense the water level within the reservoir.
 4. A motor operated drain valve with a brass body, and a cumulative timer will be incorporated into the microprocessor controller. When the timer is activated the heater(s) will be de-energized and the drain valve will open. The drain period will be field adjustable in 1-hour increments between 1 and 500 hours with the drain duration adjustable in 1-minute increments between 1 and 120 minutes. During the drain period, the humidifying chamber will drain completely and the fill valve will be energized to provide thorough rinsing action. After the drain period is completed, the drain valve will close and the humidifier will refill and provide humidity on demand.
 5. A seasonal drain system shall automatically drain the humidifier after a selected “NONUSE” period. The controller shall automatically reset the humidifier on a call for humidity.
- I. Electrical Connection: The humidifier shall be provided with a factory mounted NEMA 3R or 12 control cabinet with main disconnect switch. The panel shall include a factory wired sub-panel with magnetic contactor(s), Tri-Probe water level control module, fused control circuit transformer, numbered terminal block and heater fuse(s).

2.11 HEAT PIPE ENERGY RECOVERY HEAT EXCHANGERS

- A. General: The heat pipe shall be the sole responsibility of the unit manufacturer. The manufacturer shall guarantee the performance of the pipe as to its total heat transfer capacity, and its operation. Alternate reclaim devices shall meet or exceed the performance noted in the schedules, without exceeding the fan power requirements specified.
- B. Heat Exchanger Design:
1. The heat recovery device shall be an air-to-air heat pipe heat exchanger.
 - a. Plate and frame heat exchangers meeting the performance scheduled and specified will also be permitted at the discretion of the Architect/Engineer, however the maximum unit height scheduled on the drawings will be strictly enforced.
 - b. The basis of design shall be the Engineered Air ‘QDT’ heat pipe.
 2. The heat exchanger core shall be of 1 inch seamless aluminum tubing permanently expanded into aluminum fins. Each tube shall be an individually sealed heat pipe filled with a working fluid conforming to Group 1 in the American National Standard Safety Code for Mechanical Refrigeration. Serpentine coils or coils with tube headers will not be considered equal and shall be bid as an alternate. The secondary surface shall be continuous plate aluminum fins of corrugated design to produce maximum heat transfer efficiency, and reduce the frost threshold of the unit.
- C. Tube Construction:
1. Heat pipe tubes shall be wicked. The capillary wick of each heat pipe shall be an integral part of the inner wall of the tube to provide a completely wetted surface for maximum heat pipe capacity with minimum heat transfer resistance.

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- a. Non wicked heat pipes will not be considered as an equal, unless they have a minimum of 20 percent additional rows, and unit total static pressure does not exceed that scheduled on the drawings.
 2. Provide Heresite P-413, a pure phenolic thermosetting resinous coating to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing.
- D. Air Stream Partition: A partition shall be provided to isolate the exhaust and supply air streams from each other to prevent cross-contamination. The partition shall be two single piece sheet metal tube sheets with foam fill injected in between them to positively seal the two air streams from each other.
- E. Temperature and Frost Control (factory provided): (Incorporating temperature controller and tilt mechanism.)
1. Tilt Mechanism: The heat pipe shall be mounted on a cradle with accompanying linkage, fulcrum, actuator, and controls. Flexible connectors shall be installed to permit the necessary tilting movement of the reclaim coil. The flexible connector shall be a polyester reinforced membrane.
 2. Controller: The controller shall be a solid-state dedicated device manufactured by Engineered Air. Operation shall be to effectively tilt the heat pipe to achieve the following:
 - a. Accurate supply air temperature control
 - b. Summer/winter operation changeover
 - c. Frost control to allow the heat pipes to operate continuously with a maximum of efficiency at design conditions without frost formation

2.12 ROOF CURB

- A. Roof curb shall be supplied by the unit manufacturer for field-assembly. Manufacturer's curb shall be double wall, 24 inches height, with 2 inches thick fiberglass insulation. Curb shall consist of formed 18 gauge galvanized steel sections. Unit base design shall be made for recessed curb installation. Curb shall be provided with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1 inch upturn on the inner perimeter to provide a complete seal against the elements.

2.13 ELECTRICAL COMPONENTS

- A. The unit electrical panel shall be internally fully factory wired configured for the following individual field power connections. Connections shall enter through the bottom of the unit. Each point of connection shall have an external NEMA 3R disconnect.
1. Three phase power feed and disconnect switch for single point unit connection for primary unit power.
 - a. ERU-1, 2, and 3 will be provided with normal power.
 - b. ERU-4 will be provided with emergency power.
 2. The electric humidifier in ERU-4 shall have an independent power connection and disconnect switch. This connection shall not be placed on emergency power.
 3. Separate 115 volts emergency power feed for factory mounted controls and dampers. This connection shall be on emergency power.

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4. Separate 115 volts emergency power feed and isolation and control transformers for DDC system Sub-Contractor's controls. This connection shall be on emergency power.
 5. Separate 115 volts normal power feed for lights and GFCI receptacle (normal power).
- B. Unit Heater: The ERU Manufacturer shall supply and mount an auxiliary electric unit heater within refrigeration cabinet section of the unit. The unit heater shall have separate power connection and integral thermostat and disconnect switch. The unit heater shall be 3.3 kilowatts, 277 volts, single phase, with horizontal discharge and shall have separate power connection. The unit heater shall be manufactured by Markel, Model P3P5103CA-In or equal.
- C. Unit shall be equipped with all necessary high voltage components as follows:
1. Motor starters on all high voltage motors for constant speed applications
 2. Variable frequency drives for supply fan motors
 3. Thermal protection on all high voltage motors
 4. Fuses and fuse holders.
 5. All necessary control transformers
 6. Service disconnect switches
- D. All components shall be fully wired and tested prior to shipping.
- E. Unit shall be completed with all necessary terminal blocks, auxiliary contacts, relays, time delay, and damper actuators with auxiliary switches.
- F. Units shall be equipped with a weatherproof external fused disconnect switch for the three phase power feed. Provide disconnects for each single phase power feed entering the control enclosure
- G. Wiring shall be color coded and shall be numbered at the termination points. A terminal block with screw terminals shall be provided for field connected wiring.
- H. As built wiring diagrams shall be laminated and fastened to the inside of the control panel door. All conduits in the unit shall be EMT or Sealtite type conduit.
- I. The wiring of the units shall be in accordance with the NEC and the entire unit shall carry an ETL listing. All major electrical components shall be UL listed.
- J. Unit shall have a 120 volts AC GFI type convenience outlet accessible from the exterior of the unit.
- K. Lights: Provide marine lights with Lexan bulb covers with metal protective cage in each section provided with an access door. Lights shall be wired in EMT conduit to a switch with pilot light.
- L. Unit shall have marine-type lights complete with a main switch and a switch per access door.
- M. Electrical components associated with the electric preheat coil shall include a fan access door switch to shut down the heater when the door is opened, auxiliary high limit, control circuit disconnect switch, fan-off delay relay, airflow switch, and heating contactors.

2.14 CONTROL SYSTEM

A. The primary unit control system will be furnished by the ATC Sub-Contractor:

1. The building DDC system will be an Andover system provided by:
 - a. U&S Services, Inc.:
95 Stark Street, Tonawanda NY, 14150
Phone: 716-693-4490
Fax: 716-693-5280
Russ Stuber, stuberr@usservicesinc.com
2. The unit manufacturer shall provide unit-mounted, stand-alone microprocessor-based controls to operate all functions related to the heat pipe temperature and frost control, and the humidifier control. All other unit functions shall be under the direct control of automation provided by the ATC sub-Contractor.
3. The heat pipe temperature and frost controls and the humidifier controls shall receive signals from the primary unit DDC system in order to implement the sequence of operations. It is the obligation of the ATC sub-Contractor to fully coordinate with the signal types available from the factory controls.
4. The unit manufacturer shall factory install control devices furnished by the ATC subcontractor and shall wire them to a terminal block located in a NEMA 3R controls enclosure. The ATC sub-Contractor shall field-install the controller in the enclosure and wiring from the controller to the terminal block in the enclosure.
5. The control panel shall be provided with a hinged access door and a locking device.
6. Control panel compartment heaters and thermostats shall be provided if control panels cannot be protected from minimum ambient temperatures.
7. All control devices, except those not mounted directly to the unit, shall be factory-mounted and wired. Control panel shall have a labeled strip to connect all wires for field-installed control components.

B. The units shall be run tested through all modes of operation while at the factory. Operational test logs shall be provided to the architect prior to application for payment for these units. A representative from the energy recovery unit supplier and the DDC subcontractor shall cooperate in the integration of the unit operation and the building control system during field installation. The energy recovery unit supplier shall provide 16 hours of on-site factory technician time per unit supplied to assist in problem solving and integration.

2.15 ACCEPTABLE ERU MANUFACTURERS

A. Basis of design:

1. Engineered Air

B. Acceptable Alternate Manufacturers (provided the specifications, dimensional requirements, thermal performance, and all other criteria are met):

1. Venmar CES Inc.
2. Innovent

PART 3: EXECUTION

3.1 EXAMINATION AND INSTALLATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
- B. Examine casing insulation materials and filter media before unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for condenser piping, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Equipment Mounting: Comply with requirements for vibration isolation devices specified in Division 23, Section 230548: Vibration Controls.
- F. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts". Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- G. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- H. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- I. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect piping to units mounted on vibration isolators with flexible connectors.
- C. Connect condensate drain pans. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- D. Piping: Comply with applicable requirements in Division 23, Section 023211: HVAC Piping. Piping connections shall be made to the underside of the unit within the unit curb.

3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.

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3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor-and return-air dampers open and close, and maintain minimum outdoor-air setting.
7. Install new, clean filters.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for units include the following:

1. Open valves to full open position and turn on power to unit.
2. Energize the unit: verify proper operation of motors, drive systems, fan wheels, energy wheels and heat pump.
3. Adjust fans to indicated revolutions per minute. Replace fan and motor pulleys as required to achieve design conditions.
4. Voltage and current shall be checked to be in accordance with data plate furnished on equipment.
5. Operate units through modes of operation and verify functionality.
6. Operate the heat pump stages first on cooling cycle and then on heating cycle. Coil leaving temper ranges should be in agreement with scheduled values. Loop water temperature entering water source heat pumps shall be between minimum 60 degrees Fahrenheit (50 degrees Fahrenheit for Geothermal Alternate) and maximum 90 degrees Fahrenheit.

3.4 ADJUSTING

- A.** Adjust damper linkages for proper damper operation.
- B.** Comply with requirements in Division 23, Section 230593: Testing, Adjusting, and Balancing' for air-handling system testing, adjusting, and balancing.

3.5 DEMONSTRATION

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

END OF SECTION 238147

SECTION 238239 – ELECTRIC HEATERS

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.
- B. Division 23, Section 230513: Common Motor Requirements for HVAC Equipment for fan motor requirements.

1.2 SUMMARY

- A. This section includes:
 - 1. Cabinet Unit Heaters with Centrifugal Fans and Electric-Resistance Heating Coils
 - 2. Propeller Unit Heaters with Electric-Resistance Heating Coils
 - 3. Wall Heaters with Propeller Fans and Electric-Resistance Heating Coils
 - 4. Electric Convectors
 - 5. Concealed Electric Fan Coil Units
 - 6. Electric Duct Heaters

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, available factory finish colors for selection, and accessories for each product indicated.
- 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.
 - 1. Plans, elevations, sections, and details
 - 2. Location and size of each field connection
 - 3. Details of anchorages and attachments to structure and to supported equipment
 - 4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories
 - 5. Location and arrangement of integral controls
 - 6. Wiring Diagrams: Power, signal, and control wiring
- C. Perimeter moldings for exposed or partially exposed cabinets
- D. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals

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1.4 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.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter for each filter installed.

PART 2: PRODUCTS

2.1 GENERAL

- A. Units shall be UL listed and shall be of the capacity and electrical characteristics indicated on the drawings.
- B. Space Heater Controls (does not apply to electric duct heaters): Remote wall mounted thermostat, low-voltage relay with transformer kit. Tamper-proof thermostats shall be of the bi-metallic, snap-action type with enclosed contacts. They shall be completely concealed behind the front covers and tamper-proof.
 1. If no remote thermostat is indicated on the drawings, a factory installed, unit-mounted thermostat is acceptable.
- C. Thermal cutouts shall be built into the system to shut off the heater in the event of overheating. Units shall include a disconnect switch.
- D. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.
- E. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.2 CABINET UNIT HEATERS

- A. Description: A factory assembled and tested unit complying with ARI 440.
 1. Comply with UL 2021.
- B. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by the Architect.
 1. Vertical Unit, Exposed Front Panels: Minimum 16 gauge, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners
 2. Horizontal Unit, Exposed Bottom Panels: Minimum 16 gauge, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain
 3. Recessing Flanges: Steel, finished to match cabinet
 4. Control Access Door: Key operated
 5. Base: Minimum 0.0528 inch thick steel, finished to match cabinet, 4 inches high with leveling bolts

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- C. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV
- D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- E. Fan and Motor Board: Removable
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor; thermoplastic or painted-steel wheels, and aluminum, painted steel, or galvanized steel fan scrolls
 - 2. Motor: Permanently lubricated multi-speed; resiliently mounted on motor board (Comply with requirements in Division 23, Section 230513: Common Motor Requirements for HVAC Equipment.)
 - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- F. Acceptable Manufacturers:
 - 1. Q Mark
 - 2. Trane
 - 3. Berko
 - 4. Marley
 - 5. Lennox
 - 6. Reznor
 - 7. Markel

2.3 ELECTRIC WALL HEATERS

- A. Electric wall heaters shall include enclosures, heating elements, fans and motors, controls, and safety devices.
- B. Enclosures shall be designed for duty as a recessed rough-in box in either masonry or frame installations. The enclosures shall be 20-gauge galvanized steel and shall contain knockouts for power leads. The front panels shall be of the bar grille type and shall be constructed of 16-gauge cold-rolled steel, welded into a uniform grille and finished in baked enamel. The front grilles shall be surrounded by a decorative aluminum frame.
- C. The fans shall be aluminum. The fan motors shall be totally enclosed. Fan controls shall be of bi-metallic, snap-action type and shall activate fans after heating elements reach operating temperature. An individual fan shall continue to operate after the thermostat is satisfied and until the heating element is cool.

D. Approved Manufacturers:

1. Q-Mark
2. Berko
3. Marley
4. Trane
5. Markel

2.4 ELECTRIC CONVECTORS

- A. Heating Elements: Enclosed in metallic sheath mechanically expanded into aluminum fins, with high-temperature cutout. Element supports eliminate thermal expansion noise.
- B. Accessories: Integral disconnect switch, NEMA KS 1 Type HD with lockable handle and duplex convenience receptacles, NEMA WD 6 configuration 5-15R, located blank sections.
- C. Enclosure: Wall mounting brackets. Minimum 16 gauge sheet steel enclosure braced and stiffened. Bottom-in/slope-top out configuration with integral pencil-proof grille on top.
1. Finish: Selected from manufacturer's standard paint finish options, color selected by Architect.
- D. Manufacturer Markel or approved equal.

2.5 CONCEALED ELECTRIC FAN-COIL UNITS

- A. The fan-heater units shall be factory assembled complete with electric heating coils. Factory mounted control panel shall provide all internal control and fan power wiring for a single point field connection. Provide a factory mounted disconnect switch, pre-wired so as to disconnect all electrical components in the fan package. A single point field connection will be made at the disconnect switch.
1. Casing shall be a minimum of 20-gauge galvanized steel and acoustically insulated with 1 inch fiberglass. The casing shall be UL Listed and meet NFPA and NBFU 90A requirements. Blower casing shall be constructed of heavy Gauge steel and baked enamel finish. The cabinet shall have a throw-away filter (25 percent efficiency), and an acoustically lined return air plenum.
 2. Fan wheel shall be forward curved centrifugal type, dynamically balanced and be driven by direct drive, single speed permanent split capacitor motors.
 - a. Motors shall be single phase, 1050 revolutions per minute. An electronic motor speed control shall be provided to allow continuously adjustable fan speed from minimum to maximum and shall incorporate a minimum voltage stop to insure motor cannot operate in stall mode.
 - b. Fan assembly shall be mounted on a 16-gauge steel sub-base, but shall be internally isolated with rubber-in-shear isolators to prevent vibration transfer to the sub-base. Motors shall also be isolated with rubber-in-shear isolators between the motor mounting legs and the blower casing.
 - c. Fan motor assembly shall be accessible through access panels from both sides and rear of cabinet (bottom and top access panels are not acceptable). Access panels shall have gasket to prevent leakage and vibration transmission.

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- B. An electric heater (hot water optional) shall be part of the total listed package and shall be controlled by pneumatic, electric controls enclosed in a NEMA-1 enclosure on the side of the cabinet. The panel shall be gasket sealed to prevent air leakage. Heater shall be the requested available voltage and phase. Each fan package will be factory tested prior to shipment and certified as such.
- C. Manufacturer Markel or approved equal.

2.6 ELECTRIC DUCT HEATERS

- A. Electrical Heating Coils, Controls, 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. Coil Assembly: Comply with UL 1096.
- C. Casing Assembly: Shall be flanged type with galvanized-steel frame.
- D. Heating Elements: Shall be coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
- E. Over-temperature Protection: Shall be disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
 - 1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage
- F. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - 1. Magnetic contactor
 - 2. Solid-state stepless SCR controller receiving 0 to 10 volts DC or 4 to 20 milliamps signals from the building automation system
 - 3. Airflow proving switch.
- G. Available Manufacturers, subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Indeeco
 - 2. Brasch Manufacturing Co., Inc.
 - 3. Chromalox Wiegand Industrial Division; Emerson Electric Company

2.7 ELECTRIC UNIT HEATER

- A. Cabinet shall be 18-gauge steel with adjustable louvers. Casing shall be phosphate coated and shall have a baked enamel finish.
- B. Unit shall be mountable both horizontally and vertically. Double deflection discharge louvers.
- C. Unit shall have metal sheath type heating elements. Unit shall have automatic reset thermal overload feature.

- D. Motors shall be of the totally enclosed continuous heavy-duty, all-angle operation with built-in thermal overload protection.
- E. Acceptable Manufacturers:
 - 1. Q-Mark
 - 2. Marley
 - 3. Trane
 - 4. Berko
 - 5. Lennox
 - 6. Reznor
 - 7. Markel

PART 3: EXECUTION

3.1 GENERAL

- A. Place unit heaters in operation and check for proper operation of controls.
- B. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- C. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters level and plumb.
- B. Suspend cabinet heaters and propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 23, Section 230529: Hangers and Supports for HVAC. Vibration hangers are specified in Division 23, Section 230548: Vibration Controls.
- C. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26.
- B. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

- B. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Train Owner's Maintenance Personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 238239

SECTION 238413 – HUMIDIFIERS

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- B. 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 the following:
 - 1. Self-Contained Electric Resistance Heater Type Humidifiers
 - 2. Condensate Coolers

1.3 DEFINITION

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 volts or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
 - 1. Wiring Diagrams: Include power, signal, and control wiring.
- C. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: List and label as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, “Commercial and Industrial Humidifiers”.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Supply two (2) sets of replacement ionic bed media with each self-contained humidifier.

1.7 COORDINATION

- A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation and maintenance.

PART 2: PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

- A. General: Humidifier shall use incoloy sheathed electric resistance heaters immersed in water, with disposable ionic bed inserts used to attract solids from boiling water. Ionic beds shall ensure controllability through responsive and consistent humidity output regardless of water quality and minimize downtime required for tank cleaning.
 - 1. Electrode heating elements are not acceptable.
- B. Electric-Resistance Heater Container: Shall be cleanable, ASTM A 666, Type 304 stainless steel. Comply with UL 499 with disposable ionic bed inserts.
- C. Duct Steam Dispersion Manifold: Humidifier shall be supplied with stainless steel steam dispersion tube(s) which provide uniform steam distribution over the entire tube length and shall be supplied at various lengths to adequately span the widest dimension of the duct and shall be equipped with mounting brackets on ends. The tube shall be a ASTM A 666, Type 304 stainless-steel.
- D. Cabinet (locking sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel): Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.
- E. Control Panel:
 - 1. Liquid-crystal display
 - 2. Programmable keyboard
 - 3. Set-point adjustment
 - 4. Warning signal indicating end of ionic bed insert life
 - 5. Low-voltage, control circuit
 - 6. Diagnostic, maintenance, alarm, and status features
 - 7. High-water sensor to prevent overfilling
- F. Controls:
 - 1. Microprocessor-based control system for modulating control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls
 - 2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water
 - 3. Tank drain shall cycle based on operating history in order to conserve water and energy. Drain cycle shall be field adjustable and drain will be tempered by the fill valve.
 - 4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
 - 5. Resistance probe type water level controls: Unit shall monitor tank water level and will shut down power to the heating elements to prevent unsafe operation upon failure of the drain system, fill system, or upon an overcurrent condition.

6. Humidifier shall monitor tank operating history, and display will indicate when unit needs ionic bed replacement. Service life cycle may be field-adapted to match water quality.
7. Humidifier tank shall utilize a thermal safety switch that senses temperature within a heating element to prevent overheating.

G. Accessories:

1. Humidistat: Exhaust duct mounting, solid-state, electronic-sensor controller capable of full modulation control
2. Duct-mounting, high-limit humidistat
3. Airflow switch for preventing humidifier operation without airflow
4. Condensate Cooler: Device that mixes hot water with cold domestic water to maintain a constant drainage temperature of no more than 140 degrees Fahrenheit (Cooler body shall be constructed of Type 304 stainless steel with full welded seams.)
 - a. Thermostatic Control: Brass bodied thermostatically controlled tempering valve
 - b. Capacity: To cool 3 gallons per minute of 212 degrees Fahrenheit water when supplied with domestic water at least 20 pounds per square inch gauge and no warmer than 70 degrees Fahrenheit
 - c. Integral air gap to allow hard piping into plumbing system

H. Approved Manufacturers:

1. Armstrong International, Inc., HumidiClean Series
2. Approved Equal

PART 3: EXECUTION

3.1 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance.
- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible".

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- D. Provide stainless-steel section of ductwork for installation of each manifold mounted in duct system.
 - 1. Construct bottom of stainless steel duct section to function as a drain pan to comply with ASHRAE 62.
 - 2. Connect condensate trap and drainage piping.
- E. Install manifold supply piping pitched to drain condensate back to humidifier.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
 - 2. Install shutoff valve, backflow preventer, and union in humidifier makeup line.
- B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- C. Ground equipment according to Division 26.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections: Burt Hill Project 08082.00 June 26, 2009 Baldwin Wallace University, Thomas Family Center for Science & Innovation – Renovation & Addition
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and Adjust Controls and Safeties: Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 0.

END OF SECTION 238413

SECTION 250000 – Section Index

250900 INSTRUMENTATION AND CONTROLS

SECTION 250900 – INSTRUMENTATION AND CONTROLS

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SECTION 250900 – INSTRUMENTATION AND CONTROLS

PART 1: GENERAL

1.1 Related Documents

- A. Drawings and General Provisions of the Contract, including General Conditions of the Contract, General Conduct of the Work and Special Requirements, and Division 1 Specification sections, apply to this section.

1.2 Overview

- A. This document contains the specification and I/O summaries for the Building Automation System (BAS) at Baldwin Wallace University. The system architecture shall utilize intelligent distributed control modules, located at each site, which communicate over a local controller network. The BAS shall provide Direct Digital Control (DDC), monitored via Microsoft Internet-Explorer, the thin-client user interface. This BAS for the air conditioning, heating and ventilating systems shall interface with other microprocessor based building subsystems as specified.
- B. 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 135-2001, BACnet functionality to assure interoperability between all system components. Both the LonTalk™ protocol and the ANSI/ASHRAE™ Standard 135-2001, BACnet protocol are required to assure that the project is fully supported by the two HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.
- C. It is the intent of this document that all control points, including those at the application level, be brought to the Ethernet network level.
- D. Contractor Alert: Many aspects of the installation and implementation of this project require approval by the University's Physical Plant before the BAS installation shall proceed.

1.3 Related sections

- A. Third-Party Interfacing is required on this project for sub-systems such as:
 1. Roof Top Unit(s)
 2. Chiller(s)
 3. Variable Frequency Drive(s)
 4. Lighting Controls
 5. Electrical Monitoring
 6. OTHER as specified by Baldwin Wallace University

1.4 References

- A. ANSI/ASHRAE 135-2001: BACnet – Data Communication Protocol for Baldwin Wallace University Design Guidelines and Construction Manual

- B. Building Automation Systems: This shall include the Standard and all published Addenda.
- C. Lon: An open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol, as the common communication protocol between all peer-to-peer controllers.

1.5 Definitions

- A. **BAS** refers to the Building Automation System. (In the past, this may have been referred to as CCS, Central Control System, EMS, Energy Management System, or ATC, Automatic Temperature Control.)
- B. **CSC** refers to the Control System Contractor. The CSC is the Contractor responsible for the implementation of this section of the Specifications.
- C. **Gateway** refers to the interface (hardware and/or software) to provide seamless integration by non-BAS equipment manufacturers. Refer to paragraph 2A.2 “BAS Interfacing with third-Party Sub-systems”.
- D. **I/O** refers to Input/Output. Thus, “I/O device” means “Input/Output device”.
- E. **IP** refers to the Internet Protocol.
- F. **OEM** stands for Original Equipment Manufacturer, and refers to the manufacturer of the equipment being provided that includes a microprocessor based building subsystem [RTU(s), Chiller(s), VFD(s), Lighting Controls, and/or Electrical Monitoring] for this Project.
- G. **Object Table(s)** refers to the detailed listing(s) of BACnet objects and the functional requirements using the various operator interfaces for the system. In the past, this/these may have been referred to as “Points List(s)” and “I/O Summary”. Note: For systems using Peer-to- Peer Lon Communications, only the information supplied at the Ethernet level will be BACnet.
- H. **On-line** refers to accessibility via the thin-client user interface.
- I. **Thin-client User Interface** refers to the software program Microsoft Internet Explorer.
- J. **IT** refers to Baldwin Wallace University’s Telecommunications and Networking Services.
- K. **OWS** refers to an Operator Work Station, also seen as Operator Workstation.
- L. **University’s Physical Plant Group** refers to University employees designated by the Baldwin Wallace University Facilities Management.

1.6 Manufacturers:

- A. Automated Logic Corporation (ALC)
- B. Invensys Controls (formerly Siebe/Barber Colman)
- C. Siemens Building Technologies (SBT)
- D. No other manufacturers are allowed.

1.7 Scope of Work

A. Control System Contractor's (CSC) Responsibilities:

1. The CSC shall furnish and install all necessary hardware, wiring, pneumatic tubing, computing equipment and software required to provide a complete and functional system necessary to perform the design intent given in the sequences of operation, and as defined in this specification.
2. The CSC is fully responsible to integrate third party equipment sub-systems when supplied with a BACnet, Lon, or Modbus interface. The CSC and the third party equipment supplier shall work together to ensure proper integration of the systems. All costs associated with the work of this section shall be included in the CSC's contract.
3. The CSC shall coordinate the CSC's work with other trades.

B. System Requirements:

1. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project. All systems and components, except site-specific software, shall have previously been thoroughly tested and proven in actual use prior to installation on this project.
2. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
3. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

C. Equipment

1. System Hardware

a. The CSC shall provide the following:

- 1) Control modules
- 2) All relays, switches, sensing devices, indicating devices, and transducers required to perform the functions listed in Object Table(s)
- 3) All monitoring and control wiring and air tubing
- 4) For this project, the CSC shall provide integration gateway modules and software to interface with third party equipment as specified by the Owner; examples include RTU(s), Chiller(s), VFD(s), Lighting Controls, and/or Electrical Monitoring

Note: If possible, third party equipment manufacturers will supply controllers utilizing BACnet IP, Lon, or Modbus, communications, limiting the gateway modules required by the CSC.

2. System Software:

- a. The CSC shall provide all software identified in this specification. The database required for implementation of these specifications shall be provided by the CSC, including point descriptor, alarm limits, calibration variables, on-line graphics, reports and point summaries. The CSC shall provide and create the system using the latest software release, at the time of Shop Drawing approval.
- b. Site-license: All required software site-license for this project shall be furnished by the CAC.

D. Object Table(s):

1. The system as specified shall monitor, control, and calculate all of the points/objects and perform all the functions as listed in sequences of operation and as shown in control diagrams in this specification.
2. All objects shall be exposed as BACnet Objects, with full Functional Profile information and XIF files (Lon), to facilitate BACnet IP communication between multiple vendors.

E. Codes and Regulations:

1. All electrical equipment and material and its installation shall conform to the current requirements of the following authorities:
 - a. Occupational Safety and Health Act (OSHA)
 - b. National Electric Code (NEC)
 - c. National Fire Code
 - d. International Mechanical Code
 - e. International Building Code
 - f. International Plumbing Code
2. All distributed, application controllers supplied shall be in compliance with the following listings and standards:
 - a. UL916 for Open Energy Management
 - b. FCC Part 15, Sub-Part B, Class A
 - c. CE Electro Magnetic Compatibility
3. The control system manufacturer shall have quality control procedures for design and manufacture of environmental control systems for precise control and comfort, indoor air quality, HVAC plant operation, energy savings and preventative maintenance.
4. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

- F. Building Ethernet Connection Cabling: The CSC shall provide building compatible Ethernet cabling, (typically CAT-5), between Global Building Controller(s)/Router(s) and the Building Telecommunications Closet. The building Ethernet Connection shall be provided by the University (cooperation between Physical Plant and). The CSC shall provide repeaters between Global Building Controllers/Routers and the Building Ethernet Connection as required. Final Building Ethernet Connection shall be coordinated with the University's Physical Plant Group.
- G. Major Systems Cabling: The CSC shall provide all required cabling, between the Global Building Controller location and each location of an Air Handler, Heating System, and/or Chilled Water System Panel.
- H. The CSC shall provide all object mapping and programming to expose all objects to the network level, and shall coordinate object naming conventions and network map requirements with the University's Physical Plant Group. The naming convention shall be submitted with the BAS Shop Drawings for review and approval by the University's Physical Plant.
- I. The CSC shall provide a circuit from an existing Normal/Emergency power panel or an UPS for the Global Building Controller/Routers and, if necessary, repeaters and Application Controllers monitoring emergency equipment. A UPS is to be used only if Normal/Emergency power is not available in the building.
- J. The CSC shall provide router and software to route BACnet messages over the existing Campus Ethernet infrastructure using BACnet standard Annex J routing (BACnet over IP). Existing Campus Ethernet infrastructure has multiple subnets and is capable of routing IP messages.
- K. Refer to Figure 1, Figure 2 and Figure 3 at the end of this section for a graphical indication of the Scope of Work, as it relates to the campus infrastructure and OEM equipment.

1.8 Submittals

- A. Submit under provisions of Division 1.
 - 1. A block diagram of the system showing each console item, and each Distributed Processing Unit (DPU) and their interconnections.
 - 2. The failure mode of the system with regard to both digital and analog control points.
 - 3. A description of the proposed software packages and start-up and diagnostic routines including sample screens and/or outputs of:
 - 4. Typical display and log formats;
 - 5. Lists of available commands, information requests, and advisory messages, and the method of entry and reporting, including language;
 - 6. The formal training programs available to the University.
- B. As soon as Submittals are prepared, an electronic version shall be provided simultaneously with the mailing of the paper copies. This version shall be transmitted in electronic format, via e-mail, to expedite the approval process.
- C. Shop Drawings: The Building Number and Baldwin Wallace University Project Reference Number shall be part of each piece of the Shop Drawings Submittal. All controls drawings shall be B-size (11 inches by 17 inches sheet), C-size (24 inches by 18 inches sheet), or D-size (36 inches by 24 inches sheet), and shall be completed and provided using AutoCAD. A minimum of four (4) copies of shop drawings shall be submitted and shall consist of the following:

1. Shop Drawings shall include:
 - a. Original Specification Compliance Report: See paragraph 1.11.
 - b. Index: The first sheet of the Shop Drawings shall be an Index of all sheets in the set.
 - c. Legend: A description of symbols and acronyms used shall be provided at the beginning of the set of Shop Drawings.
 - d. Communications Riser: A single-page diagram depicting the system architecture complete with a communications riser that shall include room locations and addressing for each controller. Include a Bill of Material for all equipment in this diagram, but not included with the unique controlled systems.
 - e. Device Addressing Scheme: Install controllers implementing an addressing scheme consistent throughout the project, and be submitted, reviewed, and approved by the University's Physical Plant prior to implementation.
 - f. Equipment Numbering: Acronyms used for equipment installed for this project shall be specified on a separate document within the shop drawings labeled, "Equipment Identifier Prefix Acronym". The numbering assigned to equipment installed for this project shall sequentially follow the numbering of existing equipment of the same type in the same building. The equipment numbering scheme shall be submitted, reviewed and approved by the University's Physical Plant prior to implementation.
 - g. Systems Summary: Drawings shall include a table listing each piece of equipment and the area(s) served by each piece of equipment.
 - h. Valve Schedule: The Valve Schedule(s) shall be submitted Baldwin Wallace University. At a minimum the Valve Schedule shall indicate valve service, pressure class, size, type, body material, manufacturer, model #, location, and identification tag.
 - i. Damper Schedule: The Damper Schedule(s) shall be submitted to Baldwin Wallace University. At a minimum the Damper Schedule shall indicate damper service, size, body, manufacturer, model #, location, and identification tag.
 - j. Object Table: Object Table shall include all I/O points, all alarm points and all trend points. Information on each point shall include the following:
 - 1) Point type
 - 2) Point description
 - 3) Point name
 - 4) Alarm limits, if applicable
 - 5) Whether or not a trend is enabled on point
 - 6) What Trend is triggered on, if applicable
 - 7) Whether or not trend historian (archive) is enabled on point
 - 8) Event category

- k. Plans: Drawings shall include the proposed location of all field devices and the routing of the communications cabling.
- l. System Schematic: Drawings shall include a single-line representation of the equipment being controlled, including all field devices required for properly controlling equipment and implementing the sequences of operation for this project.
- m. Sequence of Operation: Drawings shall include Sequences of Operation for each piece of equipment with a unique configuration. The sequences shall be written in English text in such a way as to clearly convey how the design sequence of operation has been implemented by the controls design included in this Submittal. A simple duplication of the design sequence of operation provided in the specification for this project is not acceptable. The Sequences of Operation shall follow the outline below for a pattern of form and content. Each device that is referred to shall have the Device Tag identified in parentheses.
 - 1) Title
 - 2) General (include set points, schedule, etc.)
 - 3) Modes of Operation
 - Unoccupied
 - 1) Heating
 - 2) Cooling
 - Occupied
 - 1) Heating
 - 2) Cooling
 - 3) Interlocks (i.e. fume hoods, exhaust fans, etc.)
 - 4) Safeties (i.e. freeze protection, smoke detector, etc.)
- n. Point-to-point Wiring Details: Drawings shall include point-to-point wiring details and must show all field devices, start-stop arrangement for each piece of equipment, equipment interlocks, controllers, panel devices, wiring terminal numbers and any special information (i.e. shielding requirements) for properly controlling equipment and implementing the required sequences of operation.
- o. Bill of Material: Drawings shall include a bill of the material necessary and used for properly controlling equipment and implementing the required sequences of operation. As- built documents shall include the Valves and Dampers installed.
- p. Configuration Details: Drawings shall include programming and parameter setup information necessary for each controller used to properly control equipment and implement the required sequence of operation.
- q. On-line Graphics: Submit a sample of a typical graphical representation of the equipment, logic and communication riser. The sample can be from a previous project that had the same equipment.
- r. Each unique controlled system or piece of equipment shall include the following items (described above):

- 1) System Schematic
 - 2) Sequence of Operation
 - 3) Point-to-point Wiring Details
 - 4) Bill of Material
 - 5) Configuration Details
 - 6) On-line Graphic (sample)
2. Shop drawings shall be submitted to and approved by the University's Project Manager before any aspect of the BAS installation shall proceed. Therefore, shop drawings must be submitted in time for University's Physical Plant review so that all installations can be completed per the project's completion schedule. Ten working days shall be allowed for the University's Physical Plant to review submittals.
 3. As-Built Drawings shall be created after the final system checkout, by modifying and adding to the Shop Drawings. As-Built Drawings shall show exact installation. The CSC shall deliver two hard copy sets, and two electronic (AutoCAD) sets of As-Built Drawings with copy of the transmittal to the University's Project Manager.
 4. Before final configuration, the CSC shall provide Object Table(s) form(s) to the University's Project Manager that includes:
 - a. Description of all points/objects
 - b. Listing of binary and analog hardware required to interface to the equipment for each function
 - c. Listing of all application programs associated with each piece of equipment
 - d. BACnet device and object instances
 - e. Lon SNVTs with complete Functional profile Information with XIF files
 - f. Event Parameters
 - g. Failure modes for control functions to be performed in case of failure
 5. The CSC shall provide an accurate graphic flow diagram for each software program proposed to be used on the project as part of the submittal process. Revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project, shall be accurately reflected in the "as-built" graphic software flow diagrams required by this specification.

D. Schedule:

1. The CSC shall submit to the University's Project Manager a detailed schedule, identifying all activities from the contract award to system warranty expiration. The schedule shall be coordinated with all other Contractors and shall be submitted within sixty (60) days after the notice to proceed. The schedule shall include, but shall not be limited to, the following milestones:
 - a. Notice to Proceed
 - b. Submit Technical Proposal for review and approval by the University's Project Manager

- c. Submit Shop Drawings, and associated hardware and software documentation
 - d. Receive work approval (*Notice:* No portion of the field installation may begin without the Project Manager's approval of working drawings, and hardware, firmware and software documentation, unless specific written instructions to the contrary are provided by the University's Project Manager.)
 - e. Begin field installation
 - f. Complete installation of all thermowells
 - g. Complete installation of wiring runs
 - h. Complete installation of remote field devices
 - i. Deliver major BAS components and operator interface/telecommunications equipment
 - j. Complete installation of panels, communication equipment, processors, etc.
 - k. Complete installation of operator interface and telecommunications equipment
 - l. Complete identification of all bas equipment
 - m. Complete initial applications engineering and provide the university's project manager with programming and database for review
 - n. Revise programming input variables, as required
 - o. Submit copy of construction mark-up set for review and use in commissioning
 - p. Commission system
 - q. Notify the university's Project Manager, in writing, of system completion and preparations for acceptance testing
 - r. Schedule acceptance testing to permit a member of the University's Physical Plant to be present
 - s. Initiate approved field training
 - t. Complete punch list items
 - u. Submit approved As-Built Drawings
 - v. Complete training
 - w. Initiate warranty period
 - x. Terminate warranty period
2. The CSC shall submit similarly detailed schedule information, revised if necessary, for any additional work which will extend the effectiveness of the BAS and is contracted either concurrent to or immediately following the term of the present installation. It shall be the responsibility of the CSC to alert the University's Project Management of any scheduling conflicts, and to defer to the judgment of the University in the resolution of those conflicts.

3. The CSC shall provide additional workers and/or overtime hours as deemed necessary by the University to meet scheduled completion dates. The CSC will bear any such additional expense, whether the need arises from causes within the CSC's control.
4. Should the CSC fail to maintain any part of the installation schedule, the University reserves the right to require written weekly progress reports. If the University so elects, the CSC shall provide a then-current schedule and shall provide written updates to that schedule to the University on a weekly basis. If this option is exercised by the University, the schedule shall be delivered to the University no later than the Thursday immediately preceding the week during which the schedule will become effective. Bidders will note that it remains the intent of the University to execute all available remedies under this contract to ensure the CSC's Best efforts to satisfy the initial milestone scheduling. All programming tools shall be provided as part of the system. CSC shall provide any system upgrades released during the warranty period free of charge to the University.

E. Operating and Maintenance Manuals

1. Operating and Maintenance (O&M) manuals for the system shall include the Workstation User's Manual and Project Engineering Handbook, and Software Documentation. Project specific manuals shall include detailed information describing the specific installation.
 - a. User's Manual shall contain as a minimum:
 - 1) System overview
 - 2) Networking architecture
 - 3) The object tables
 - 4) The sequences of operation
 - 5) The graphical programming
 - 6) Established set points and schedules
 - 7) Summary of trend objects
 - 8) User manuals for the 'third party' software
 - b. Project Engineering Manual shall contain as a minimum:
 - 1) System architecture overview
 - 2) Hardware cut-sheets and product descriptions
 - 3) Wiring diagrams for all controllers and field hardware
 - 4) Installation, mounting and connection details for all field hardware and accessories
 - 5) Commissioning and setup parameters for all field hardware
 - 6) Maintenance procedures, including final tuning and calibration parameters
 - 7) Spare parts list

- 8) Record Software Documentation shall contain as a minimum:
 - Graphical programming must be represented using either Visio or AutoCAD.
 - Graphical representation of all control logic for every piece of mechanical equipment controlled on the project, together with a glossary or icon symbol library detailing the function of each graphical icon. 'Line by line' computer program documentation is unacceptable.
 - Detailed description of control sequences used to achieve the specified sequences.
- f. PICS: Provide a BACnet Protocol Implementation Conformance Statement (PICS). Provide complete description and documentation of any proprietary services and/or objects.

1.9 Coordination with other Contractors

- A. When the Project involves removal and/or demolition of existing BAS Panel(s) and/or BAS cables (wire or fiber):
 1. Contact the Project Manager and Physical Plant to coordinate the disconnection of the equipment from the active CCS network.
 2. Contact the Project Manager to coordinate the placement of removed equipment into an inventory of Spare Parts for the Building being renovated.
- B. Review the installation of all controlled systems such as air handling equipment, duct work, piping, pumps, chillers, fans, and similar equipment for the purpose of providing the appropriate installing Contractor correct information for wells, relays, panels, access panels, and similar appurtenances required for the control system. Such information shall include physical size, proper location and orientation, and accessibility requirements.
- C. The CSC shall coordinate the installation of all control devices, and shall ensure that supporting work by others such as installation of thermometer wells, pressure taps, orifice plates and flanges, access panels, electronic transducers, and other items required are included. The CSC shall schedule the work to ensure that the items are installed in the proper manner at the appropriate time.

1.10 Contractor (CSC) Experience and Performance

- A. The University requires a BAS that is installed, programmed, commissioned, and serviced by an experienced CSC. To insure the University of proper BAS service and support, the CSC shall be the authorized distributor of the BAS manufacturer for the local area and if requested by the University shall supply proof thereof. In view of this, the CSC shall have installed a minimum of five BASs of the same type and size as the BAS herein specified and shall provide job names, a brief description of the scope of each BAS job, and a point of contact for each job. The actual, local CSC or BAS branch office, rather than the BAS manufacturer, will provide this information.
- B. The CSC shall have a local office or representative staffed with factory-trained engineers, fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components. The CSC shall be responsible for replacement of: the controllers with current job software, printer, PC(s), sensors, and devices at all times for a period of not less than 1 year following project completion, and shall guarantee replacement and software reprogramming of a system in need of repair, within a 24-hour period after notification from the University. In the case of an after-hours emergency, the CSC shall provide afterhours emergency services which will, upon notification of an emergency situation, result in CSC personnel being on-site within four hours if necessary.

1.11 Warranty and Service

- A. Provide warranty under provisions of Division 1.
- B. Provide all services, materials and equipment necessary for the successful operation of this system for a period of one year. Provide all recommended preventive maintenance of the BAS system, which is indicated in the O&M Manuals during this period. In addition, provide two (2) semi-annual visits for testing and evaluating the performance of the networked equipment installed per this specification. One visit shall be during the cooling season and one visit shall be during the heating season. Provide a written report after each visit is complete. Coordinate service visits through the University's Physical Plant. This service visit shall include, but not be limited to, the following:
 - 1. Check calibration and re-calibrate if needed instrumentation sensors for airflow, liquid flow, pressure, humidity, temperature, and transducers. Written records shall be kept indicating the performance of such calibrations along with pertinent data.
 - 2. Check the operation of dampers and damper actuators to assure no lock up has occurred and stroke is proper. Written records shall be kept indicating the performance of such calibrations along with pertinent data.
 - 3. Check the overall system field operations by performing an all-points review (by hard copy or by documenting all-point inquiries). Verify that all monitoring and command points are valid and active.
 - 4. Written records shall be kept indicating the performance of such exercises.
- C. If a problem develops at any time during the warranty/service period, the CSC shall monitor and log the affected BAS point/object for the remainder of the warranty/service period. A "problem" in the above statement will refer to an incident in which any of the following occur:
 - 1. An alarm occurs due to defective control system components or improper installation or programming.
 - 2. Overall performance of the system is compromised due to defective control components or improper installation or programming.
 - 3. Major recalibration (by greater than 5 times the catalogued accuracy) is required for a sensor during one of the service visits.
- D. The CSC shall provide any system software upgrades released during the warranty period, free of charge to the University.

1.12 Comply (without exception)

- A. Exception: Meet the functional intent. For each paragraph/subparagraph, the Contractor shall identify all differences in specific functions stated in the given paragraph/subparagraph and provide a description of what is excluded or how he intends to meet the function specified.
- B. Does Not Comply: Cannot meet specified function and will not provide.

- C. The BMS Contractor is hereby warned against indicating compliance with a given specification item at compliance report time and subsequently including a different non-compliant item at submittal time. References to “industry standard practices” shall not constitute a justification for such a change. Any deviations from the original specification compliance report, a copy of which shall be included with the shop drawing submittal, will not be accepted by the Professional. In addition, all “exceptions” and “does not comply” responses shall be explained in sufficient detail to allow the Professional to evaluate the economic impact of the difference and judge if the impact creates an unfair advantage when pricing alone is the sole evaluation criteria for the overall system. The University reserves the right to require full unconditional compliance with any and all items deemed necessary and/or in the best interest of the project. All submittal data shall clearly indicate sufficient technical information to readily determine specification compliance.
- D. It is recognized that the BMS design for this project, both hardware and software, represents a specific approach to addressing both Owner ease of operation and long-term energy efficiency of the completed HVAC project. To that end, this specification clearly establishes “minimum” hardware, software, installation, commissioning and man-machine interface requirements. While it is clear that there may be distinctions in how different ATC manufacturers configure their hardware and software approaches/solutions for this project, it must be pointed out that this specification establishes “minimum standards applicable to all” named manufacturers. Named manufacturers should not assume that just because they are named as an acceptable manufacturer, they can use lower level hardware and/or software components to meet the functional intent of this specification. Where necessary, because a lower level panel or terminal device fails to satisfy “all” of the specification requirements, manufacturers shall use higher-level hardware to satisfy specification requirements, even if all requirements are exceeded in the process. It remains the intent of this specification to require “greater than or equal to compliance” from all manufacturers not used as the basis of design.
- E. It is also recognized that the hardware and software complexities of current generation BMS products make the equivalent nature of competing product lines ever more difficult to establish. With this in mind, named manufacturers shall also be required to supplement their specification compliance report with a complete technical submittal including:
1. BMS Overview diagram for full system indicating what type of DDC controller will be used for each piece of HVAC equipment
 2. Full hardware specification data sheets for each type of DDC controller to be used
 3. Full hardware specification data sheets for each terminal (sensing/controlled) device to be used
 4. Sample of implemented Sequences of Operation program code sufficient to establish compliance with specification requirements
- F. The Specification Compliance Report and associated Technical Submittal will be reviewed by the University and named manufacturers who fail to establish “greater than or equal to” system design and performance will have their name removed by addendum.

PART 2A: PRODUCTS, HARDWARE

2A.1 Laptop Computer

- A. For all projects Baldwin Wallace University will provide a laptop computer to the University’s Physical Plant personnel prior to the start of the Acceptance Testing (reference subsection 3.11 – Acceptance of Completed BAS Installation).

B. The CSC shall provide and install the control system software and database on the Baldwin Wallace University supplied laptop computer as part of the project. The Baldwin Wallace University supplied laptop computer shall have the following minimum characteristics:

1. Manufacturer Dell, Inspiron 600m
2. Configuration: IBM compatible, Pentium M Processor 725.
3. Minimum memory: 1gigabyte DDR SDRAM 2 DIMMs
4. Minimum processor speed: 1.6 gigahertz
5. Minimum Front Buss Speed: 400 megahertz
6. Warranty: Manufacturer's standard warranty, minimum one (1) year.
7. Display: 15 inches XGA color monitor.
8. Floppy disk drive: 1.44 megabytes
9. Hard disk drive: 60 gigabytes, minimum
10. Optical drive: CD-RW
11. PC Slots: Connectors for (1) Type I or Type II cards
12. Network Interface Card: 3 com 10/100 PC card adapter
13. Wireless Networking Card: Intel PRO/Wireless 2200 Internal Wireless (802.11 b/g, 54 megabits per second)
14. I/O Ports:
 - a. 9-pin serial connector (a must)
 - b. Serial infrared communication port (IrDA-1.1 compliant)
 - c. 15-pin monitor connector
 - d. USB (Universal Serial Bus) 2.0
15. Power: Lithium Ion battery, 53 watt energy per hour (WH), A/C adapter
16. Operating system: Microsoft Windows Professional, SP2, with Media and with NTFS File System for all Operating Systems.
17. Nylon carrying case.

2A.2 Networking/Communications

A. The design of the hardware and software shall incorporate a new server that will communicate with all Global Building Controllers via BACnet IP, using Baldwin Wallace University's existing LAN. The campus LAN uses IP communication protocol.

1. Ethernet Switch: Baldwin Wallace University will supply an Ethernet switch for each building. It is the CSC's responsibility to supply and install all cabling required to connect to the supplied switch. All network parameters must be assigned and approved by the University's Project Manager prior to implementation.
- B. The system must be fully BACnet compliant at the time of installation. This means that the system must use BACnet as the native communication protocol between workstations or servers on the network.
- C. The BACnet communication protocol is the required protocol of the network. Note: LonTalk and Siemens P1 are also an acceptable communications protocol for peer-to-peer communications between Application Controllers.

2A.3 BAS INTERFACING WITH THIRD-PARTY SUB-SYSTEMS

- A. General: The CSC shall integrate all sub-systems to the BAS, using Lon or native BACnet. A sub-system shall be integrated via a gateway that converts the proprietary protocol to Lon or BACnet protocol. Sub-systems include RTU(s), VFD(s), Chiller(s), Lighting Controls and/or Electrical Monitoring provided as part of this project (refer to Figure 1, Figure 2 and Figure 3 at the end of this specification section and related specification sections). These sub-systems shall be controlled, monitored and graphically programmed through the Graphical User Interface (GUI) software of the BAS. *Note:* Third party sub-systems shall communicate via BACnet IP, Lon, Modbus if available, eliminating the need for most Gateways.
- B. The CSC shall coordinate with the third party sub-system supplier to ensure integration of the third party system into the BAS.
- C. Gateway: The gateway(s), required for the sub-system(s), shall be provided by the OEM. The gateway(s) is(are) further specified below:
 1. All system information specified in the sequence of operation and related documents shall be available to the BAS. Read and write capability, as indicated by an object table provided by the OEM, shall be provided to the mechanical and electrical equipment indicated and be available to the BAS system. The OEM shall provide to the CSC, a table of gateway objects and their functionality, including normal operating limits (i.e. high and low oil temperature limits from a chiller control panel).
 2. Define how the proposed gateway interaction with equipment will comply with this section. OEMs shall bid a fully BACnet IP compliant device to facilitate interoperability between OEM electrical/mechanical sub-systems and the BACnet BAS or provide the necessary gateway to integrate into the web-based BACnet BAS (WebCTRL, Apogee, or I/A) using the BACnet, Siemens P1, or LonTalk protocol.
 - a. The OEM shall provide any software or hardware required to access or modify any electrical/mechanical subsystems (i.e. RTUs, VFD, Chillers, Lighting Controls and/or Electrical Monitoring).
 - b. Typical gateway requirements for projects include: A BACnet interface to the chiller manufacturer's product(s), a BACnet interface to the lighting controls manufacturer's product(s), a Modbus interface to the VFD manufacturer's product(s), a Modbus interface to the electrical monitoring manufacturer's product(s) (Cutler-Hammer), a Modbus or BACnet interface to the lab equipment manufacturer's product(s).
 3. If the equipment manufacturer does not have this capability, they shall contact the authorized representative of the CSC for assistance and shall include in their equipment price any necessary hardware and/or software obtained from the CSC to comply with this section.

- D. OEM Configuration Tools and Licenses: Configuration Tools, and all software licenses, required to configure all OEM controllers installed on this project shall be provided.

2A.4 GLOBAL BUILDING CONTROLLER/ROUTER

A. Acceptable Products:

1. ALC: LGE or LGR Ethernet Router, ME-Line
2. Invensys: Universal Network Controller
3. Siemens: Apogee MBC or MEC

B. General – Global Building Controller/Router:

1. The Global Building Controller/Router shall be a microprocessor based communications device. One of the functions of the Global Building Controller/Router is to provide a communications gateway between a controller network and an IP Ethernet network. The Global Building Controller/Router shall communicate via IP and be connected to the Baldwin Wallace University campus Ethernet infrastructure. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification. Controller networks shall use either BACnet, Siemens P1, or LonTalk protocol.
2. The Global Building Controller/Router shall support a network of at least 50 controllers.
3. The Global Building Controller/Router shall provide a port which can be connected to Operator Workstations, portable computers, or modems.
4. Global Building Controller/Router shall provide full arbitration between multiple users, whether they are communicating through the same or different Global Building Controller/Routers.
5. The Global Building Controller/Router shall be responsible for routing global information from the various controller networks which may be installed throughout a building.

C. Memory: Each Global Building Controller/Router shall have sufficient memory to support its own operating system and databases including:

1. Control Processes
2. Energy Management Applications
3. Alarm Management
4. Historical/Trend Data for all points
5. Maintenance Support Applications
6. Custom Processes
7. Operator I/O
8. Serial Communications

- D. Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, application controllers, sensors, and actuators.

- E. Integrated On-Line Diagnostics: Each Global Building Controller/Router shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The Global Building Controller/Router shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each Global Building Controller.
- F. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage.
- G. Power Failure Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all Global Building Controllers/Routers to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical Global Building Controller/Router configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - 1. Upon restoration of normal power, the Global Building Controller/Router shall automatically resume full operation without manual intervention.
 - 2. Should Global Building Controller/Router memory be lost for any reason, the user shall have the capability of reloading the Global Building Controller/Router via the Local Area Network (LAN).
- H. Communications:
 - 1. The controller network shall use BACnet as its native communication protocol. The communication between controllers shall be ARCNET or MS/TP at least 38.4 Kbps. LonTalk and is also an acceptable communications protocol for peer-to-peer communications between Application Controllers.
 - 2. The Global Building Controller/Router shall utilize FLASH memory, battery backed RAM or firmware which shall allow for operating system updates to be performed remotely via TCP/IP or UDP/IP.
- I. UPS: Uninterruptible Power Supply(s) is(are) required for the Global Building Controller(s), and Application Controllers that monitor emergency equipment, if Normal/Emergency Power is not available in the building.

2A.5 APPLICATION CONTROLLERS

A. Acceptable Products:

- 1. ALC: M-Line, ME-line, S-Line and SE-Line Controllers, ZN-Line Controllers
- 2. Invensys: MNL-50, MNL-100, MNL-110, MNL-130, MNL-150, MNL-200, MNL-800, MNL-V1, MNL-V2, MNL-V3
- 3. Siemens: Apogee System FLN Devices

B. General – Application Controllers:

- 1. Application controllers must use BACnet, Siemens P1, or LonTalk as the native communication protocol between controllers.
- 2. Each Application Controller must be capable of standalone direct digital operation utilizing its own processor, non-volatile flash memory, I/O, minimum 8 bit A to D conversion, and include voltage transient. Firmware revisions to the module must be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.

3. The Application Controllers shall be expandable to the specified I/O point requirements.
4. All point data, algorithms and application software within the controllers shall be custom programmable from the Operator Workstation.
5. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/write-able nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.
6. Each Application Controller shall be configured on the workstation/server software as a BACnet device or Lon SNVT. All of the points shall be configured as BACnet objects or Lon SNVTs. Each controller shall include self-test diagnostics which allow the controller to automatically relay to the Global Building Controller/Router any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.
7. Each Application Controller shall be capable of performing event notification (alarming).
8. Each Application Controller shall contain both software and firmware to perform full DDC PID control loops.
9. Each Application Controller shall contain a port for the interface of maintenance personnel's portable computer. All network interrogation shall be possible through this port.
10. The Application Controllers shall be capable of being mounted directly in or on equipment located outdoors.
11. Input-Output Processing:
 - a. Digital outputs shall be relays or triacs, 24 volts AC or DC minimum. Each output shall be configurable as normally open or normally closed.
 - b. Universal inputs shall be capable of 0 to 5 volts DC, 0 to 20 milliamps, and dry contact.
 - c. Analog output shall be electronic, voltage mode 0 to 10 volts DC or current mode 4 to 20 milliamps.
 - d. Analog pneumatic outputs shall be 0 to 20 pounds per inch. Analog pneumatic outputs may require use of external I/P transducer. Each pneumatic output shall have a feedback transducer to be used in the system for any software programming needs. The feedback transducer shall measure the actual pounds per inch output value and not a calculated value. An LED shall indicate the state of each output.
 - e. All programming sequences shall be stored in non-volatile memory. All programming tools shall be provided as part of the system. Provide documentation of all programming including configuration files.
12. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the Application Controller. All operating parameters for application programs residing in each Application Controller shall be stored in read/write-able nonvolatile flash memory within the controller. Firmware revisions, application programs and program modifications to the controller shall be capable of being performed over the Wide Area Network (WAN).
13. Each Application Controller shall be able to support various types of zone temperature sensors, such as temperature sensor only, temperature sensor with built-in local override switch, with set point adjustment switch.

14. Each Application Controller for VAV application shall have a built-in air flow transducer for accurate air flow measurement in order to provide the Pressure Independent VAV operation.
15. Each Application Controller for VAV applications shall have an integral direct coupled electronic actuator. The actuator shall provide on-off/floating point control with a minimum of 35 in-pound of torque. The assembly shall mount directly to the damper operating shaft. The actuator shall not require any limit switches, and shall be electronically protected against overload. When reaching the damper or actuator end position, the actuator shall automatically stop. The gears shall be manually disengaged with a button on the assembly cover. The position of the actuator shall be indicated by a visual pointer. The assembly shall have an anti-rotational strap.
16. Each Application Controller shall have LED indication for visual status of communication, power.
17. Astronomical Time: Astronomic capability shall allow the system to calculate sunrise and sunset times based on geographical location, and incorporate Daylight Savings Time, for dusk-to-dawn control or dusk-to-time control. This is required in any Application Controller with I/O for the Exterior lighting circuit(s), as a back-up to light level measurement control.
18. In the event of a loss of communication, the Application Controller shall control from a standalone algorithm which maintains the assigned space temperature until communication is restored.
19. UPS: Uninterruptible Power Supply(s) is (are) required for any Application Controller that monitors emergency equipment, if Normal/Emergency Power is not available in the building.
20. All Application Controller level objects shall be exposed as BACnet Objects or LON SNVTs with full Functional Profiles and XIF files provided.

2A.6 SERVER

- A. A. For this project, Baldwin Wallace University will provide a fully configured server. The CSC shall provide and install all software required by the BAS system.

2A.7 LAPTOP COMPUTER

- A. For this project, the CSC shall provide the Laptop Computer to the University's Physical Plant prior to the start of the Acceptance Testing (reference subsection 3.11 – Acceptance of Completed Bas Installation).
- B. Provide a new laptop computer with the control system software and database as part of the project. The exact model is not critical, but the new laptop computer shall have the following minimum characteristics:
 1. Manufacturer Dell, Inspiron 600m
 2. Configuration: IBM compatible, Pentium M Processor 725
 3. Minimum memory: 1GB DDR SDRAM 2 DIMMs
 4. Minimum processor speed: 1.6 gigahertz
 5. Minimum Front Bus Speed: 400 megahertz
 6. Warranty: Manufacturer's standard warranty, minimum one (1) year
 7. Display: 15 inches XGA color monitor

8. Floppy disk drive: 1.44 megabytes
9. Hard disk drive: 60 gigabytes, minimum
10. Optical drive: CD-RW
11. PC Slots: Connectors for (1) Type I or Type II cards
12. Network Interface Card: 3com 10/100 PC card adapter
13. Wireless Networking Card: Intel PRO/Wireless 2200 Internal Wireless (802.11 b/g, 54 megabits per second)
14. I/O Ports:
15. 9-pin serial connector (a must)
16. Serial infrared communication port (IrDA-1.1 compliant)
17. 15-pin monitor connector
18. USB (Universal Serial Bus) 2.0
19. Power: Lithium Ion battery, 53 watt energy per hour (WH), A/C adapter
20. Operating system: Microsoft Windows Professional, SP2, with Media and with NTFS File System for all Operating Systems
21. Nylon carrying-case

2A.8 FIELD HARDWARE/INSTRUMENTATION

A. Input Devices – General Requirements:

1. Temperature sensors shall be of the type and have accuracy ratings as indicated and/or required for the application and shall permit accuracy rating of within 1 percent of the temperature range of their intended use.
2. Sensors used for mixed air application shall be the averaging type and have an accuracy of plus/minus 1 degree Fahrenheit.
3. Outside air temperature sensors shall have a minimum range of minus 52 to 152 degrees Fahrenheit and an accuracy of within ± 1 degrees Fahrenheit in this temperature range.
4. Room temperature sensors shall have an accuracy of plus/minus 1.0 degrees Fahrenheit in the range of 32 to 96 degrees Fahrenheit.
5. Chilled water and condenser water sensors shall have an accuracy of plus/minus 0.25 degrees Fahrenheit in their range of application.
6. Hot water temperature sensors shall have an accuracy of plus/minus 0.75 degrees Fahrenheit over the range of their application.

2A.9 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

1. Thermistor temperature sensors as follows:

- a. Accuracy: Plus or minus 0.5 degrees Fahrenheit (0.3 degrees Celsius) at calibration point
- b. Wire: Twisted, shielded-pair cable
- c. Insertion Elements in Ducts: Single point, 18 inches (20 centimeter) long; use where not affected by temperature stratification or where ducts are smaller than 9 square feet (1 square meter)
- d. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 square feet (1 square meter); length as required
- e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 millimeters)
- f. Room Sensors: Match room thermostats, locking cover
- g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight
- h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws

2. Resistance Temperature Detectors: Platinum

- a. Accuracy: Plus or minus 0.2 percent at calibration point
- b. Wire: Twisted, shielded-pair cable
- c. Insertion Elements in Ducts: Single point, 18 inches (20 centimeter) long; use where not affected by temperature stratification or where ducts are smaller than 9 square feet (1 square meter)
- d. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 9 square feet (1 square meter); length as required
- e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 millimeters)
- f. Room Sensors: Match room thermostats, locking cover
- g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight
- h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws

3. Humidity Sensors: Bulk polymer sensor element

- a. Accuracy: 5 percent full range with linear output
- b. Another standard span for room sensors below is 20 to 90 percent relative humidity with 2 percent accuracy

- c. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity
- d. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity
- 4. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent
 - b. Output: 4 to 20 milliamps
 - c. Building Static-Pressure Range: 0 to 0.25 inch water gauge (0 to 62 pascals)
 - d. Duct Static-Pressure Range: 0 to 5 inches water gauge (0 to 1243 pascals)
 - e. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 milliamps
- B. Equipment operation sensors as follows:
 - 1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches water gauge (0 to 1243 pascals)
 - 2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 pounds per square inch gauge (55 to 414 kilopascals)
 - 3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current
- C. Digital-to-Pneumatic Transducers: Convert plus or minus 12 volts DC pulse-width modulation outputs, or continuous proportional current or voltage to 0 to 20 pounds per square inch gauge (0 to 138 kilopascals)
- D. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle (For chilled-water applications, provide vapor proof type.)
- E. Carbon-Monoxide Detectors: Single or multichannel, dual-level detectors, using solid-state sensors with three (3) year minimum life, maximum 15-minute sensor replacement, suitable over a temperature range of 23 to 130 degrees Fahrenheit (minus 5 to plus 55 degrees Celsius), calibrated for 50 and 100 parts per million, with maximum 120 seconds response time to 100 parts per million carbon monoxide
- F. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23 to 130 degrees Fahrenheit (minus 5 to plus 55 degrees Celsius), calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 milliamps output, and wall mounted
- G. Occupancy Sensor: Dual technology, with time delay, daylight sensor lockout, sensitivity control, and 180 degrees field of view with vertical sensing adjustment, for flush mounting

2A.10 THERMOSTATS

- A. Combination Thermostat and Fan Switches: Line-voltage thermostat with two-, three-, or four- position, push-button or lever-operated fan switch.
 - 1. Label switches: “Fan on-off,” “fan high-low-off,” “fan high- med- low-off”. (Provide unit for mounting on two-gang switch box.)
- B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellow sactuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.
 - 1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
 - 2. Dead Band: Shall be maximum 2 degrees Fahrenheit (1 degrees Celsius).
- C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated
 - 1. Bulbs in water lines with separate wells of same material as bulb
 - 2. Bulbs in air ducts with flanges and shields
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument
 - 5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application
 - 6. Modulating Thermostats: Constructed so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.e
- D. Room thermostat accessories include the following:
 - 1. Insulating Bases: For thermostats located on exterior walls
 - 2. Thermostat Guards: Locking, solid metal, ventilated
 - 3. Adjusting Key: As required for calibration and cover screws
 - 4. Aspirating Boxes: For flush-mounted aspirating thermostats
 - 5. Set-Point Adjustment: ½ inch (13 millimeters) diameter, adjustment knob
- E. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 millimeters) of bulb length is equal to or below set point
 - 1. Bulb Length: Minimum 20 feet (6 meters)
 - 2. Quantity: One thermostat for every 20 square feet (2 square meter) of coil surface

2A.11 VALVE AND DAMPER ACTUATORS

- A. Electronic direct-coupled actuation shall be provided. Actuators shall have a minimum 5-year equipment warranty.
- B. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.
- C. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
- D. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of failsafe operation are acceptable for valves larger than 4 inches.
- E. All spring return actuators shall be capable of both, clockwise or counterclockwise, spring return operation.
- F. Proportional actuators shall accept a 0 to 10 volts DC or 0 to 20 milliamps analog control input and provide a 2 to 10 volts DC or 4 to 20 milliamps operating range. An actuator capable of accepting a pulse width modulating control signal is not acceptable. An actuator capable of accepting a three-point floating control signal is not acceptable.
- G. All 24 volts AC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 volt-ampere for AC or more than 8 watts for DC applications. Actuators operating on 120 volts AC power shall not require more than 10 volt-ampere. Actuators operating on 230 volts AC shall not require more than 11 volt-ampere.
- H. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-pound of torque shall have a manual crank for this purpose.
- I. All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
- J. Actuators shall be provided with a conduit fitting.
- K. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
- L. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

2A.12 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Globe Valves NPS 2 (DN 50) and Smaller: Bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

- C. Globe Valves NPS 2-1/2 (DN 65) and larger: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc
- D. Hydronic system globe valves shall have the following characteristics:
 - 1. Rating: Pressure class based on maximum pressure and temperature rating of piping system
 - 2. Internal Construction: Replaceable plugs and seats of stainless steel or brass
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
 - 3. Sizing: 3 pounds per inch gauge (21 kilopascals) maximum pressure drop at design flow rate
 - 4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.
- E. Butterfly Valves: Pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - 1. Body Style: Lug
 - 2. Disc Type: Elastomer-coated ductile iron, or disc rated for applicable service
 - 3. Sizing: 1 pounds per inch gauge (7 kilopascals) maximum pressure drop at design flow rate
- F. Terminal Unit Control Valves: Characterized ball, forged brass body, stainless steel trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends
 - 1. Rating: Class 125 for service at 125 pounds per square inch gauge (862 kilopascals) and 250 degrees Fahrenheit (121 degrees Celsius) operating conditions, or applicable service rating per codes.
 - 2. Sizing: 3 pounds per inch gauge (21 kilopascals) maximum pressure drop at design flow rate, to close against pump shutoff head.
 - 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

PART 2B: PRODUCTS, SOFTWARE

2B.1 SYSTEM SOFTWARE OVERVIEW

- A. Acceptable Products:
 - 1. ALC: Eikon and WebCTRL are acceptable ALC System Software products.
 - 2. Invensys: Enterprise Server, Workplace Pro and Workplace Tech are acceptable I/A System Software products.
 - 3. Siemens: Apogee

- B. The CSC shall provide all software required for operation of the BAS system specified herein. All functionality described herein shall be regarded as a minimum.

The CSC shall provide the following as a minimum:

1. Completed database
2. Configuration of all controller and operator workstation application programs to provide the sequence of operation indicated
3. All Configuration Tools, and all software licenses, required to configure all controllers installed on this project

2B.2 SYSTEM CONFIGURATION

- A. Database Creation and Modification: All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through a portable computer or central workstation.
- B. The system shall permit the operator to perform, as a minimum, the following:
 1. Add and delete points/objects.
 2. Modify point parameters.
 3. Create and modify control sequences and programs.
 4. Reconfigure application programs.
- C. All data points/objects within the database shall be completely accessible as independent or dependent variables for custom programming, calculation, interlocking, or manipulation.
- D. The University shall be provided with a software account that has unlimited privileges for the entire site installation.

2B.3 GRAPHIC PROGRAMMING

- A. The system software shall include Graphic Programming for all DDC control algorithms resident in individual control modules. Any system that does not use a drag and drop method of graphical icon programming as described herein shall be unacceptable. Line by line computer code shall also be unacceptable. This graphic programming shall be used to create the sequences of operation necessary to complete a control sequence. Blocks shall represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each block shall be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming shall be performed while on screen and using a mouse; each block shall be selected from a block library and assembled with other blocks necessary to complete the specified sequence. Blocks are then interconnected on screen using graphic “wires”, each forming a logical connection. Once assembled, each logical grouping of blocks and their interconnecting wires then forms a program which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

- C. The clarity of the graphic sequence must be such that the user has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self- documenting and provide the user with an understandable and exact representation of each sequence of operation.
- D. Full simulation capability shall be provided with the graphic programming. User shall be able to fully simulate the constructed sequence on screen.
- E. The following is a minimum definition of the capabilities of the Graphic Programming software:
 - 1. Program – Shall be a collection of points/objects, blocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 - 2. Logical I/O – Input/Output points/objects which shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 - 3. BACnet Points/objects – Shall be points/objects that comply with the BACnet structure as defined in the BACnet standard.
 - 4. SNVT- Shall be Standard Network Variables for their LonMark profile as documented by the LonMark Interoperability Association.
 - 5. Blocks – Shall be software devices which are represented graphically and may be connected together to perform a specified sequence.
 - 6. Wires – Shall be graphical elements which are used to form logical connections between blocks, and between blocks and logical I/O. Different wire types shall be used depending on whether the signal they conduct is analog or digital.
 - 7. Labels – Labels shall be similar to wires in that they are used to form logical connections between two points/objects. Labels shall form a connection by reference instead of a visual connection, i.e. two points/objects labeled 'A' on a drawing are logically connected even though there is no wire between them.
 - 8. Parameter – A parameter shall be a value, which may be tied to the input of a block. Each parameter will then be and can be modified to varying degrees based upon the appropriate password level being used by the operator. Different parameter blocks shall be used depending on whether the parameter is digital or analog.
 - 9. Constant – A constant shall be a coefficient which is used in various calculations. Certain coefficients which are used in various calculations always remain constant and therefore should be constants which are embedded in the program and should not be parameters. Different constant blocks shall be used depending on whether the constant is digital or analog.
 - 10. Icon – An icon shall be graphic representation of a software program. Each graphic block has an icon associated with it which graphically describes it function.
 - 11. Menu-bar Icon – Shall be an icon which is displayed on the menu bar on the screen which represents its associated graphic block.
 - 12. Passwords – each block shall have its own assignable password level.

2B.4 DIRECT DIGITAL CONTROL SOFTWARE

- A. Each control module shall perform the following functions:
 - 1. Identify and report alarm condition.
 - 2. Execute all application programs indicated on the Object Table(s).
 - 3. Execute DDC algorithms.
 - 4. Trend and store data.
- B. In the event of a loss of communication, all lower controller and components shall revert to occupied mode..
 - 1. Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.
 - 2. Upon resumption of power, the control module shall automatically restart and printout the time and date of the power failure and restoration at the respective workstation system.
 - 3. The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

2B.5 SOFTWARE USER INTERFACE

- A. The on-line graphics, scheduling, and events shall be created using the Automated Logic WebCTRL, Siemens Apogee, or Invensys Enterprise Server/Workplace Pro software.
- B. All of the system objects, schedules, and events shall be capable of being represented as BACnet objects by the CSC.
- C. Events (Alarms):
 - 1. The CSC shall provide all alarm event notification and alarm events messages for objects on the object table provided to and approved by the University's Physical Plant.
 - 2. Alarm event notification, alarm event messages, and event routing shall be in accordance with the existing Baldwin Wallace University standards.
 - 3. CSC implemented events objects:
 - a. All I/O objects listed on the object tables for each piece of equipment shall have an event defined for the off-normal condition.
 - b. Analog objects shall list the high and low alarm limits.
 - c. Every device connected to the system shall also be alarmed for an offline condition
 - d. Two notification classes shall be defined to route alarms.
 - 1) Critical alarms shall be printed, logged, and pop-up windows shall occur via an email notification.
 - 2) Maintenance level alarms shall be printed and logged.
 - e. An event shall be generated for a device communications failure. All devices shall have this feature implemented.

D. On-line Graphics:

1. The on-line graphics shall be provided by either an approved Automated Logic Corporation (ALC) dealer, Siemens Pittsburgh branch, or an approved Invensys IFO. The on-line graphics submittal shall be submitted to the CSC to be included with the Shop Drawing Submittal, for review and approval by the University's Project Manager.
2. On-line Graphics Submittal by the CSC shall include a list of the color graphic screens to be provided and sample graphics for each unique mechanical system.
3. All mechanical equipment shall have a representative graphic.
 - a. Graphical representation shall be of the mechanical equipment hierarchy for the project, including all equipment controlled by the BAS.
 - b. Hypertext links to the cooling source and heating source of each piece of equipment shall be defined on the graphic.
 - c. Object in alarm condition shall be shown red and signify "Alarm" on the graphic.
 - d. The device communication status shall be displayed on all equipment on-line graphics.
 - e. The program run state shall be displayed on all equipment on-line graphics.
 - f. An on-line text description of the Sequence of Operation shall be provided as a graphics screen.
4. All mechanical equipment shall also have a graphic representing the logic programming: An on-line graphical representation of the programming logic with real-time values, accessible via the standard thin-client user interface program Microsoft Internet Explorer.
5. There shall also be a graphics screen for each communication trunk showing the communication status for each device connected to the system.
 - a. If a device is in communications failure, the controller color shall be magenta. If the device communications status is normal, the controller color shall be green.
 - b. The program run state of each device shall also be displayed on the communication trunk graphic. If the program is in the normal running state the color should be green. If it is in the halted or failure state, the color should be magenta.
6. All floors in the building shall have a graphic screen.
 - a. Equipment locations and space temperatures shall be displayed on the floor plan graphic.
 - b. Hypertext links to the room controller parameters shall be defined by clicking on the room location the controller serves.
 - c. Hypertext links to equipment parameters shall be defined by clicking on the equipment location on the floor plan.
 - d. Dynamic thermo-graphics shall be defined for each room controller to visually depict the room alarm (event) status of the room. The color-coding is defined below.

7. If the actual space temperature is in the dead band between the heating set point and the cooling set point, the color displayed shall be green for the occupied mode, representing ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing 'after-hours' conditions.
8. If the space temperature rises above the cooling set point, the color shall change to yellow. Upon further rise beyond the cooling set point plus an offset, the color shall change to orange. Upon further rise beyond the cooling set point plus the yellow band offset, plus the orange band offset, the color shall change to red indicating unacceptable high temperature conditions. At this point an alarm shall be generated to notify the operator.
9. When space temperature falls below the heating set point, the color shall change to light blue. Upon further temperature decrease below the heating set point minus an offset, the color shall change to dark blue. Upon further space temperature decrease below the heating set point minus the light blue band offset minus the dark blue band offset the color shall change to red indicating unacceptable low temperature conditions. At this point an alarm shall be generated to notify the operator.
10. All graphics screens shall be reviewed, coordinated and approved by the University's Project Manager prior to implementation. Graphical Screens: The following graphical screens, as a minimum, shall be developed for this project.
 - a. Main Screen (GIS Map of Baldwin Wallace University)
 - b. Floor Overviews (with thermographic temperature indication)
 - c. Hot Water System
 - d. Hot Water System Set Points
 - e. Chilled Water System
 - f. Chilled Water System Set Points
 - g. AHUs
 - h. AHU Set Points
 - i. Energy Recovery System and Set Points (as required)
 - j. Laboratory Exhaust System (as required)
 - k. Laboratory Exhaust System Set Points (as required)
 - l. Lab Airside Summary Screen (for each floor, as required)
 - 1) Schedules (one screen per zone)
 - 2) Schedule Overrides (one screen per zone)
 - m. Holiday Schedules
 - n. Individual Graphic Screens for all third part equipment controllers
 - o. HVAC Overview
 - p. Elevator Overview (if communications available with elevator equipment)
 - q. Fire System Overview

- r. Lighting System Overview
 - s. Miscellaneous
11. Graphics architecture shall drill down in a logical sequence.
- a. Main Page Baldwin Wallace University Gis Map
 - b. Building Conditions
 - c. Room Conditions
 - d. Room Sensors
 - e. Equipment serving Room (VAV)
 - f. Building Equipment serving Room Equipment (Air Handler)
 - g. System serving Building Equipment (Hot Water System)
 - h. Building Control As-Builts (Serving Room with Live Data)
 - i. Available Third Party Equipment (Boiler Control Panel)
- E. Scheduling:**
- 1. All equipment occupied/unoccupied scheduling shall be capable of being accomplished via a BACnet BV that is controlled by a BACnet schedule.
 - 2. The CSC shall provide a BACnet BV or Lon SNVT for all VAVs, FCUs, Air Handlers, Exhaust equipment to be implemented in schedules.
 - 3. Equipment schedules shall be coordinated between the University Project Management and the University customer.
 - 4. The system shall allow the operator to designate any combination of equipment to form a group that can be scheduled with a single operator command through the mouse interface at the workstation.
 - a. Any designated group shall have the capability to be a member of another group.
 - b. The operator shall be able to make all schedule additions, modifications and deletions using the mouse and appropriate dialog boxes. In addition, the operator shall have the capability to edit all schedules and then download any or all schedule changes to the control modules with a single operator command through the mouse interface.
 - c. The operator shall be able to view a color-coded forecast of schedules for instant overview of facilities schedules. Schedule graphic forecast shall include colored coded indication of all types of schedules, i.e. normal, holiday and override.
- F. The following applications software, per “programs” in System Points/Objects List(s), shall be provided for the purposes of emergency utility demand limiting and optimizing energy consumption while maintaining occupant comfort:**

1. Time Scheduling

The system shall be capable of scheduling by individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes) Reset Source Temperature Optimization (STO))

- a. The system shall automatically perform source optimization for all air handling units, chillers and boilers in response to the needs of other downstream pieces of equipment, by increasing or decreasing supply temperature set points, i.e. chilled water, discharge air, etc. using University defined parameters. In addition to optimization, the STO capability shall also provide for starting and stopping primary mechanical equipment based on zone occupancy and/or zone load conditions.
- b. The STO program will allow set points for various equipment in the heating/cooling chain to be reset between the university's defined maximum and a minimum set point based on the actual requirements of the building zones. The actual set point shall be calculated based on the number of heating or cooling requests which are currently being received from the equipment or zones served. Once every update period, the STO program surveys the network to see if any piece of equipment requires any additional heating or cooling from its source.
- c. As an example, a VAV air handler is the source of cold air for a number of VAV boxes. Assume that the STO program for the air handler has the following parameters established for it by the University's Physical Plant:

1) Optimized set point description (degrees Fahrenheit):

Initial set point 60.00, maximum set point 65.00, minimum set point 55.00.

Every two (2) minutes, trim by 0.25 and respond by minus 0.50, but no more than 2.0.

Every two (2) minutes, the STO program will total up all of the requests and calculate a new set point:

$$'New\ setpoint' = 'previous\ setpoint' + 'trim\ by' + ('respond\ by' \times 'number\ of\ requests')$$

Assuming four (4) requests were received and the previous set point was 57, the new set point would be:

$$New\ set\ point: 57.00 + 0.25 + (-0.50 \times 4) = 55.25$$

- 2) If the number of requests received multiplied times the 'respond by' value is greater than the 'but no more than' value, the 'but no more than' value is used inside the parenthesis in the above calculation.

2. Set Back/Set Up (Day/Night Setback (DNS))

- a. The system shall allow the space temperature to drift down or up within a preset (adjustable) unoccupied temperature range. The heating or cooling shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.
- b. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100 percent outside air units.
- c. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room in the building if full DDC control is not being effected.

- d. User shall be able to define, modify or delete the following parameters:
 - 1) DNS set point temperature(s)
 - 2) Temperature band for night heating operation
 - 3) Period when the DNS is to be activated
3. Timed Local Override (TLO)
 - a. The system shall have TLO input points/objects, which permit the occupants to request an override of equipment which has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (momentary contact), wind-up timer, or ON/OFF switches as detailed in the Object Table(s).
 - b. If a push button is used the system operator shall be able to define the duration of equipment ON time per input pulse and the total maximum ON time permitted. Override time already entered shall be canceled by the occupant at the input point. If a wind-up timer is used the equipment will stay in override mode until the timer expires. Year to date, month-to-date and current day override history shall be maintained for each TLO input point. History data shall be accessible by the operator at any time and shall be capable of being automatically stored on hard disk and/or printed on a daily basis.
4. Space Temperature Control (STC)
 - a. There shall be two space temperature set points, one for cooling and one for heating, separated by a dead band. Only one of the two set points shall be operative at any time. The cooling set point is operative if the actual space temperature has more recently been equal to or greater than the cooling set point. The heating set point is operative if the actual space temperature has more recently been equal to or less than the heating set point. There are two modes of operation for the set points, one for the occupied mode (example: heating = 72 degrees Fahrenheit, cooling = 76 degrees Fahrenheit and one for the unoccupied mode (example: heating = 55 degrees Fahrenheit, cooling = 90 degrees Fahrenheit).
 - b. The occupied/unoccupied modes may be scheduled by time, date, or day of week via a BACnet BV or Lon SNVT.
 - c. All set points and offsets shall be operator definable. When in the occupied mode, start-up mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.
 - d. The cooling and heating set points may be increased (decreased) under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of set point increase or decrease for each of the three levels. Each space temperature sensor in the building may be programmed independently.
 - e. An optimum start-up program transitions from the unoccupied set points to the occupied set points. The optimum start-up algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope (AI: Space Temperature).
 - f. A PID control loop, comparing the actual space temperature to its set point, shall modulate the dampers and heating coil valve or heating stages in sequence to achieve the set point target.

5. Historical Data and Trend Analysis: A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.
 - a. Continuous Point Histories: Global Building Controllers/Routers shall store point history files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all physical hardware input and output points shall be collected during the warranty period. to allow the user to immediately analyze equipment performance and all problem-related events. Point History Files for binary input or output points and analog output points shall be archived on the server workstation hard drive.
 - b. Control Loop Performance Trends: Global Building Controllers/Routers shall also provide high-resolution sampling capability with an operator-adjustable resolution of 10 to 300 seconds in one-second increments for verification of control loop performance.
 - c. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator- specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours, in one-minute intervals, shall be provided. Each standalone Global Building Controller/Router shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 5000 data samples.
 - d. Data Storage and Archiving: Trend data shall be stored at the Global Building Controllers/Routers, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in third party personal computer applications.
6. Runtime Totalization: Global Building Controllers/Routers shall automatically accumulate and store runtime hours for binary input and output points as specified.
 - a. The Totalization routine shall have a sampling resolution of one minute or less.
 - b. The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.
7. Analog/Pulse Totalization: Global Building Controllers/Routers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
 - a. Totalization shall provide calculation and storage of accumulations of up to 99999.9 units (e.g., kilowatts-hour, gallons, thousands British thermal units (kBTU), tons, etc.).
 - b. The totalization routine shall have a sampling resolution of one minute or less.
 - c. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.
8. Event Totalization: Global Building Controllers/Routers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.
 - a. The Event Totalization feature shall be able to store the records associated with a minimum of 9999999 events before reset.
 - b. The user shall have the ability to define a warning limit. Unique, user specified messages shall be generated when the limit is reached.

PART 3: EXECUTION

3.1 Examination

- A. Verify that systems are complete and ensure that the systems are capable of being started and operated in a safe and normal condition before attempting to operate the BAS systems.
- B. Beginning of work means acceptance of existing conditions.

3.2 General Installation

- A. Install equipment level and plumb.
- B. Install software in control units and, as applicable, in operator workstation desktop PC(s) and laptop computer(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- C. Connect and configure equipment and software to achieve sequence of operation specified.

3.3 Wiring Installation

- A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
- B. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with requirements of applicable Specification Division 26 sections and all national, state, and local electrical codes. All the wiring shall be installed in accordance with the current National Electrical Code (NEC).
- C. Provide wiring as required by functions as specified and as recommended by equipment manufacturer's to serve specified control functions.
- D. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the University's Physical Plant's representative prior to rough-in.
- E. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices in pilot circuits of contactors, starters, relays, etc., and wiring for valve and damper operators.
- F. Install signal, communication, and fiber-optic cables according to the Information Technology section, and as follows:
 - 1. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - 2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
- G. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

- H. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- I. Provide auxiliary pilot duty relays on motor starters as required for control function.
- J. All exposed control wiring and control wiring in the mechanical, electrical, telephone, and similar rooms shall be installed in raceways. Install exposed control wiring system in conduit for electric/electronic control systems. UL plenum-rated cable shall be provided when located in ceiling spaces, plenum wire must be in raceway or conduit. All control wiring shall be installed in a neat and workmanlike manner parallel to building lines with adequate support. Both conduit and plenum wiring shall be supported from or anchored to structural members. Conduit or plenum wiring supported from or anchored to piping, duct supports, the ceiling suspension system, is not acceptable. Provide adequate strain relief for all field terminations.
- K. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

3.4 Control Device Installation

- A. All room sensors and thermostats shall be mounted so as to be accessible in accordance with ADA Guidelines, unless otherwise noted on the drawings. It is the CSC's responsibility for final coordination of the sensor/thermostat locations with the professional and the University's Project Manager.
- B. Remote control devices not in local panels shall be accessible for adjustment and service below 7 feet above finished floor whenever possible.
- C. Locate all temperature control devices wired under Division 16.
- D. Install guards on thermostats in the following locations:
 - 1. Entrances
 - 2. Public areas
 - 3. Where indicated
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Local controllers shall be mounted at eye level for accessibility and service, and located within 50 feet of the system served, unless otherwise shown on the plans.
- G. Freestanding enclosures and panels shall be supported on steel unistrut frames, or approved equal, and be securely anchored to the floor and be well braced.
- H. A minimum of 3 feet working clearance shall be provided in front of all enclosures and panels; clearance shall be ensured to permit the enclosure door to open at least 90 degrees from its closed position.
- I. Mounting height shall be a maximum 6 feet–6 inches to the top of the enclosure.
- J. Shall be suitable for use in environments having an ambient temperature range of 31 to 104 degrees Fahrenheit and a relative humidity of up to 95 percent noncondensing.
- K. There shall be no pneumatic equipment or device installed in a Global Building Controller/Router enclosure. There shall be no equipment or device installed in a Global Building Controller/Router that is not a functional component of the campus system interface or building BAS system.

- L. A padlocking hasp and staple or keyed cylinder shall be provided for each door.
- M. A field-installed, 14-gauge galvanized steel drip shield shall be provided where enclosures and panels may be subjected to dripping water.

3.5 Connections

- A. Piping installation requirements are specified in other sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Ground equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 Control Power

- A. Power supply for Global Building Controllers/Routers and associated BAS components shall be connected via a dedicated circuit to the building normal emergency panel. A grounding conductor shall be run from building service entrance panel ground bus. Conductor shall be insulated and isolated from other grounded conductors and building conduit system.
- B. Power supply for Application Controllers used to monitor emergency equipment and/or equipment serving critical spaces (i.e. Animal Rooms, Computer Server Rooms, etc.) shall be connected via a dedicated circuit to the building normal/emergency panel.
- C. UPS: Uninterruptible Power Supply(s) shall supply power for the Global Building Controller(s), and Application Controllers that monitor emergency equipment, if Normal/Emergency Power is not available in the building.
- D. Provide power for Application Controllers and all associated control components from nearest electrical control panel or as indicated on the electrical drawings— coordinate with Electrical Contractor.
- E. Power for each control panel shall be provided through a switch (standard light switch) located inside the panel. A standard duplex receptacle shall also be provided inside the control panel. The receptacle shall be unswitched. Control transformer(s) shall be located in rated enclosure outside the control panel, and attached to the side of the panel.

3.7 Identification

- A. The CSC shall label each system device with a point address or other clearly identifiable notation inside the device cover. Labels shall be permanent, and method of labeling shall be approved by the University's Project Manager.
- B. All control equipment shall be clearly identified by control shop drawing designation as follows:
 1. Control valves and damper actuators: brass tags or engraved bakelite tags
 2. Other Remote Control Devices: Metal tags or laser-printed, adhesive backed, metalized polyester film labels
 3. Control Enclosures and Panels: Engraved nameplate with panel number and system served

3.8 Trends

- A. All input and output control and status points will have trends programmed. Each trend will store a minimum of 1000 samples utilizing a first-in/first-out algorithm so that the oldest data is over-written as new data is stored. The controller will also be programmed for the capability of enabling historical trending on each trended point individually so that historical trending can be enabled on any point without enabling it on any other trended point.
- B. All trends shall be programmed to be triggered according to the type of point, as follows:
 - 1. All equipment start/stop control point trends will be triggered on the control point's change of state.
 - 2. All equipment status point trends will be triggered on the status point's change of state.
 - 3. All space-temperature and outside-air trends will be triggered on any change of value of 2 degrees Fahrenheit.
 - 4. All space-humidity and outside-air-humidity trends will be triggered on any change of value of 5 percent.
 - 5. All fan air temperature trends will be triggered on any change of value of 5 degrees Fahrenheit.
 - 6. All water temperature trends will be triggered on any change of value of 3 degrees Fahrenheit.
 - 7. All damper motor control point trends will be triggered on any change of value of 10 percent of its control range.
 - 8. All valve control point trends will be triggered on any change of value of 10 percent of its control range.
 - 9. All VFD motor control point trends will be triggered on any change of value of 5 percent of its control range.
 - 10. All fan air static pressure trends will be triggered on any change of value of .05 inches water column.
 - 11. All water pressure trends will be triggered on any change of value of 3 pounds per inch.
 - 12. All steam pressure trends will be triggered on any change of value of 2 percent of the steam pressure input range.

3.9 Alarms

- A. All I/O objects listed on the object tables, for each piece of equipment, shall have an event (alarm) defined for the off-normal condition.
- B. Analog objects shall list the high and low alarm limits.
- C. Every device connected to the system shall also be alarmed for an off-line condition.
 - 1. Two notification classes shall be defined to route alarms:
 - a. Critical alarms shall be printed, logged, and pop-up windows shall occur via an email notification.
 - b. Maintenance level alarms shall be printed and logged.

- D. The event objects and routing shall be reviewed by the University's Physical Plant to identify the class, routing, limits, and message content for each object prior to implementation.
- E. An event shall be generated for a device communications failure. All devices shall have this feature implemented.

3.10 Schedules

- A. A list of schedules to be implemented shall be reviewed and approved by Baldwin Wallace University. The list shall also include the schedule times to be implemented.

3.11 Acceptance of Completed BAS Installation

- A. Acceptance of the completed BAS installation includes verification of the proper equipment communication setup. This shall be accomplished by submitting a BACnet network analysis capture for a period of 5-minutes. The capture file (in .TXT format) shall be submitted to the University's Physical Plant for Review and Approval. For Lon System ATC Contractor must possess a LonManager Protocol Analyzer or equivalent product and be familiar with the capabilities and use of this equipment. Protocol Analyzer shall be utilized to observe, analyze and diagnose the behavior of the installed network. The software package shall include the following tools: Protocol Analyzer Tool, Traffic Analysis Tool, and Network Diagnostics Tool. ATC Contractor shall utilize a Protocol Analyzer Tool to monitor network traffic on all installed control channels for a minimum of twenty-four (24) hours per channel. ATC Contractor shall reconfigure nodes, add repeaters and/or add routers as necessary to maintain traffic at no more than 50 percent of channel bandwidth capacity. The Physical Plant Approval shall be received, and any identified problems shall be resolved before Acceptance Testing shall begin. Corporate assistance shall be requested and used as necessary to resolve any network-issues in a timely fashion. Upon completion of the installation, the CSC shall start up the system and perform all necessary calibration, testing, and debugging operations. An acceptance test shall be performed by the CSC in the presence of the University's Physical Plant representative. Acceptance test shall be scheduled with at least 10 working days advance notice. The acceptance test shall be observed by at least one member from the University's Physical Plant.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 2. Test and adjust controls and safeties.
- C. Replace damaged or malfunctioning controls and equipment.
 - 1. Start, test, and adjust control systems.
 - 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- D. The acceptance test shall include, but not be limited to:
 - 1. The CSC shall submit a checklist of the objects for the test. The checklist shall be submitted to the University's Physical Plant, and reviewed and approved by the University's Physical Plant, prior to the test. The checklist shall include all objects that have event (alarm) routing defined.

2. The CSC and OEM manufacturer shall verify the proper operation of all input/outputs.
 3. The CSC shall verify the proper event (alarm) routing to Physical Plant BAS operations center for all points on the main equipment and perform a spot check of the operations of 10 percent of terminal units equipment.
 4. The CSC shall verify that the software programs meet the design intent of the control sequences in the Construction Documents.
 5. The CSC shall verify the proper operation of the system software on the operator workstation.
 6. The CSC and the OEM manufacturer shall verify all inputs meet or exceed manufacturer's stated tolerances for accuracy.
 7. The CSC shall verify that all on-line graphical displays of equipment accurately represent the real time state of the field equipment.
 8. The CSC shall verify that all on-line graphical displays of programming logic accurately represent the real time state of the field equipment.
 9. The CSC shall verify the reliability of all communications of all field devices to the appropriate operator workstation located in the Physical Plant Building.
 10. The test shall include all workstation/server level integration included in the scope of this project with the CSC and OEM manufacturers.
 11. The test shall include functional verification of all interfaces and system integration required to meet the scope of this project.
 12. Final acceptance shall include acceptance by the University's Physical Plant.
 13. The Acceptance Test shall be conducted with the CSC, OEM manufacturer, the Prime Contractor representative and a member of the University's Physical Plant present.
- E. Turnover of Alarms to Baldwin Wallace University BAS Operators: Alarms being turned over to Baldwin Wallace University BAS Operators shall have been activated, tested for proper routing and determined to not be producing frequent and nuisance alarms. It is expected that Alarms will not be turned-over to Baldwin Wallace University BAS Operators until there is final acceptance of the completed BAS installation.
- F. Acceptance: When the field test procedures have been successfully demonstrated to the University's Physical Plant and the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a Notice of Completion shall be issued by the University's project representative and the warranty period shall start.
- G. All of the points which are alarmed shall be trended and archived from the time of installation through the end of the warranty period. All archived files will be readily accessible to the University's Physical Plant.
- H. Start-up and commission systems: Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- I. Provide any recommendation for system modification in writing to the University's Physical Plant. Do not make any system modification, including operating parameters and control settings, without prior approval of the University's Physical Plant.

- J. Provide certificate stating that control system has been tested and adjusted for proper operation.
- K. Project Record Documentation: After a successful acceptance testing, submit project record drawings of the completed project for final approval. After receiving final approval, supply six (or as specified in Division 1) complete project record sets (maximum ANSI “D” size), together with AutoCAD disks to the University’s Project Management.

3.12 TRAINING

- A. The CSC shall provide factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of the system. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The training shall be specifically oriented to the system and interfacing equipment installed.
- B. Instructions shall include 2 parts, the “New BAS Equipment Orientation” and the “BAS Product Training” as outlined below:
 - 1. New BAS Equipment Orientation: Two (2) 3-hour “walk-through” sessions for the University’s Technical Service employees. This shall include showing where equipment is located throughout the area involved in the project, including –but not limited to- from the major equipment to the locations of controlling and monitoring sensors.
 - a. General – One session will be more general in nature for the Area Services and Weekend Personnel who will be initial responders, dealing mostly with “too hot” or “too cold” calls.
 - b. Technical – One session will be more technical, being oriented for the Central Services Personnel that will need to troubleshoot more complex problems.
 - c. Schedule “walk-through” sessions with the University with at least ten days advance notice. Provide an agenda, to be approved by the University’s Physical Plant prior to scheduling training.
 - d. Project Specific BAS Product Training: This training shall be provided during the period of installation, or at the University’s option, banked for use following the installation period of this contract as “Factory Training Credits”. A minimum of forty (40) hours of instruction from a factory-trained instructor for no less than 5 technicians shall be provided.
 - e. Factory Training Credits shall be used to engage a factory-authorized service representative to train University’s maintenance personnel onsite to adjust, operate, and maintain control systems and components.
 - f. Train University’s Maintenance Personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, operation of portable operator’s terminal and maintaining equipment and schedules.
 - g. Provide operator training on modification of data display, alarm and status descriptors, requesting data, executing command, calibrating and adjusting devices, resetting default values, and requesting logs.
 - h. Provide a student binder with training modules.
 - i. Schedule BAS Product Training sessions with the University with at least twenty (20) days advance notice. Provide an agenda, to be approved by the University’s Project Manager, prior to scheduling training.

3.13 Adjusting and Cleaning

- A. Start-up: Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- C. Final Adjustment: After completion of installation, adjust sensors, thermostats, control valves, motors, and similar equipment provided as work of this section. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

PART 4: SEQUENCES OF OPERATION

4.1 This part shall include sequences of operation, object tables, and control diagrams. The following lists of points represent the minimum acceptable monitoring requirements:

A. Chilled Water System:

- Chilled Water Supply Flow (gallons per minute)
- Pump Status
- Percentage of Load on Chiller
- Kilowatt of Chiller
- Kilowatt/ton (instantaneous value)
- System Load (calculation from temperature difference and gallons per minute)
- Return Chilled Water Temperature
- Supply Chilled Water Temperature
- Kilowatt-hour of Chiller
- Operating Hours of Chiller
- Alarm

B. Heating System:

- Hot Water Supply Flow (gallons per minute)
- Primary Pump Status
- Lead/Lag Status of Converter
- Temperature Control Valve Position
- Hot Water Return Temperature
- Hot Water Supply Temperature
- System Load (calculation from temperature difference and gallons per minute)

C. Air Handler Units (AHUs):

- Supply Fan
- Discharge static Pressure
- Flow at Discharge (cubic feet per minute)
- Supply Fan Revolutions (per minute or hertz)
- Cooling Coil Leaving Air Temperature
- Heating Coil Leaving Air Temperature
- Supply Air Temperature
- Outside Air Temperature
- Exhaust or Relief Damper Position
- Cooling Coil Valve Position
- Heating Coil Valve Position
- Coil Chilled Water Supply Temperature
- Coil Chilled Water Return Temperature
- Coil Hot Water Supply Temperature
- Coil Hot Water Return Temperature
- Duct Static Pressure

D. Laboratory Exhaust Fans:

- Flow near Inlet Fan Revolutions (per minute or hertz)
- Building Static, If Control Point

E. Air Terminal Units:

- Flow (Primary)
- Percentage of Design Flow Cooling
- Percentage of Design Flow Heating
- Supply Air Temperature to Zone
- Zone Space Temperature
- Reheat Valve Position

F. Emergency Generators

G. Domestic Hot Water Systems:

- Hot Water Heaters
- Leaving Temperature
- Recirculating Pumps

H. Domestic Water Booster Pumps

I. Fire Alarm Interface

J. Lighting and Controls

K. Variable Frequency Drives:

- Variable Frequency Drive Start/Stop
- Speed Reference
- Fault Diagnostics
- Meter Points
- Motor Power (horsepower)
- Motor Power (kilowatts)
- Motor Kilowatts-hour
- Motor Current
- Motor Voltage
- Hours Run
- Feedback Signal #1
- Feedback Signal #2
- DC Link Voltage
- Thermal Load on Motor
- Thermal Load on Variable Frequency Drive
- Heatsink Temperature
- Operating Hours

L. NIGHT, SIDEWALK & ROADWAY LIGHTING

1. Each circuit shall have I/O for control and status. When either type of exterior lighting circuit is included in a Project, the following shall be provided:
 - a. Control: Each exterior lighting circuit shall be controlled by each of the following means:

- 1) Automatically via astronomic capability in the Application Controller(s) with I/O for the exterior lighting circuit(s)
 - 2) Via network communications, using the Lighting Master Point at Physical Plant
 - 3) A software toggle, manual on/off control from a BAS graphic
 - 4) A hardware hand-off-auto (BAS control)
- b. Status: Status shall be determined via a current sensor, set-up in software to indicate on status with a current in excess of 80 percent (adjustable) of total circuit current. Where there are multiple phases, each phase shall be monitored. The intent is to know when the lights are on and all but one or two of the lamps are functioning.
- c. Alarm: An alarm shall indicate when a lighting circuit has been turned on, but the status remains off.
- d. Hours-of-Use: An accumulated-time, indicating the total on hours until reset.

M. EMERGENCY SYSTEMS

1. Automatic Transfer Switch (ATS)

NOTE: Automatic (Emergency) Transfer Switches exist in many different applications, including where there is an Emergency Generator, a Fire Pump, or Emergency Standby HVAC equipment. All Automatic (Emergency) Transfer Switches need to include indication of normal and source voltage availability, status, and alarm, per the following.

- a. Normal Source Voltage Availability: The CSC shall use the contacts provided by the ATS Manufacturer/Electrical Contractor. These contacts shall indicate an acceptable source voltage based on ATS settings.
- b. Emergency Source Voltage Availability: The CSC shall use the contacts provided by the ATS Manufacturer/Electrical Contractor. These Contacts shall indicate an acceptable source voltage based on ATS settings.
- c. Status: The CSC shall use the NC contact of the Manufacturer-installed SPDT auxiliary contacts in the Emergency Transfer Switch to provide an input indicating the Status of the ATS.
- d. Alarm: The Status of the ATS shall be alarmed in the BAS, to indicate anytime the ATS has switched to the Emergency source.

2. Emergency Generator (remote exercising capability)

- a. Remote Start/Stop, with no load (See explanation “e.” below.)
- b. Remote Start/Stop, and force a transfer of building load to generator: (see explanation e below, plus means to transfer load)
- c. Status: (See explanation “e.” below.)
- d. Alarm: (See explanation “e.” below.)
- e. The CSC shall utilize the Start/Stop and Status contacts provided in the Emergency Generator Control Panel. Programming written for the Emergency Generator remote exercising shall have the capability to be scheduled. An alarm shall indicate when either:
 - 1) The Start command has been sent to the Emergency Generator, but the Status does not change from “off” to “running”, or

- 2) The Stop command has been sent to the Emergency Generator, but the Status does not change from “running” to “off”. Also, the BAS operator shall be able to Start the Emergency Generator by sending a Start Command to the Emergency Generator, watch for a Status from the Emergency Generator and send a Stop command to the Emergency Generator. (The intent is this replaces the “timeclock” usually provided in a Transfer Switch Control Panel for the exercising purpose.)
3. Emergency Generator (minimum points to be monitored):
 - a. The following points shall be hardwired from NC contacts of the Manufacturer-installed SPDT auxiliary contacts in the Emergency Generator Control Panel, to indicate:
 - 1) Generator Fault Status
 - 2) Low Fuel Level Status
 - 3) Fuel Tank Leak Detector Status
 - 4) Air Damper Status (NOTE: per Paragraph 2A.4 B. 20. Applications Controllers/UPS, the BAS Controller(s) with these Status Points connected, are on Normal/Emergency Power.)
 4. Emergency Generator, Interface provided:
 - a. On installations of Emergency Generators larger than 250KW, the Generator installation will provide a BACnet IP, Lon, or Modbus interface. The CSC shall coordinate with the Generator and/or Interface Manufacturer to communicate with this Interface. The CSC shall provide all necessary programming.

BAS FIGURES (Figure 1, Figure 2, and Figure 3 follow):

Figure 1: Building Automation System with Automated Logic Corporation Product

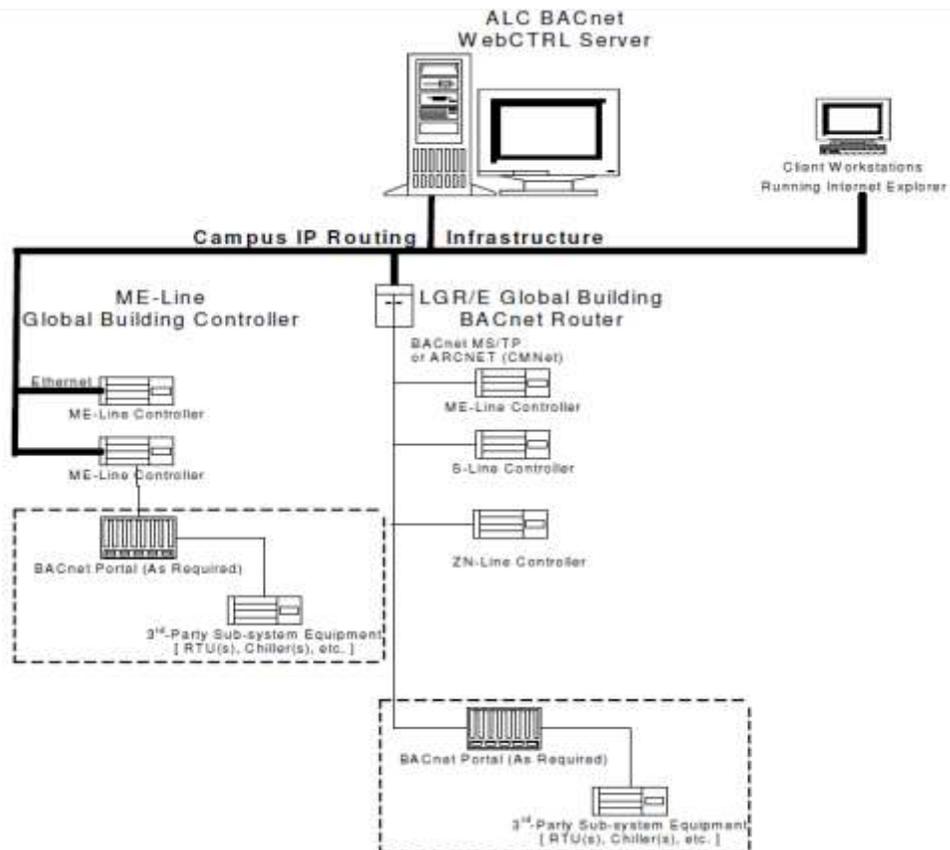


Figure 2: Building Automation System with Siemens (SBT)

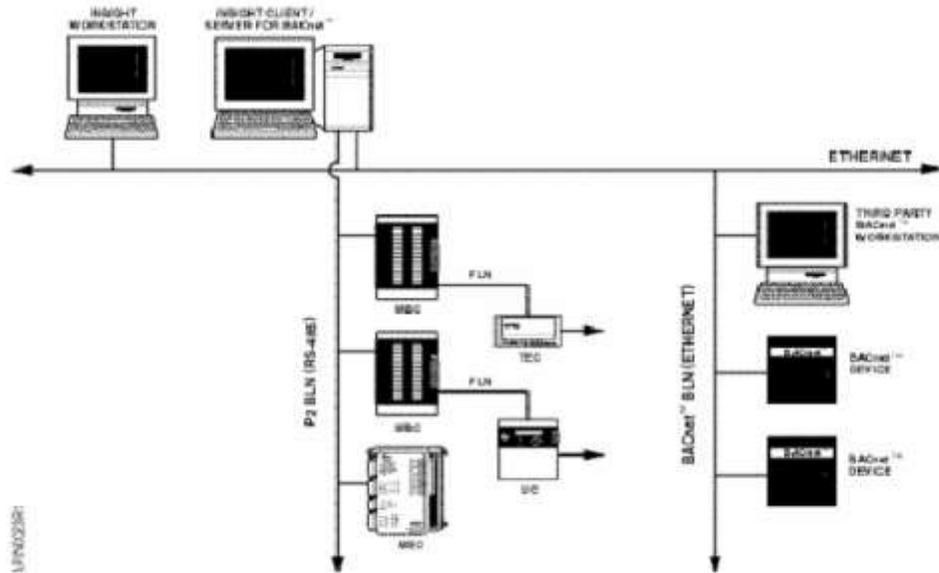
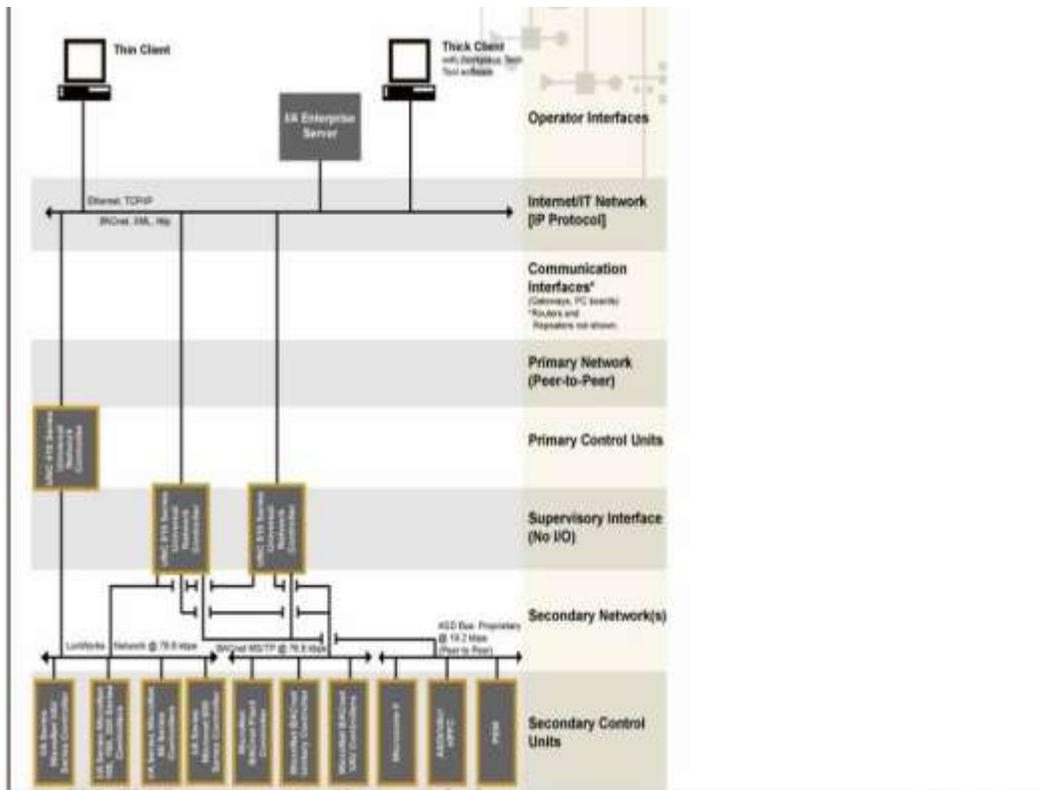


Figure 3: Building Automation System with Invensys



SECTION 260000 – Section Index

- 260500 COMMON WORK ELECTRICAL
- 260505 POWER STUDIES
- 260510 UNDERGROUND WORK
- 260524 MEDIUM VOLTAGE CABLES AND SWITCHES
- 260540 UNDERGROUND DUCT BANKS
- 260913 ELECTRICAL REMOTE MONITORING
- 262100 TRANSFORMERS
- 262500 POWER DISTRIBUTION SYSTEMS
- 263213 PACKAGED ENGINE GENERATED SYSTEMS
- 265100 INTERIOR LIGHTING
- 265600 EXTERIOR LIGHTING

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 All work must meet NEC and be UL listed.
- 1.3 Coordinate colors of all devices including receptacles, switches, data outlets, building management devices and any other finish MEPS.

PART 2: PRODUCTS

- 2.1 The acceptable manufacturers for electrical equipment, including: switchboards, panel boards, motor centers, motor starters, service disconnects, and unit sub-stations, will be UL listed.
- 2.2 Preferred Vendors:
 - A. Square D
 - B. General Electric
 - C. Eaton-Cutler-Hammer. (No EZ Trim, “door in door” panel covers permitted)
 - D. Allen Bradley
 - E. Siemens

PART 3: EXECUTION

- 3.1 MC, AC and Flex Cabling, Cable Tray, and Conduit
 - A. All electrical circuits shall be in conduit. If the Contractor wishes to use anything other than conduit, they must obtain written authorization from Baldwin Wallace University.
 - B. Interior branch circuits shall be in Electric Metallic Tubing (EMT).
 - C. Exterior circuits shall be in rigid galvanized conduit.
 - D. MC, AC and Flex cable shall be permitted for branch circuits in lengths less than 20 feet where located in inaccessible areas, where fished or by permission from Baldwin Wallace University.
 - E. MC, AC and Flex cable is allowable for connections to lights above drop ceiling, motor connections and shall be less than 6feet in length.
 - F. All low voltage wiring, including fire cabling and controls wiring, shall be in cable tray or conduit. Fire and control wiring shall be in separate conduits.
 - G. See Division 26, Section 260510: Underground Work for requirements of underground work.
 - H. All conductors of any voltage will be copper and installed in an approved raceway.
 - I. All magnetic motor starters shall be equipped with a “Hand-off-auto” switch.

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- 3.2 Electrical equipment rooms will have no other equipment in them other than that designed to deliver electrical service to the building. Rooms will be dry and have clean ventilation sized to keep room temperature at 75 degrees Fahrenheit year around.
- 3.3 Initial layout of the panel will leave 20 percent of the available breaker space empty at the time of completion of construction. The conductor in the panel will occupy no more than 20 percent of the panel gutter space at the time of completion of construction.
- 3.4 Minimum conduit size will be ¾ inch on all home runs to panels.
- 3.5 Prints created by a designer will have the panel directories completed on the print. This is the job of the designer and not the Contractor. It will be up to the Contractor to assure that all labels are in place and correct.
- 3.6 All junction boxes shall be labeled with circuit numbers.
- 3.7 Wires and cabling of different voltages shall not be mixed in raceways or conduits.
- 3.8 All rooms that contain heat generating electrical equipment shall be adequately ventilated.
- 3.9 All electrical rooms shall have sealed, painted, or VCT floor covering.
- 3.10 All abandoned equipment, cables and conduits shall be removed. This includes, but is not limited to all fire alarm devices and wiring, old telephone wiring and CATV systems.
- 3.11 Coordinate all panel legends with Baldwin Wallace University Facilities. (Room numbers don't always match construction drawings.)
- 3.12 Panel legends are to include room numbers and circuit description (Lighting, Receptacles, equipment ID's).
- 3.13 All wiring is to be replaced in renovations, no re-use permitted.
- 3.14 No fused disconnects are permitted above ceilings.
- 3.15 Final clean up to include all panel and enclosure tops and dirt catching areas such as Unistrut and any other locations where dirt can collect.
- 3.16 TELE/DATA Room Requirements:
 - A. At a minimum, two (2) 20 amps circuits should be supplied to the room.
 - B. Each circuit should terminate with a 5-20R.
 - C. If generator power is available, an additional 20 amps circuit should be supplied and terminated with a 5-20R.
 - D. A ground bus bar should be installed on the back wall behind racks.
 - E. All current national electric standards must be met.
 - F. See Division 27 for TELE/DATA requirements.
- 3.17 Notify Baldwin Wallace University Electrical Department. at least twenty-four (24) hours before any electrical inspections.

END OF SECTION 260500

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SECTION 260505 – POWER STUDIES

PART 1: GENERAL – NOT USED

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 260505

SECTION 260510 – UNDERGROUND WORK

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

PART 2: PRODUCTS

2.1 Manholes for Electrical Distribution

- A. Manholes shall be in accordance with Baldwin Wallace University standards. Manhole lids shall be in accordance with Baldwin Wallace University standards.
- B. All aluminum doors shall be ¼ inch diamond plate. All aluminum doors shall be designed for ASTM Specifications and live loads shall be increased by 30 percent. Aluminum door hinges shall be aluminum piano type hinges welded directly to the door frame and door top. A ¼” diameter stainless steel hinge pin shall be used to connect the door and the frame.
- C. All pulling eyes shall be designed and reinforced to withstand an ultimate tension of 21000 pounds. All pulling eyes shall be designed and reinforced to permit lifting and setting of the vault.
- D. Manhole knockout areas shall be provided as shown in Detail ELEC-D03. Knockout areas shall be reinforced with size 4x4 or 6x6 wire fabric, and have a minimum thickness of 2 ¼ inches concrete thickness.
- E. Aluminum Frames – all frames shall be provided as follows:
 - 1. Integral Frame: The frame encased in a removable concrete top shall be an integral part and anchored into the concrete top.
- F. All manholes shall have gravity drains.

PART 3: EXECUTION

- 3.1 Any conduit over 600 volts or any building feeds will be concrete encased. Where 'x' voltage over 600 volts is installed inside of a building, it will be labeled, with the largest practical, preprinted labels as “ 'x' volts” every six feet, 80 degrees apart. All duct banks will have at least one spare conduit.
- 3.2 All underground conduits will be Schedule 40 PVC. Conduit installed in non-traffic (pedestrian) areas will be in accordance with Baldwin Wallace University standards. Conduit installed in traffic areas (vehicle) will be encased in concrete.
- 3.3 Underground conduit shall have a 200 pounds test braided nylon line installed in each empty raceway.
- 3.4 Underground conduit for a branch circuit will have 2 inches of sand under the conduit and 4 inches of sand above the conduit. The conduit top will be 24 inches below grade. Marker tape will be installed 8 inches below grade directly above the conduit. The Owner's personnel will inspect the ditch to verify this condition before the ditch is filled.
- 3.5 If more than one conduit is in a ditch and they are to be concrete encased, they will be outfitted with racks to maintain separation between the conductors.

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3.6 All concrete work shall be done in accordance with standard practices and this Specification (Refer to Division 03.)

3.7 All reinforcement bars shall conform to ASTM Standards.

END OF SECTION 260510

SECTION 260524 – MEDIUM VOLTAGE CABLES/SWITCHES

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 The design engineer's calculations, including but not limited to maximum pulling tension and sidewall pressures, shall be made available to the Owner (ten) 10 days prior to any medium voltage cable installation.

PART 2: PRODUCTS

- 2.1 The accepted manufacturers of medium voltage cable. See First Energy Requirements.

PART 3: EXECUTION – NOT USED

END OF SECTION 260524

SECTION 260540 – UNDERGROUND DUCT BANKS

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.

PART 2: PRODUCTS

2.1 N/A

PART 3: EXECUTION

3.1 All underground duct banks, conduits or direct bury cable shall have detectable red warning markers at least 12 inches above installation

3.2 Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.3 Duct Installation

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions. All manholes shall be installed with gravity drains.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12.5 feet, both horizontally and vertically, at other locations, unless otherwise indicated. Contractor may use field fabricating techniques per conduit manufacturer written instructions to achieve binds/curves as necessary.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Existing Manholes: Use end bells, spaced approximately 10 inches on center for 5 inches ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 pounds per square inch gauge hydrostatic pressure.
- F. Concrete-Encased Ducts: Support ducts on duct separators.

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1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with no less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stager separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install ¾ inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross sidewalks, roads, paved areas and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
7. Warning Tape: Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12 inches increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

G. Always provide a spare conduit for each conduit used.

3.4 Pull aluminum or wooden test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

END OF SECTION 260540

SECTION 260913 – ELECTRICAL REMOTE MONITORING

PART 1: GENERAL

1.1 System Description

- A. Provide microprocessor-based metering equipment and all communications and graphics for system.
- B. Communication Link: Coordinate with Baldwin Wallace University technology staff for cable requirements.

1.2 Submittals

- A. Wiring diagrams for system, including all devices, components, and auxiliary equipment: System diagram is unique to the Project system; a manufacturer's generic system diagram is not acceptable. Diagrams differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.

PART 2: PRODUCTS

2.1 Manufacturers

- A. Manufacturers (subject to compliance with requirements, provide products by the following, only):
 - 1. Eaton Cutler-Hammer
 - 2. E-Mon Energy Monitoring
 - 3. Siemens
 - 4. Square D

2.2 Microprocessor-based Metering Equipment

PART 3: EXECUTION

3.1 Installation

- A. General: Install system according to NFPA 70, applicable codes, and manufacturer's printed instructions.
- B. Wiring Method: Install wiring in raceways. Conceal raceways except in unfinished indoor spaces.
- C. Wiring Method: Install wiring in raceways except in accessible indoor ceiling spaces. Conceal raceways and wiring except in unfinished spaces.

END OF SECTION 260913

SECTION 262100 – TRANSFORMERS

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 The substation transformers shall be designed, manufactured, tested and installed in accordance with the latest applicable standards of NEMA and ANSI, particularly NEMA 201 & 210, IEEE 100 and ANSI C57.
- 1.3 Substations shall be surrounded by an 8 feet tall chain link fence with privacy slats. The ground area inside the substation shall be covered with limestone gravel. The gravel and barrier shall extend 3 feet outside of fenceline and 3 feet past gate swing area.

PART 2: PRODUCTS

- 2.1 Transformers must have copper windings.
- 2.2 All transformers with primary voltage of 23 kilovolts shall include a 32-step load tap changer.
- 2.3 All substation transformers shall have high voltage windings that are cylindrical/disc and copper wound. Low voltage coils shall be cylindrical/disc and copper wound. Coils shall be designed to make use of directed fluid flow.
- 2.4 Outdoor substation transformers must be mineral oil filled. Outdoor pad mount transformers shall be mineral oil filled with no load tap changers.
- 2.5 No dry type medium voltage transformers are acceptable out of doors.
- 2.6 Transformer shall be set on modular pre-cast concrete vault/foundations.
- 2.7 Grounding electrode to be installed at foundation and connected to transformer.
- 2.8 Neutral bonding jumper installed at transformer.
- 2.9 No supply side jumpers installed with circuit conductors.
- 2.10 Main bonding jumper to be installed at first disconnect.
- 2.11 Building grounding electrode (steel, water, ring, etc.) bonded to first disconnect.
- 2.12 Loop feed type.
- 2.13 Integral primary fuses.

PART 3: EXECUTION

- 3.1 All exterior transformers shall be surrounded by a fence. If metallic, the fence needs grounded. The grounding grid needs to extend at least 3 feet outside of the fenceline and 3 feet past gate swing area.
- 3.2 Bollards shall be placed around transformers in high traffic areas but they shall not impede access panel opening.

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3.3 All outdoor oil filled transformers shall use mineral oil as the cooling fluid.

3.4 Ensure clearance is provided for maintenance. The space must conform to NEC safe working distances.

3.5 Outdoor oil filled transformers shall be set in a containment area that is served by a sump pump. The pump shall be tied to a liquid level in the transformer that shuts off the pump if the oil level drops. Containment covers shall not be used.

END OF SECTION 262100

SECTION 262500 – POWER DISTRIBUTION SYSTEMS

PART 1: GENERAL

1.1 Work Includes:

- A. Short Circuit Analysis
- B. Coordination Analysis
- C. Arc Flash Analysis

1.2 Related Work Specified Elsewhere:

- A. Electrical General Provisions
- B. Electrical Basic Materials and Methods

PART 2: NOT USED

PART 3: EXECUTION

3.1 Power Distribution Studies:

- A. Contractor shall provide power distribution system studies as outlined below. Studies shall be performed by a registered professional engineer from the manufacturer supplying the electrical distribution equipment or by an independent professional engineering company specializing in such studies, such as Midwest Power Systems Inc. (Contact Mr. David Schuessler, P.E., at (216) 328-1930). Completed power distribution system studies shall be bound and submitted to the engineer. Submit five (5) copies of each study, including recommendations for corrective action when necessary.
- B. Short Circuit Analysis
 - 1. Calculation of the maximum root mean square (RMS) symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.
 - 2. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
 - 3. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
 - 4. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions and other circuit information as related to the short-circuit calculation.
 - 5. Include a computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.

6. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit at each bus location and other information pertinent to the computer analysis.
7. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment shall be provided and include recommendations as appropriate for improvements to the system.
8. The Contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
9. Any inadequacies shall be called to the attention of the engineer and recommendations shall be made for corrective measures.

C. Protective Device Time-Current Coordination Analysis

1. The time-current coordination analysis shall be performed with the aid of a digital computer and shall include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
 - a. All circuit breakers with adjustable settings shall be coordinated with the device immediately upstream and the largest device immediately downstream for instantaneous overcurrent, short time overcurrent, long time overcurrent, and ground fault trip, as applicable.
 - b. All main overcurrent protective devices with ground fault trips shall have the ground fault device set to coordinate with the ground fault setting of the largest downstream device.
 - c. Where main disconnect ground fault devices cannot be coordinated with downstream ground fault devices, the pickup shall be set at 40 percent of the main device rating, but not more than 1200 amps; and the time delay shall be set at the maximum setting not to exceed one second. Ground fault device settings shall not exceed the requirements of NEMA Publication 2.2.
2. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.
3. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
4. Computer printouts shall accompany the log-log plots and shall contain descriptions for each of the devices shown, setting of the adjustable devices, the short-circuit current availability at the device location when known, the device identification numbers to aid in locating the devices on the log-log plots and the system on line diagram.
5. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one line diagram.
6. A computer generated system on line diagram shall be provided which clearly identified individual equipment buses, bus numbers, devices identification numbers and the maximum available short-circuit current at each bus.
7. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with the recommendations as required for increasing system protection or device coordination.

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8. Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer and recommendations shall be made for improvements.

D. Arc Flash Analysis

1. An arc flash analysis shall be performed to determine appropriate Arc flash incident energy levels, category requirements, boundary distances and to provide detailed Arc Flash (PPE) labels on distribution equipment for Owner's employees and/or future Contractors working on the equipment.
2. PPE recommendations shall be based on the latest editions of NFPA 70E, standard for electrical safety requirements for employee workplaces, and IEEE Standard 1584, Guide for Performing Arc Flash Hazard Calculations.
3. Recommendations shall be provided in a tabular format with written report.
4. Detailed PPE Labels shall be provided to Contractor for installation on equipment.

END OF SECTION 262500

SECTION 263213 – PACKAGED ENGINE GENERATED SYSTEMS

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.
- 1.2 All life safety generators must be diesel.
- 1.3 All none life safety generators to be natural gas.

PART 2: PRODUCTS

- 2.1 Preferred manufacturer of generators: Kohler (Other acceptable manufactures are Caterpillar and Cummins)

PART 3: EXECUTION

- 3.1 An AC generator will be used for emergency power instead of a battery pack. The generator will be load tested by the manufacturer or manufacturer's approved representative in accordance with the manufacturer's instruction, to 100 percent of the generator capacity. The test will be performed in the presence of the Owner's representative and the test procedure will be provided to the Owner's representative at least one week in advance.
- 3.2 Minimum generator sizing will be for emergency egress lighting, fire alarm systems, and any other equipment required by the State of Ohio Fire Marshall's Office. Larger sized generators will be at the Owner's request, or through program documents.
- 3.3 All emergency egress walkway, parking lot, exterior lights over doorways, and exit signs and lighting will be on basic emergency service.
- 3.4 Coordinate with Owner on fuel source for generator.
- 3.5 Generator fault relay to be connected to BMS system.

END OF SECTION 263213

SECTION 265100 – INTERIOR LIGHTING

PART 1: GENERAL

1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.

PART 2: PRODUCTS

2.1 The 4 feet Sylvania T8 FO32/741/ECO lamp is not allowed for use at Baldwin Wallace University due to these lamps not meeting upcoming energy standards.

2.2 The Sylvania T8 U-bend, FBO32/741/6/ECO is not allowed for use at Baldwin Wallace University due to these lamps not meeting upcoming energy standards.

2.3 All fluorescent lamps shall be: T5's or T8's with electronic ballasts, a Correlated Color Temperature, (CCT) in the range of 4100 to 6500 kelvins, a Color Rendering Index, (CRI) of no less than 80, and a minimum 25000-hours life at twelve (12) hours/start. The Scotopic/Photopic ratio shall not be less than 1.75. Dimmable electronic ballasts could be used in classrooms, lecture halls, and conference rooms. Lighting control must be at door and podium location for staged lighting near the screen.

2.4 The use of occupancy sensors is encouraged if sensor is specified by manufacturers and models. For safety, in public areas, a minimum number of fixtures to provide 5 feet candles will not be controlled by occupancy sensors. Sensor types will be scheduled.

A. The preferred occupancy sensors are the Leviton OSCxx-MOW and ODS series.

B. All classrooms and other areas with projectors shall have an override switch.

2.5 Generator rooms and main electrical rooms shall have both emergency lighting powered by the generator and battery packs.

2.6 Battery packs shall not be used in buildings with generators unless required by code or as noted above.

PART 3: EXECUTION

3.1 Light fixture location and height shall consider ease of replacement and maintenance.

3.2 All lay-in fixtures shall be secured to the grid using screws or clips such as Caddy #515 or equivalent. The use of integral "hurricane clips" is prohibited.

3.3 A reflected ceiling plan is required on all projects.

3.4 Fluorescent lighting shall be 4100 kelvins.

3.5 Fluorescent ballasts shall be "program start" or equivalent where available.

3.6 Recessed can fixtures shall be incandescent type with LED lamps, not fluorescent or HID.

3.7 TELE/DATA Room Requirements:

- A. Use 2 feet by 2 feet fluorescent fixtures to provide appropriate light to the room. At least two (2) fixtures to help prevent shadowing and provide redundancy if one light fails.
- B. The fixture should be controlled by a motion sensor that will turn the fixture on/off based on motion.
- C. Lighting should be on the generator.

END OF SECTION 265100

SECTION 265600 – EXTERIOR LIGHTING

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 All outdoor emergency egress lighting shall be fed from an emergency power source.
- 1.3 No ballasts shall be installed below grade.

PART 2: PRODUCTS

- 2.1 All exterior lights will be LED (with the exception of paragraph 2.3 below).
- 2.2 Use glass lenses on wall pack fixtures.
- 2.3 Walkway Lighting:
 - A. Premium Manufacturers:
 1. King Luminaire: Model #K118R-LAR-V-150 (MOG) HPS-120 (Coordinate with system voltage)
 2. Stresscrete Pole: Model #K16-#1/KWC13-G-E11-DB-C/W-140-35/35
- 2.4 Roof Top Locations:
 - A. All roof mounted equipment shall have lighting and receptacles located nearby for service requirements.

PART 3: EXECUTION

- 3.1 Exterior lighting shall be controlled by either the BMS system or single photo cell and shall include a readily accessible override switch.
- 3.2 Outdoor lighting controls such as photo cells, shall be accessible and located less than 10 feet AFF or finished grade.

END OF SECTION 265600

SECTION 270000 – Section Index

270500 MINIMUM REQUIREMENTS FOR STRUCTURED CABLING

SECTION 270500 – MINIMUM REQUIREMENTS FOR STRUCTURED CABLING

A. PURPOSE

1. To provide consistent guidelines to insure that new or upgraded buildings (telecommunications) wiring will meet the electronic information needs of the University (both short and long term) in the most cost-effective manner.

B. SCOPE

1. This policy applies to all University staff, faculty, administrators, officers and students (collectively, “users”), including those on the regional campuses and Extended Learning sites.

C. POLICY

1. All new installations and upgrades of building telecommunications wiring for the transport of voice, data, video, imaging information, etc. must meet or exceed the Minimum Wiring Requirement specifications as listed below.

D. OBJECTIVES

1. To provide a minimum telecommunications wiring standard for new buildings and renovations with a view towards future expansion and adequate service.
2. To facilitate ease of expansion and upgrading of present services.
3. To provide for realistic cost considerations.
4. To provide a consistent wiring plan that can be implemented in such a way as to maximize telecommunications services while minimizing cost and initial design effort.

COMMON MATERIALS AND METHODS FOR TECHNOLOGY WORK SUMMARY

PART 1: GENERAL

- A. This section includes general administrative and procedural requirements for technology installations. Reference individual sections for further expansion of these requirements:

1.1 ABBREVIATIONS

- A. General: Utilize the following abbreviations and definitions for discernment with the specifications.
- B. Abbreviations:
 - NEC - National Electrical Code
 - OSHA - Occupational Safety and Health Act
 - ANSI - American National Standards Institute
 - NFPA - National Fire Protection Association
 - ASA - American Standards Association

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- IEEE - Institute of Electrical and Electronics Engineers
- NEMA - National Electrical Manufacturers Association
- UL - Underwriters' Laboratories, Inc.
- ICEA - International Cable Engineers Association
- ASTM - American Society of Testing Materials
- ETL - Electrical Testing Laboratories, Inc
- TIA - Telecommunications Industry Association
- ICIA - International Communication Industries Assoc.
- EIA - Electronic Industry Association
- OEM - Original Equipment Manufacturers
- EC - Electrical Contractor
- SC - Structured Cable Contractor
- T - Telecommunications
- GC - General Contractor
- U - University
- AVC - Audiovisual Contractor
- OSP - Outside Service Provider
- NIC - Not in Contract

1.2 DEFINITIONS

- A. ACCEPTED means as accepted by Baldwin Wallace University or its representative.
- B. APPROVED means as approved by Baldwin Wallace University or its representative.
- C. AS DIRECTED means as directed by Baldwin Wallace University or its representative.
- D. AS REQUIRED means as required by some other part of the contract documents which may include reference specifications or manufacturer's recommended practice.
- E. AS SHOWN which means as shown on drawings, shop drawings or other graphical elements of the contract documents.
- F. BIDDER is used to indicate that entity generating the bid response.
- G. BUILDING TELECOMMUNICATIONS ROOM means the main telecommunications room serves the telecommunication needs of the entire building. Modular patch panels and connecting blocks are located in this room. All telecommunications services enter the building through this room. Floor telecommunications rooms are connected via risers and wire trays to the building telecommunications room. The building telecommunication room can also serve as a floor telecommunications room for its own floor.
- H. COMMUNICATION JACK means a telecommunications connector. It may be a voice jack (such as a RJ-45), a data jack (such as a RJ-45, RS-232, or BNC connector), an integrated connector for voice and data (RJ-45), or any other appropriate connector.

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- I. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.
- J. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.
- K. CONTRACTOR is used to indicate the successful Bidder to whom the University has awarded the contract.
- L. EQUAL means equivalent as approved by Baldwin Wallace University or its representative.
- M. FLOOR TELECOMMUNICATIONS ROOM means the floor telecommunications room serves the telecommunications needs of its floor. Modular patch panels are located in the room. Floor telecommunications rooms are connected to the building telecommunications room via risers and wire trays
- N. FURNISH means to indicate the responsibility to ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.
- O. INSTALL means to join, unite, fasten, link, attach, setup or otherwise connect together before testing and turning over to University, complete and ready for regular operation, the particular work referred to. It is also used to indicate the responsibility of receiving the item at the job site, providing adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.
- P. INTEGRATED COMMUNICATIONS OUTLET (ICO): A single outlet located in a room where a connection can be made to equipment. The ICO provides an interconnection to the building and/or university voice and data systems. This communications outlet is designed to accommodate both voice and data services.
- Q. PROVIDE means to furnish, install, place, erect, connect, test and turn over to University complete and ready for the regular operation, the particular work referred to.
- R. PROVIDED BY OTHERS shall refer to material and work, which is related to this contract, but has been provided by parties other than the Contractor.
- S. The term SHALL is mandatory; the term WILL is informative; and the term SHOULD is advisory.
- T. The SPECIFICATION is defined as the body of documentation provided to the Contractor with the Request for Quotation, Request for Proposal or Request for Bid as well as all addenda to said documentation. Throughout this document, words such as “herein” refer to the entire Specification, and not just this written document. The Specification includes, but is not limited to, this written specification document, all drawings, cable terminations and labeling schedule as listed in the Wire Pull List, additions and/or modifications as detailed in written addenda, additions and/or modifications as detailed in drawing additions or reissues.
- U. UNIVERSITY or CLIENT means Baldwin Wallace University or their designated representative.
- V. UNIVERSITY FURNISHED CONTRACTOR INSTALLED (OFICI) shall refer to equipment that will be furnished by the University for installation by the Contractor. The Contractor shall be responsible for installing and integrating this equipment as detailed herein.
- W. WIRING means the inclusion of all raceways, fittings, conductors, connectors, patch panels, labeling, junction and outlet boxes, connections, testing and all other items necessary and/or required in connection with such work.

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1.3 PERMITS, CODES, STANDARDS AND INSPECTIONS

- A. Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules, and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to Baldwin Wallace University.
- B. The installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.
- C. The installation shall be in compliance with the requirements of the latest revisions of:
 - D. Occupational Safety and Health Act (OSHA)
 - E. Institute of Electrical and Electronic Engineers (IEEE)
 - F. National Electric Code (NEC)
 - G. National Board of Fire Underwriter's (NBFU)
 - H. National Electrical Manufacturer's Association (NEMA)
 - I. National Electric Safety Code (NESC)
 - J. Legislative Act 235 (1965)-Handicapped Legislative Act 287 (1974)
 - K. Excavation Building Officials and Code Administrators (BOCA)
 - L. Americans with Disabilities Act (ADA)
 - M. Electronic Industry Association (EIA)
 - N. Telecommunications Industry Association (TIA)
 - O. All local codes and ordinances in effect and having jurisdiction
 - P. All requirements of electric and telephone utility companies
 - Q. The BICSI Telecommunications Distribution Methods Manual
 - R. All approved published instructions set forth by equipment manufacturers
- S. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.
- T. Should any change in drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Baldwin Wallace University prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instructions of Baldwin Wallace University at no additional cost to the University.

1.4 VISITING PREMISES

- A. All Contractors shall visit the project site before submitting his bid/quote, in order to familiarize themselves with the existing conditions, which may affect his work. It is the Contractor's responsibility to analyze existing conditions.
- B. Sufficient allowances shall be provided in the Contractor's bid/quote to cover work, due to existing conditions, that will be required to complete this contract work.

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- C. By submission of a bid/quote the Contractor is attesting that responsible personnel did, in fact, visit the site during the bidding period and verify all existing pertinent conditions.
- D. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid-quote.

1.5 PROJECT DRAWINGS AND SPECIFICATIONS

- A. When applicable, The Contractor shall carefully examine drawings and specifications of all trades and report all discrepancies to Baldwin Wallace University in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Baldwin Wallace University. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of Baldwin Wallace University. Baldwin Wallace University's interpretation is final and binding. Drawings and Specifications are not intended to define all details, finish materials, and special construction, which may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.
- B. Drawings are diagrammatic only and do not show exact routes and locations of equipment and associated wiring. When applicable, The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from Baldwin Wallace University. If there is a conflict between contract documents, the document highest in precedence shall control. The precedence shall be: first; permits from agencies as required by law, second; special provisions, third; specifications, fourth; drawings, fifth; reference specifications and sixth; vendor submittals.

1.6 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. When applicable, this Contractor shall be responsible for all cross connecting and coordination with all vendors and other trades to provide a complete operational system.

1.7 PRODUCT LISTING

- A. When two or more items of the same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, conduit, fittings, sheet metal, solder, fasteners, and similar items, except as otherwise indicated. Provide products that are compatible within systems and other connected items. All powered equipment shall be UL listed.

1.8 RECORD DOCUMENTS

- A. When all work has been completed and before final acceptance, the Contractor shall furnish to Baldwin Wallace University a complete set of documents (electronic and paper versions) that clearly represent all contract work "as-built". This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the as-built documentation.

1.9 GENERAL WARRANTIES

- A. Provide complete warranty information for each item to include date of beginning of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
- B. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the University.

PART 2: PRODUCTS

- 2.1 Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.
- 2.2 All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.
- 2.3 Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by Baldwin Wallace University.
- 2.4 Where the Contractor proposes substitute equipment, Contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work, shall be the responsibility of this Contractor, regardless of the trade involved.

PART 3: EXECUTION, DELIVERY, STORAGE AND HANDLING

- A. Deliver products to the project identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage and handling.

3.1 INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of systems, materials, and equipment. Comply with the following requirements: Coordinate systems, equipment, and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for cabling installations.
- D. Sequence, coordinate, and integrate installations of cabling materials and equipment for efficient flow of the Work.
- E. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
- F. Coordinate the cutting and patching of building components to accommodate installation of cabling equipment and materials.
- G. Coordinate the installation of all materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- H. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Plywood on MDF/IDF walls shall be void-free and treated on all sides with two coats of fire-resistant paint.
- J. Ensure that the fire rating of all walls and floors is maintained.

CONDUIT AND RACEWAY

PART 1: GENERAL

- A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable support systems.
- B. Wire basket support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.
- C. Ladder cable tray systems are defined to include, but are not limited to straight sections of ladder type cable trays, bends, tees, elbows, drop-outs, supports and accessories. Ladder cable tray is to be installed by the G.C. and supported independent of any cabinet or rack.
- D. This section also defines additional requirements for conduit installations.

1.1 REFERENCES

- A. NFPA 70 – National Electrical Code.
- B. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- C. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
- D. NEMA VE 2-2000 – Cable Tray Installation Guidelines.
- E. ASTM A123 – Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes.
- F. NEMA VE 1 – 1998-Metallic Cable Tray Systems.

1.2 QUALITY ASSURANCE

- A. Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 392).
- B. Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to installation of cable tray systems.
- C. Installer: Qualified with at least three (3) years of successful installation experience on projects with technology raceway work similar to that required for this project.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver cable tray (ladder type and wire basket) support systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment. Store cable tray (ladder type and wire basket) and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2: PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with these specifications, cable tray (ladder type and wire basket) cable support systems to be installed shall be as manufactured by B-line, GS Metals Corporation or Baldwin Wallace University approved equal.

2.2 SECTIONS AND COMPONENTS:

- A. Provide cable tray (ladder type and wire basket) of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- B. Material and finish specifications for each metal cable tray type are as follows: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633.
- C. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be coated after the wire basket runway has been fabricated in accordance with ASTM A123 (CSA Type 1). All hot-dip galvanized sections must be returned to the point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so may result in damage to cables and/or injury to installers.
- D. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.
- E. To provide for allowable amounts of cable bend radius, provide cable fallouts or waterfalls at all points where cable transitions from horizontal to vertical.

CABLE TRAY AND SUPPORT SYSTEMS

PART 1: GENERAL

- A. All straight section longitudinal runs shall be straight (with no bends).
- B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
- C. Wire basket sizes shall conform to the following nominal criteria:
 - 1. Straight sections shall be furnished in standard lengths.
 - 2. Wire basket shall have a 4 inches usable loading depth by the width identified on the drawings.
 - 3. All fittings shall be field formed as needed.
- D. The installation and all fittings of all raceways shall allow Category 6 cable and fiber optic cable to be pulled in and through in such a manner as to not exceed the pulling tension or minimum bending radius.
 - 1. All splicing assemblies shall be the bolted type using flange locknuts.
 - 2. Cable tray supports shall be center support hangers, trapeze hangers or wall brackets and shall be supported by ¼ inch or ⅜ inch diameter rods.

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- E. Special accessories shall be furnished as required to protect, support and install all cable tray support systems. Coordinate material and installation with the requirements of Section Technology Hangers and Supports.
- F. Material and finish specifications for ladder type cable tray shall be as follows: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
- G. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 inches on center. Spacing in radius fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of $\frac{7}{8}$ inch with radius edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pounds concentrated load when tested in accordance with NEMA VE-1, section 5.4.
 - 1. Ladder type tray sizes shall have 4 inches minimum usable load depth.
- H. Ladder type straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 feet lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
 - 1. Ladder type tray widths shall be 12, 18, or 24 inches as shown on drawings.

1.1 INSTALLATION

- A. Actual locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site.
- B. Install cable tray (ladder type and wire basket) as indicated; in accordance with recognized industry practices (NEMA VE- 2 2000), ensure that the cable tray equipment complies with requirements of the NEC, and all general installation practices.
- C. Coordinate cable tray (ladder type and wire basket) with other electrical and mechanical work as necessary to properly interface installation of raceway with other work.
- D. Provide sufficient space encompassing cable tray (ladder type and wire basket) to permit access for installing and maintaining cables.
- E. For added support and stability, securely fasten cable tray (ladder type and wire basket) to top of racks and to walls in all MDF/IDF rooms at elevations shown on drawings.
- F. Install all raceways parallel to the wall or ceiling lines unless otherwise noted. Support basket cable raceways every 4 feet minimum and at 6 inches from ends or boxes.
- G. Ground the raceway per NEC Article 250, 392 and ANSI/TIA/EIA-607. Route raceways in a manner to avoid steam or water piping.
- H. Fish or blow through every run of conduit before plastering to guard against obstructions or omissions and plug ends carefully with tight fitting wood plugs or bush caps to avoid filling with plaster, dust, etc. and to avoid the possibility of condensation.
- I. Leave nylon or steel fish wire in all raceways where permanent wiring is not being installed under this contract.

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- J. Install conduit making the total cross-sectional area of each raceway of sufficient size to permit ready installation or withdrawal of the cables required therein.
- K. Route cable tray (ladder type and wire basket) a minimum of 5 inches clearance from fluorescent light fixtures, 12 inches clearance from electrically operated equipment and all wiring at 120 or more volts and 4 feet from transformers or large motors.
- L. All technology conduits are to be provided with nylon bushings to allow for cable pulling without damage.
- M. For cable support, provide strain relief a minimum of every 10 feet in vertical conduits runs. Provide the proposed method and products as a product submittal.
- N. In areas without suspended ceilings, install cable tray (ladder type and wire basket) raceways 6 inches below the lowest obstruction unless otherwise directed.
- O. Provide a pull box or pull point immediately before and after any conduit or raceway section containing three ninety- degree bends, or any single run exceeding fifty feet in length. Pull box openings must face in the direction from which personnel will approach and must have a minimum eight inches in front of and to all sides of the opening.
- P. Test cable tray (ladder type and wire basket) support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance.
- Q. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the “worst case” loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.
- R. Carefully investigate the structural, electrical/electronic and finished conditions of work accordingly.

TECHNOLOGY HANGERS AND SUPPORTS

- A. This section includes secure support from the building structure for technology items by means of hangers, supports, anchors, sleeves, inserts, seals and associated fastenings.
- B. All support shall utilize threaded fasteners for all Technology/attachments.
- C. Exception: Spring steel fasteners may be used in lieu of threaded fasteners only for ¾” raceways above suspended ceilings.
- D. Types of supports, anchors, sleeves and seals specified in this section include the following:
 - 1. Clevis hangers
 - 2. Riser clamps
 - 3. C-clamps
 - 4. I-beam clamps
 - 5. Conduit straps
 - 6. Round steel rods
 - 7. Lead expansion anchors

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8. Toggle belts
 9. Wall and floor seals
- E. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly or as specified.

1.1 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings requires, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Installer's Qualifications: Firm with at least three (3) years of successful installation experience with projects utilizing electronic/electrical supporting device work similar to that required for this project.
- C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of supporting devices.
- D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.
- E. UL Compliance: Provide components that are UL listed and labeled.
- F. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.
- G. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

1.2 MANUFACTURERS (subject to compliance with requirements, provide products by the following)

- A. Slotted Metal Angle and U-Channel Systems:
 1. Allied Tube and Conduit
 2. American Electric
 3. B-Line Systems, Inc.
 4. Cinch Clamp Co., Inc.
 5. Elcen Metal Products Co.
 6. Greenfield Mfg. Co., Inc.
 7. Haydon Corp.
 8. Kin-Line, Inc.
 9. Midland-Ross Corp.
 10. Power-Strut Division

11. Van Huffel Tube Corp.
12. Unistrut Diversified Products

B. Anchors:

1. Abbeon Cal Inc.
2. Ackerman Johnson Fastening Systems Inc.
3. Elcen Metal Products Co.
4. Ideal Industries, Inc.
5. Joslyn Mfg. and Supply Co.
6. Rawl Plug Co. Inc.
7. Star Expansion Co.
8. U.S. Expansion Bolt Co.
9. Hilti, Inc.

U-CHANNEL STRUT SYSTEMS

- A. Provide U-channel strut system for supporting electronic/electrical equipment, 12-gauge hot dipped galvanized steel, of types and sizes indicated; construct with $\frac{9}{16}$ inch diameter holes, 8 inches on center on top surface, with standard green finish, and with the following fittings which mate and match with U-channel and are of the same Manufacturer: fixture hangers, channel hangers end caps, beam clamps, wiring stud thin wall conduit clamps, rigid conduit clamps, conduit hangers, and U-bolts.

1.1 SUPPORTING DEVICES

- A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features: Use Clevis Hangers: For supporting equipment weighing approximately 54 pounds or less.
- B. Use Riser Clamps: For supporting equipment weighing approximately 510 pounds or less.
- C. Use Reducing Couplings: For supporting equipment weighing approximately 16 pounds or less. Use C-Clamps: For supporting equipment weighing approximately 70 pounds or less.
- D. Use I-Beam Clamps: For supporting equipment weighing approximately 52 pounds or less.
- E. Use One-Hold Conduit Straps: For supporting equipment weighing approximately 7 pounds or less.
- F. Use Two-Hole Conduit Straps: For supporting $\frac{3}{4}$ inch rigid metal conduit, galvanized steel; $\frac{3}{4}$ inch strap width; and 2- $\frac{1}{8}$ inches between center of screw holes.
- G. Use Hexagon Nuts; for $\frac{1}{2}$ inch rod size; galvanized steel; weighing approximately 4 pounds per 100 feet. Use Round Steel Rod: Black steel; $\frac{1}{2}$ inch diameter; weighing approximately 67 pounds per 100 feet.
- H. Use Offset Conduit Clamps: For supporting 2 inches or less rigid metal conduit; black steel; weighing approximately 200 pounds per 100 feet.

1.2 ANCHORS

- A. Provide anchors of types, sizes and materials indicated; and having the following construction features:
- B. Lead Expansion Anchors: ½ inch, approximately 38 pounds per 100 units.
- C. Toggle Bolts: Springhead; 3/16 inch by 4 inches; approximately 5 pounds per 100 units.

SLEEVES AND SEALS

- A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
- B. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls.
- C. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
- D. For fire rated penetrations comply with all UL fire stopping system requirements.

1.1 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

1.2 FABRICATED SUPPORTING DEVICES

- A. General: Shop-or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabrication of angles, channels and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

1.3 EXECUTION

- A. Provide supporting devices that comply with manufacturer's standard materials. Install in accordance with published product information, and as required for a complete installation. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option.
- B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installations of supporting devices.
- C. Support all technology cables a minimum of every 4 feet with bridle rings, unless other supports are available.
- D. Coordinate with the building structural system and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.
- E. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.
- F. Install surface-mounted cabinets and panels with minimum of four anchors.

1.4 MISCELLANEOUS SUPPORTS

- A. Support miscellaneous technology components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panels, control enclosures, pull boxes, junction boxes and other devices.

1.5 FASTENING

- A. Unless otherwise indicated, fasten technology items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panels, boxes and control components in accordance with the following: Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
- B. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Baldwin Wallace University immediately. Fill all holes that are not used.
- C. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

1.6 TESTS

- A. Test pull-out resistance of one of each type, size and anchorage material for the following fastener types:
 - 1. Expansion anchors
 - 2. Toggle bolts
 - 3. Powder-driven threaded studs
- B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. When appropriate, obtain the Structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

FIRE STOPPING

PART 1: GENERAL

- A. Provide through penetration fire stop systems to prevent the spread of fire through openings made in fire-rated walls or floors to accommodate penetrating items such as conduit, cables and cable tray. Fire stop shall restore floor and wall to the original fire rated integrity and shall be waterproof. The fire stop systems and products shall have been tested in accordance with the procedures of UL and material shall be UL classified as materials for use in through penetration fire stops.
- B. The fire stop system shall comply with the NEC and with NFPA 101-Life Safety Code (latest edition) and shall be made available for inspection by the local inspection authorities prior to cable system acceptance. The Contractor shall be responsible for verifying the fire rating of all walls and floors having cabling penetrations. When applicable, coordinate sealant installation with work of other trades and with the general Contractor on site.

- C. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479) or shall be approved by a qualified Professional Engineer (PE), licensed in Ohio. A drawing showing the proposed fire stop system shall be provided to the Baldwin Wallace University prior to installing the fire stop system(s).

1.1 TECHNOLOGY GROUNDING AND BONDING

- A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA-607 Grounding Standard and NEC requirements except where the drawings or specifications exceed NEC requirements. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, CATV equipment etc. entering or residing in technology spaces shall be grounded to the respective ground system using a minimum #6 AWG solid copper bonding conductor and compression connectors. All wires used for technology grounding purposes shall be identified with green insulated wires. All cables and bus bars shall be identified and labeled in accordance with the Technology Identification requirements.

1.2 QUALITY ASSURANCE

- A. Manufacturers firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and rating required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Installer: Qualified with at least three (3) years of successful installation experience on projects with technology ground work similar to that required for this project.
- C. Listing and labeling: Provide products specified in this section that are listed and labeled. The terms “listed” and “labeled” shall be defined as they are in the National Electric Code, Article 100.
- D. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- E. Field-testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.
- F. Component Standard: Components and installation shall comply with NFPA 70, “National Electric Code” (NEC).
- G. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical and electronic grounding.
- H. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical and electronic grounding.

PART 2: PRODUCTS

2.1 GROUNDING AND BONDING PRODUCTS

- A. Manufacturers (Subject to compliance with requirements, provide products by the following):
 1. B-Line Systems, Inc.
 2. Burndy Corp.

3. Crouse-Hinds Co.
 4. Electrical Components Div.; Gould Inc.
 5. General Electric Supply Co.
 6. Ideal Industries, Inc.
 7. Thomas and Betts Corp.
- B. Products: Supply types indicated and of sizes and rating to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- C. Conductor Materials: Shall be copper with min 98 percent conductivity.

WIRE AND CABLE CONDUCTORS

- A. Equipment Grounding Conductor: Green insulated
- B. Grounding Electrode Conductor: Stranded cable
- C. Bare Copper Conductors: Conform to the following:
 1. Solid Conductors: ASTM B-3
 2. Assembly of Stranded Conductors: ASTM B-8
 3. Tinned conductors: ASTM B-33

MISCELLANEOUS CONDUCTORS

- A. Ground Bus: Bare annealed copper bars of rectangular cross section. All bus bars shall be two-hole lug type. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.
- B. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gauge bare copper wire, $\frac{3}{4}$ inch wide, 9- $\frac{1}{2}$ inches long; 48.250 centimeters. Protect braid with copper bolt hole ends with holes sized for $\frac{3}{8}$ inch diameter bolts.

CONNECTOR PRODUCTS

- A. Listed and labeled as grounding connectors for materials used and approved by a nationally recognized testing laboratory. Pressure Connectors: High-conductivity-plated units. All lugs shall be two-hole type.
- B. Bolted Clamps: Heavy-duty units listed for the application.

GROUNDING ELECTRODES

- A. For technology systems, provide a #6 AWG minimum insulated stranded copper conductor from the grounding electrode system to each telecommunication room, terminal cabinet and central location.
- B. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by manufacturers for indicated applications.

- C. Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding straps, as recommended accessories by manufacturers.

1.1 GENERAL

- A. Each facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
- B. The main communications entrance facility/equipment room shall be equipped with a telecommunications main grounding bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bar (TGB) connected to the TMGB by a #6 AWG minimum insulated stranded copper conductor. The TMGB shall be connected to the building electrical entrance grounding facility (master ground bus) with a #2 AWG minimum insulated stranded copper conductor. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
- C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, security equipment, CATV equipment etc. entering or residing in telecommunication spaces shall be grounded to the respective TGB or TMGB using a minimum #6 AWG insulated stranded copper conductor and compression connectors.
- D. All cables and bus bars shall be identified and labeled in accordance with the identification requirements of the Information Technology Department.
- E. Except as otherwise indicated, provide grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
- F. All bonding conductors shall not be placed in a ferrous metallic conduit. If it is necessary to place any bonding conductors in ferrous metallic conduit that exceeds 1 meter in length, the grounding conductors shall be bonded to each end of the conduit with a conductor sized as a # 6 AWG minimum.
- G. All connections to building steel shall be exothermically (CAD) welded and connected to the telecommunications grounding bus bar with a minimum #2 AWG cable.
- H. All cable tray and equipment racks shall be bonded together with grounding straps of a minimum of a #6 AWG cable. Bonding cables shall be equipped with a compression type ground lug on both ends. The ground lugs shall be attached to a point on the rack that is free of paint and equipped with a star washer. After connecting the ground lugs, seal the connection.
- I. All ground cable connections to the telecommunications ground bar shall be with compression type lugs. No setscrew type lugs shall be used.
- J. All ground conductors shall be free of splices.

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- K. All ground conductors shall be routed in a neat and workmanlike manner and shall be free of sharp bends and kinks.
- L. All new and existing protected entrance terminals in the telecommunications room shall be grounded and connected to the telecommunications grounding bar with a # 6 AWG conductor.
- M. Bond the Data/Communications cable tray located in the at the building service entrance points with a minimum of # 2 AWG cable. Note that each tray is grounded at one building service entrance panel only. Connect the bonding conductor to the tray bonding conductor with a compression type fitting. No setscrew type lugs shall be used.

1.2 INSPECTION

- A. Installer must examine areas and conditions under which technology grounding connections are to be made and notify Baldwin Wallace University in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

1.3 APPLICATION

- A. Provide technology grounding systems where shown, in accordance with applicable portions of NEC and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

1.4 INSTALLATION

- A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA607 Grounding Standard and NEC requirements except where the drawings or specifications exceed these requirements.
- B. Coordinate with other work as necessary to interface installation of grounding system with other work.
- C. Route grounding conductors along the shortest and straightest paths without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
- D. Install bonding connections in accessible locations with approved components.
- E. Each TGB shall be directly bonded to building steel and other permanent metallic systems where accessible.
- F. The TGB and TMGB must be visibly labeled and physically secured.
- G. Where the ground wire is exposed support at a minimum of every 24 inches both vertically and horizontally.

1.5 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
- B. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer to in order of galvanic series.
- C. Make connections with clean bare metal at points of contact.
- D. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

1.6 FIELD QUALITY CONTROL

- A. Upon completion of installation of technology grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 2 ohms, or less.

1.7 LABELING

- A. All ground cables shall be labeled in accordance with ANSI/TIA/EIA 606.

TECHNOLOGY IDENTIFICATION SUMMARY

PART 1: GENERAL

- A. This section includes requirements for identification of components including but not limited to the following: Identification labeling for cables and conductors operational or instructional signs equipment labels and signs.
- B. Comply with the EIA/TIA Standard 606, "The Administration Standard for the Telecommunications Infrastructure".
- C. The Contractor shall submit, for approval by Telecommunications and the University, a labeling system for the cable installation. The University will coordinate the exact verbiage of the labeling scheme with the successful Contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cabinets, ground bars, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- D. All label printing will be machine generated by Panduit or Baldwin Wallace University approved equal hand-held printers using indelible ink ribbons or cartridges. Self-laminating labels shall be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

1.1 QUALITY ASSURANCE

- A. Installer's qualifications: Firm with at least 3 years of successful installation experience with products utilizing technology identification equipment similar to that required for this project.
- B. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual latest edition and with the TIA-526, TIA-568-B.2-1 and TIA-606-A Standards.
- C. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", with regard to type and size of lettering for raceways and cable labels.
- D. NEMA Compliance: Comply with applicable requirements of NEMA Standards WC-1 and WC-2 pertaining to identification of power and control conductors.

- E. Major items of equipment shall have manufacturer's name, address and catalog number on the plate securely attached in a convenient place.

1.2 SUGGESTED NUMBERING AND LABELING SCHEME

- A. User Workstation outlets numbering standard: (CCC-FF-A/B/C/D). CCC is the floor that the outlet is on. FF is the sequential outlet number for the room where the outlet is located. Outlets shall be numbered clockwise from the main entrance door to the room where the outlet is located.
- B. A/B/C/D is the position on the faceplate.
- C. There shall not be any open places on the patch panel.
- D. Terminate all outlets from the same room sequentially on the same patch panel.
- E. If an outlet is added it gets a new number that is next on the sequence even if it is on an existing faceplate.
- F. Labeling techniques. The label shall be black letters on white background. Labels must be produced by label-making equipment. The blank white label tags that are included in the faceplate hardware are to be installed with clear plastic shields in all positions on the faceplate.

1. Riser Cables:

- a. Numbering scheme: Riser cables must be assigned specific numbers. Each shall be tagged with the room number of the MDF/IDF at both ends of the cable clearly shown.
- b. Labeling techniques: Each cable is to be labeled on each end within 12 inches of where it terminates on the cross-connect panel. Cable tags must be securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and be permanent. Cable tags that appear less than permanent will not be accepted.
- c. Directly writing on the cable sheath will not suffice as proper labeling of riser cables.
- d. Entrance UTP cabling cross-connect panels:
- e. Numbering scheme: 25-pair cables from the Utility RJ21X blocks are terminated on blocks. Cable pairs are numbered in 25-pair increments. The first cable is numbered 1 to 25, the second 26 to 50, etc. Pair #1 is terminated on the left position of the top block. Subsequent cable pairs are terminated from left to right and from top to bottom.
- f. Labeling techniques: The first label block shall read, "Cables to RJ21X blocks, 1 to 25 inches. Subsequent label blocks shall denote the same for pairs 26 to 50, etc. The label shall be black letters on white background. Labels must be produced by label-making equipment. Handwritten labels are not allowed.

2. Fiber optic cross-connect panels:

- a. Numbering scheme: Fiber optic cables and terminations shall be numbered and labeled per current EIA/TIA Standards. The numbering scheme denotes the cable function (campus backbone, building entrance, or intra-building), sheath number, and buffer tube number.
- b. Labeling techniques: A label shall be installed onto the outside of the front face of the connector housing to read "horizontal fiber optic cables to outlets" or "entrance/riser fiber optic cables" as appropriate. Labels must be produced by label-making equipment. Handwritten labels are not allowed. Horizontal fiber optic cables shall be labeled on the label tags on the closet connector housing.

Each cable terminated shall be labeled with the following information: type of fiber optic cable and outlet number. For example, a label block for a multi-mode horizontal fiber optic cable termination might read, “MM – 17 inches. Terminations are numbered by the outlet number, not the housing or connector panel position number. Only adapter positions that are terminated are labeled.

3. OSP fiber optic cables:
 - a. Numbering scheme: The numbering scheme denotes the cable function (campus backbone or building entrance). Each fiber optic cable sheath shall be tagged in each MDF and IDF with the number and type of strands in the sheath (i.e. 18SM/18MM) and the building name of the far end of the cable clearly shown. In each intermediate manhole or hand hole each cable sheath shall be tagged with the number and type of strands in the sheath and the building names of each of the cable endpoints clearly shown.
 - b. Labeling techniques. Each cable is to be labeled within 36 inches of where it enters each MDF or IDF. Cable tags may be cloth or plastic tape securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and permanent. Cable tags that appear less than permanent will not be accepted. Directly writing on the cable sheath will not suffice as proper labeling. In intermediate manholes and hand holes, one wrap-around cable marker shall be installed on each cable sheath. Markers shall have a clear Mylar covering reading “fiber optic cable – caution” with space for cable designation. Cable markers shall be orange in color. Other types of tags, tapes, or sheath marking are not acceptable.
4. Equipment racks:
 - a. Numbering scheme. Each rack is numbered sequentially denoting the following information: building name, MDF/IDF room number, and rack number. There is no correspondence between the rack equipment configuration (type) and the rack number.
 - b. Labeling techniques. Two labels shall be installed onto the front face of each equipment rack, one at the bottom of the rack, and one at the top. All labels shall be black letters on white background. Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver’s standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.
5. MDF/IDF room electrical receptacles:
 - a. Each electrical receptacle in MDF/IDFs shall be labeled with the following information: room number where electrical panel is located, panel number, and circuit number. Each receptacle is to be labeled on top or front of the faceplate or outlet box. Preprinted adhesive labels or tags shall be used.

PART 2: PRODUCTS

- A. Manufacturers Subject to compliance with requirements, provide products by the following (for each type marker): Panduit Corp or University and Telecommunications approved equal.

2.1 TECHNOLOGY IDENTIFICATION PRODUCTS

- A. Cable/Conductor Identification bands:

1. Provide Manufacturer’s standard wrap-around cable/conductor markers, of size required for proper application, and numbered to show circuit identification.

B. Equipment Labels:

1. General: Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.
2. Thickness: $\frac{1}{16}$ inch, for units up to 20 square inches or 8 inches length; $\frac{1}{8}$ inch for larger units.

C. Lettering and Graphics:

1. General: Coordinate names, abbreviations, and other designations used in technology identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the technology systems and equipment.
2. Fasteners for Plastic-Laminated Signs shall be self-tapping stainless steel screws or number $\frac{10}{32}$ stainless steel machine screws with nuts and lock washers. (Exception: Where specifically approved contact type permanent adhesive may be used where screws cannot or should not penetrate substrate.)

PART 3: EXECUTION

- A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application.
- B. Lettering and Graphics: Coordinate names, abbreviations, colors and other designations used in technology identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by standards.
- C. Install identification devices as indicated, in accordance with manufacturers written instructions.
- D. Sequence of work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.1 CABLE/CONDUCTOR IDENTIFICATION

- A. Apply cable/conductor identification on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project's technology work.

3.2 OPERATIONAL SIGNS

- A. Provide instructional signs with approved legend where instructions or explanations are needed for system or equipment operation.

3.3 OUTLET IDENTIFICATION

- A. Label each voice and data outlet with the proper designation and provide appropriate icon.

3.4 INSTALLATION

- A. Provide equipment identification labels of engraved plastic-laminate on all equipment racks and on major units of technology equipment in buildings. Except as otherwise indicated, provide single line of text, with ½-inch high lettering on 1-½-inch high label (2 inches high where two lines are required), white lettering in black filed. Text shall match terminology and numbering of the Contract Documents and shop drawings.
- B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

3.5 TESTING

- A. Contractor, at his own expense, shall make any tests directed by an inspection authority or by Baldwin Wallace University and shall provide all equipment, instruments and materials to make such tests.
- B. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted and left in satisfactory operation condition to suit load conditions, by means of instruments furnished by the Contractor.
- C. Notify the University seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to Baldwin Wallace University for its approval.

3.6 WORK

- A. All work shown shall be new work provided under this Contract except that work labeled “present to remain” and that equipment labeled “to be furnished by others, but installed by the Contractor”.

3.7 CUTTING, PATCHING, REPAIRING AND PAINTING

- A. Perform required cutting, drilling and chasing to receive new equipment. In general, perform all patching and repairing necessary to restore to original condition, all surfaces that may become damaged during the installation. All work shall be executed by persons normally employed in the type of work to which they are assigned.
- B. Paint all structural steel and all steel parts used for hangers and for supporting conduits, junction boxes and technology equipment with one (1) coat of “red” oxide primer before erection. After steel is in place, paint again with one (1) coat of “light grey” paint.
- C. The Contractor is responsible for all cutting, patching, plastering and painting associated with the new installation.

3.8 CLEAN UP

- A. Upon completion of the contract, remove all workmen’s appurtenances from the premises. Clean the premises of all debris caused by the work and leave the installation clean and in first-class operating condition.

3.9 STORAGE OF MATERIAL AND EQUIPMENT

- A. Store materials and equipment in a location approved by the University.
- B. Be responsible for the condition of all materials and equipment employed in the installation until final acceptance by the University.

- C. Be responsible for the replacement of all damaged or defective work, materials or equipment. Do not install sensitive or delicate equipment until major construction work is completed. Ensure that equipment is protected from all construction site activities.
- D. Observe and conform to all applicable safety regulations required by the University and OSHA.

3.10 INTERPRETATION AND CONFLICTS

- A. Bring any discrepancies determined or omissions found lacking in the Contract Documents to Baldwin Wallace University's attention before submitting the bid. After award of Contract, Baldwin Wallace University will make the interpretation of any conflict.
- B. The failure to question any controversial item will constitute acceptance by the Bidder who shall execute it to the satisfaction of the University after being awarded the Contract.
- C. If mention has been omitted pertaining to details, items or related accessories required for the completion of any system, it is understood such item and accessories are included in the Contract. After the Contract is awarded, claims based on insufficient data or incorrectly assumed conditions, or claims based on misunderstanding the nature of the work, will not be recognized.
- D. The general conditions, requirements, and special provisions, of any larger body of specifications, of which this specification may be a part, are hereby made a part of this specification. In the event that any clauses or provisions of the larger body of specification conflict with the letter or intent of this specification, the Contractor shall immediately notify Baldwin Wallace University for clarification and direction.

3.11 MARKING AND IDENTIFICATION

- A. Clearly mark all new equipment, devices and miscellaneous apparatus for easy identification and for safety.

3.12 LOCATION OF EQUIPMENT AND RACEWAY

- A. The drawings are diagrammatic and indicate the general arrangement of equipment to be installed.
- B. Carefully investigate the structural, electrical/electronic and finished conditions of work accordingly.
- C. Actual locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site. Install all items to meet the various conditions in the building and make deviations necessary without additional cost.

3.13 WIRING METHODS

- A. All wire and cable shall be installed in finished areas in new or existing raceways as indicated.
- B. New raceways shall be installed in the locations as specified.

3.14 ORDINANCES AND CODES

- A. Nothing contained in the specifications or shown on the drawings shall be so construed as to conflict with any local, municipal or state laws and regulations, governing the installation or other contract work, and all such ordinances and regulations, including the latest: National Electric Code, ANSI/EIA/TIA standards and the National Electric Safety Code, are hereby incorporated and made a part of these Specifications, and shall be satisfied by the Contractor at no additional expense to the University. The Contractor shall secure all permits and inspection certificates for submission to the University.

3.15 SYSTEM CONTINUITY

- A. Reconnect all existing items that remain in use. Provide all materials and labor required to retain continuity of existing circuits or systems that are disrupted by these alterations even though not indicated on the drawings.

3.16 SUBMITTALS

- A. Shop drawings shall be checked, corrected and approved by the Contractor before being submitted to the University/Telecommunications for approval. Before submitting shop drawings, the Contractor shall carefully examine them and shall certify by his stamp that, to the best of his knowledge, they comply with the Contract Documents. The Contractor must receive written approval from the University or an authorized representative of the Baldwin Wallace University, in writing, prior to fabricating or installing any materials. Approval will be given based upon shop drawings. The shop drawings shall indicate complete details of work to be performed. Drawings shall include a title block naming the Project, Contractor, drawing title, drawing number, revision number if applicable and date. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior approval.
- B. Where the shop drawings deviate from the requirements of the Contract documents, the Contractor shall (1) correct the shop drawings as required, or (2) where the deviations do not necessarily require correction, notify the University/Telecommunications of the deviations.
- C. Submit to the University/Telecommunications two (2) sets of shop drawings or otherwise noted documents/equipment for the appropriate equipment and obtain written approval before ordering materials. Materials may include, but not be limited to, the following:
 - 1. Patch Panels (UTP and fiber including connectors)
 - 2. Cable (UTP and fiber)
 - 3. Patch Cables
 - 4. Outlets, Faceplates and Jacks
 - 5. Cable Management Devices
 - 6. Inner Duct
 - 7. Punch Down Blocks
 - 8. Protection Devices
 - 9. Racks and Cabinets
 - 10. Nameplates and Identification Devices
 - 11. Basket Style Cable Tray
 - 12. Ladder Style Cable Tray
 - 13. Grounding Equipment
 - 14. Hangers and Supports
 - 15. Strain Relief Products
 - 16. Security Equipment (including door devices and power supplies)

- D. All other equipment identified or inferred and as may be required by the Architect, University or Telecommunications, as per project requirements.
- E. Submit complete submittal list for University/Telecommunications approval prior to purchasing any equipment.
- F. In some cases, manufacturer warranty may call for the review of system documentation to assure that the system design meets manufacturer warranty requirements. In such instance, with prior approval of the University, the Contractor shall provide a complete set of Project Documents and product data to the system manufacturer for review. The system manufacturer shall review the complete system package and provide documentation attesting to the system compliance with manufacturer warranty requirements. This documentation shall be included with the Contractor Shop Drawings submittal. Baldwin Wallace University will not review the Contractor Shop Drawings submittal, which does not include the manufacturer warranty compliance review documentation.
- G. Each shop drawing shall contain reference to the applicable drawing and specification section and verification of compatibility with the systems involved.
- H. All nameplate data shall be submitted with equipment submittals – refer to other sections for complete identification requirements.
- I. Shop drawings shall show conformance with specified performance characteristics, or the Contractor shall assume responsibility for all deviations including all additional costs as a result of the deviations.

3.17 STANDARDS OF MATERIAL AND WORKMANSHIP

- A. All work shall be executed by persons skilled in the work to which they are assigned. This shall include all copper and fiber connections including testing, and all plastering and painting.
- B. All materials and equipment in the work shall be new and of first quality, produced by manufacturers of recognized reputation for each line of material and equipment. The fact that materials or equipment offered have been recently developed or are untried may be sufficient justification for their rejection.

3.18 PROTECTION OF WORK AND EQUIPMENT

- A. This Contractor shall use the required safety precautions, methods and skills to prevent possible unsafe conditions or conditions unduly susceptible to fire.
- B. When this Contractor is working in areas in which the building occupants have access, Contractor shall provide suitable barriers around his operation.
- C. This Contractor is responsible for containing the undue spread of vapors or odors from his work area.

3.19 TESTS AND INSTRUCTIONS

- A. Upon completion of the work, and upon the request of the University or Telecommunications, the Contractor shall be prepared to test all systems in the presence of the University or Telecommunications. Such testing shall occur at a time that is mutually acceptable to all parties. The Contractor's representatives assisting in the performance of these tests shall be thoroughly familiar with the details of the system and shall include the field supervisor responsible for installing the system.
- B. Correct all failures or improper conditions.
- C. Demonstrate to the University the proper care and maintenance of all new items.

3.20 GUARANTEE

- A. The Contractor and his surety shall guarantee in writing for a minimum period of one (1) year from the date of final acceptance that all materials, equipment and labor furnished by Contractor are free from defects. Refer to cable system warranty for additional requirements. The Contractor shall further guarantee that if any piece of material or equipment is found to be defective within the guarantee period because of faulty manufacture or faulty installation, in the opinion of the University, Contractor will replace and install and test such material or equipment without any further expense to the University.

COMMON STRUCTURED CABLING MATERIALS AND METHODS

PART 1: GENERAL

1.1 SUMMARY

- A. This section includes general administrative and procedural requirements for the structured cabling system and campus inter building distribution systems. It includes Contractor qualifications, terminations and testing parameters.

1.2 CODES AND REGULATORY REFERENCES

- A. Codes: The cabling system installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.
- B. The following industry standards are the basis for the structured cabling system described in this document:
1. TIA/EIA
 2. TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
 3. TIA/EIA-568-B.1 General Requirements
 4. TIA/EIA-568-B.2 Balanced Twisted Pair Cabling Components Standard
 5. TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard
 6. TIA/EIA-569-A Commercial Building Standard for Telecom Pathways and Spaces
 7. TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 8. TIA/EIA-607 Commercial Building Grounding/Bonding Requirements NFPA
 9. NFPA 70 National Electric Code (NEC)
 10. ISO/IEC
 11. ISO 11801 Generic Cabling for Customer Premises
- C. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- D. This document does not replace any code, either partially or wholly. The Contractor must be aware of local codes that may impact this project.

1.3 USER/END LOCATION

- A. Leviton Jacks Category 6 Quick Port or Panduit NetKey (Leviton compatible)
 - 1. Blue for Phone
 - 2. Beige for Data
- B. Faculty/Staff offices with 130 square feet or less require two (2) data ports and one (1) phone port on one (1) wall (farthest wall from door)
- C. Faculty/Staff offices with more than 130 square feet require two data ports and one phone port on two (2) walls.
- D. Departments will need to designate each office space as either a secretary or adjunct faculty office:
 - 1. If the office is designated for secretary use then three (3) data ports and one voice port will be required for each drop, based on the square footage requirements listed above
 - 2. If the office is designated for adjunct faculty use then at least two (2) locations with two data and one (1) voice will be required for each drop, based on the square footage requirements listed above.
- E. Flush mount locations should use Leviton Gang Plates with ID
- F. Surface mount locations (We have not chosen a standard box)

1.4 CONTRACTOR QUALIFICATIONS

- A. All bidders shall demonstrate their qualifications by providing the following documents: A list of the LAST five (5) Structured Cabling systems that were installed by the bidder:
- B. The listing shall include only systems that included the installation of fiber optic cable and category 5e or 6 twisted pair.
- C. The listings shall be for the last five projects that are completed and have been turned over to the University.
- D. The listing shall include a brief description of the project, size of the system, products used, University's name, phone number, address, and representative, date started, and date of completion.
- E. The bidder shall have a BICSI Registered Communication Distribution Designer (RCDD) or equivalent certification with five-year experience, on staff. Submit the RCDD or equivalent Certificate.
- F. The Contractor must provide a dedicated RCDD who is responsible for providing design/build services and project management as a service to Baldwin Wallace University for the implementation of the MAC's. The RCDD must be available to Baldwin Wallace University 24/7.
- G. All of the above documents shall be submitted along with the Bid Form, by the bid due date.
- H. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data and voice network systems. The Contractor shall at a minimum possess the following qualifications:
- I. Those licenses/permits required to perform telecommunications installations in the specified jurisdiction. Personnel trained and certified in the design of the Category 6 Cabling System.

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- J. Personnel trained and certified to install the Category 6 Cabling System.
- K. The Contractor shall provide proof of current certification for the Category 6 Cabling System.
- L. Contractor must be a Mohawk/CDT Accredited Contractor. Contractor must have a minimum of 5-year experience in Inside Plant Cabling.
- M. Contractor must have a minimum of five (5 year experience in Outside Plant Cabling.
- N. It is preferred that the Contractor supply training certificates as proof of Wireless Training.
- O. Contractor must provide a dedicated account manager who is responsible for providing all services required, including resolution of services and account billing issues
- P. Personnel must be knowledgeable in local, state, and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall apply.
- Q. The Contractor shall have been in the business of installing structured cabling systems for a minimum of five (5) years.
- R. The Contractor must possess and maintain current liability insurance certificates. The Contractor should have an office located within a 30-mile radius of the Baldwin Wallace University campus.
- S. The successful bidder shall provide the following additional documents:
- T. The bidder shall furnish a list of all test equipment that will be used in the installation and testing of the fiber optics, multi pair copper distribution cable and the twisted pair cable.
- U. The bidder shall furnish a listing of the names of full-time employees that will work on the project and list their training and certification in the installations and testing of structured cabling.

PART 2: WARRANTIES

2.1 Warranty and Certification of the Cabling systems and connectors:

- A. The Contractor shall provide a 20-years performance and product warranty that all cable, connectors and connecting hardware shall be free from defects in material, workmanship and fabrication. Submit detailed warranty documentation with close out documentation.
- B. The system shall be certified by the cable/connector manufacturer and warranted for the specified performance for minimum of twenty (20) years. The Contractor shall conform to the manufacturer's certification program including submittal of all required documentation to the manufacturer.
- C. The Contractor shall obtain, from the manufacturer, a Registration Document and Certificate for the specific installation. Upon receipt of the Registration Document and Certificate the Contractor shall forward a copy to the Baldwin Wallace University and deliver the original to the University.
- D. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract or any equipment which is damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the University.

- E. A warranty for defects in workmanship and labor should be covered for the full manufacturer's warranty for the products installed. If a product installed has a 15-years Manufacturer's warranty, then we would require a 15-years support warranty for workmanship and labor.

2.2 SUBMITTALS

- A. The Contractor shall provide product submittals for all system components. These components shall include all cable, termination devices; splice connectors, patch panels, associated racks and enclosures, patch cords and labeling devices. The selected Contractor will allow sufficient time in project scheduling for client and review by Telecommunications.

2.3 QUALITY ASSURANCE PARAMETERS

- A. All work shall be performed in accordance with these guidelines, current industry testing standards, and with the test equipment manufacturer recommendations. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual, latest edition. System shall be Category 6 Cabling System Registered.
- B. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.
- C. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.
- D. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Telecommunications.
- E. Where the Contractor proposes substitute equipment, Contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work shall be the responsibility of this Contractor, regardless of the trade involved.

PART 3: EXECUTION

3.1 UTP CABLE TESTING

- A. Riser and inter building distribution cable testing: Each cable pair within all UTP riser cables shall be tested for continuity to ensure conductors are terminated in proper sequence, with correct polarity (tip and ring), and without conductor-to-conductor shorts, conductor-to-ground shorts, or opens.
- B. Horizontal cable testing: All UTP station cables shall be tested to prove compliance with the current industry standard, TIA-568-B.2-1 Part 2: Balanced Twisted Pair Cabling Components, Addendum 1 – Transmission Performance Specifications for 4-pair 100 Category 6 Cabling and any subsequent addendum. Channel tests are the only acceptable test format for testing Category 6 cabling. Link tests will not be sufficient.
- C. Horizontal cable testing equipment: The testing of UTP station cables shall be performed using the recommended test equipment specifically designed to test cables for all Category 6 parameters from 0 to 250 megahertz. Testers shall be loaded with the most recent test values per the above referenced standard. The Contractor may be required to provide documentation (or demonstration) that the testers used are properly programmed as described above.

- D. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A including applicable Technical Service Bulletins and amendments. The appropriate level III tester shall be used to verify Category 6 Cabling Systems.

3.2 FIBER OPTIC CABLE TESTING

- A. Inter building cable testing requirements: One direction. Test multi-mode strands at 850 nm and 1300 nm. Test single-mode strands at 1310 nm and 1550 nm. Use optical time domain reflectometer (OTDR) for tests. Record signature trace, length, and attenuation.

3.3 TEST RESULTS

- A. Submission. Prior to acceptance the Contractor shall submit a copy of all applicable test results to the University/Telecommunications in both electronic (file) and paper form.
- B. Category 6 UTP cables: The test results submitted for Category 6 UTP cables shall include the following: Graphical/numerical data. Both graphical data plots and numerical data are required for the following test parameters:
 - 1. NEXT
 - 2. PS NEXT
 - 3. ELFEXT
 - 4. PS ELFEXT
 - 5. Attenuation
 - 6. Return loss
 - 7. Numerical data. Numerical data only is required for the following test parameters:
 - 8. Propagation delay
 - 9. Delay skew
 - 10. Resistance
- C. UTP Riser Cables: Continuity tests shall be performed on each pair. The Contractor shall submit a document confirming that these cables were tested satisfactorily per these guidelines.
- D. Fiber Optic Cables: Test results for fiber optic cables shall consist of the measured attenuation, the maximum attenuation allowed per these guidelines, and whether the test passed or failed for each fiber optic cable link.

3.4 TERMINATIONS

- A. Incoming analog circuits shall be connected to an incoming riser pair, a cross connect feeds it to the T&R patch field, and a standard patch cord connects the analog circuit. (T&R pair continuity must be confirmed and documented in the identification of the T&R patch panel).

3.5 SYSTEM DOCUMENTATION

- A. When all work has been completed and before final acceptance, the Contractor shall furnish to Baldwin Wallace University a complete set of documents, both electronic and paper versions, that clearly represent all contract work “as-built”. This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the As-Built Documentation.

- B. The Contractor shall submit, within forty (40) working days of the completion of each phase, two (2) full sets of As-Built Documentation to the Baldwin Wallace University for approval. Prior to delivery, each document section and each drawing shall be signed and dated by the Contractor’s Project Manager attesting to the accuracy of the as-built documents.
- C. Electronic drawing files must conform to project drawing standards and be in the AutoCAD R14 format or the most current release. The As-Built drawings shall include at minimum, equipment locations, cable routes and outlet locations, and clearly show any deviations from the Contract Documents.

Note: Baldwin Wallace University is under no obligation to provide the Contractor with digital drawing files. However, digital drawing files may be provided to the Contractor for use in the development of Shop Drawings or As-Built Drawings under a confidentiality agreement between the Contractor and Baldwin Wallace University if available.

- D. Test printouts and electronic documentation (CD’s) generated for each cable by the wire (or fiber) shall be submitted as part of the documentation package. The CD’s shall contain the electronic equivalent of the test results and be of a format readable from Microsoft Word or Excel.
- E. The As-Built Drawings shall include outlet locations. Their sequential number, as defined elsewhere in this document, shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. These documents shall be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Baldwin Wallace University.
- F. Baldwin Wallace University may request that a 3 percent random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications Contractor, additional testing can be requested to the extent determined necessary by Baldwin Wallace University, including a 100 percent re-test. This re-test shall be at no additional cost to the University.
- G. Test Results documentation shall be clearly marked on the outside front cover with the words “Project Test Documentation”, “Baldwin Wallace University”, and the Date of Completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) ID, measurement direction, and reference setup. The test equipment name, manufacturer, model number, serial number, software version and calibration date shall also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- H. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

BACKBONE CABLING RELATED DOCUMENTS

- A. Refer to specification paragraph Fire Stopping.

PART 1: GENERAL

1.1 SCOPE OF WORK

- A. General: All UTP terminations must follow 568b Wiring Schematic. All copper and fiber optic cabling shall be manufactured by Mohawk/CDT or Belden. The Contractor shall provide a complete structured cabling system that will accommodate voice, data and security for all rooms specified in the project.

PART 2: PRODUCTS

2.1 Backbone Cabling:

A. Cables allowed for use in the backbone include: 100 UTP multi-pair copper cables. The cable shall support voice, data and imaging applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.

B. Fiber

1. A typical building will have 12 single-mode and 12 multi-mode of fiber optic.
2. The fiber will be terminated with ST connectors.
3. All single-mode fiber optic cables should be pigtail fusion spliced with machine polished pigtails.

C. Cable Types

1. All UTP cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard.
 - a. Copper [Multi-pair UTP]
 - b. Multi-pair cables shall:
 - c. Manufactured by: Mohawk/CDT or Belden
2. Be 100 cables Category 3, greater than 4 pairs. Be categorized using power sum testing and meet the hybrid cable requirements for use in horizontal cabling.
3. Be appropriate for the environment in which it is installed.
4. The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room/closet. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect. This is known as a hierarchical star topology.
5. Backbone pathways shall be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.

2.2 Building Entrance Protection

A. Each cable pair shall be protected with building entrance protectors at each end sized for the specific cable. Individual plug-in protector modules shall be provided for each pair. Products shall be Avaya/Lucent Type 489 with 110 connectors and 5 pin solid state protectors with heat coils.

B. Fiber

1. Cable Routing: Fibers will be terminated in the MDF using SC connectors in rack mounted panels equipped with sufficient ports, slack storage space and splice trays if required to terminate and secure all fibers.
2. Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all Telecommunications rooms/closets, such that no drilling of additional sleeves/slots is necessary.

PART 3: EXECUTION

3.1 Site Survey: Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

3.2 Physical Installation: Industry requirements: The following installation, documentation, component and system industry specifications shall be met or exceeded:

- A. ANSI/TIA/EIA-568-B.1 and Addendum “Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements”
- B. ANSI/TIA/EIA-568-B.2 and Addendum “Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair”
- C. ANSI/TIA/EIA-568-B.3 and Addendum “Commercial Building Telecommunications Cabling Standard – Part 3: Optical Fiber Cabling and Components Standard”
- D. ANSI/TIA/EIA-569-A and Addendum “Commercial Building Standard for Telecommunications Pathways and Spaces”
- E. ANSI/TIA/EIA-606 and Addendum “Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”
- F. ANSI/TIA/EIA-607 and Addendum “Commercial Building Grounding and Bonding Requirements for Telecommunications”.
- G. ANSI/TIA/EIA-526-7 “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
ANSI/TIA/EIA-526-14A “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”
- H. IEC/TR3 61000-5-2 – Ed. 1.0 and Amendments “Electromagnetic Compatibility (EMC) Part 5: Installation And Mitigation Guidelines – Section 2: Earthing and Cabling”
- I. ISO/IEC 11801:2000 Ed1.2 and amendments “Information Technology – Generic Cabling for Customer Premises”.
CENELEC EN 50173:2000 and Amendments “Information Technology – Generic Cabling Systems”

3.3 Cable Pathways:

- A. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
- B. Grounding and bonding of pathways shall comply with applicable codes and regulations.
- C. Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
- D. The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

3.4 Cable Routing:

- A. In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 meters (5 feet) apart.

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- B. Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms (root mean square voltage), shall be installed with a minimum clearance of 50 millimeters (2 inches).
- C. The installation of telecommunications cabling shall maintain a minimum clearance of 3 meters (10 feet) from power cables in excess of 480 Vrms.
- D. No telecommunications cross-connects shall be physically located within 6 meters (20 feet) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.
- E. In the telecommunications room/closet where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.
- F. In a false ceiling environment, a minimum of 9 inches shall be observed between the cable supports and the false ceiling.
- G. Continuous conduit runs installed by the Contractor should not exceed 30.5 meters (100 feet) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
- H. Maximum conduit pathway capacity shall not exceed a 40 percent fill. However, Perimeter fill is limited to 60 percent fill for move and changes.

3.5 Pulling Tension:

- A. The maximum cable pulling tensions shall not exceed manufacturer's specifications.

3.6 Bend Radius:

- A. The maximum cable bend radii shall not exceed manufacturer's specifications.
- B. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
- C. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

3.7 Slack:

- A. In telecommunications room/closets a minimum of 3 meters (10 feet) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

3.8 Cable Wraps:

- A. Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent. Siemon Company VCM Series.

3.9 Grounding:

- A. Grounding and bonding shall be done per applicable codes and standards.

3.10 Fire protection:

- A. Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
- B. Fire stops shall be done to all applicable code.

3.11 Workmanship:

- A. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

HORIZONTAL CABLING

PART 1: GENERAL

1.1 SCOPE OF WORK

A. General:

- 1. All UTP terminations must follow 568b Wiring Schematic.
 - a. The Contractor shall provide a complete structured cabling system that will accommodate voice, data, security and video applications for all areas.
 - b. The Contractor shall provide upgrades and additions to the existing structured cabling system to accommodate voice, data, security and video applications.
 - c. Contractor shall provide other outlets as listed below or indicated on drawings.
 - d. Pathways will be a combination of surface mounted raceways where exposed or below lay-in ceilings, and j-hooks above the ceiling.

1.2 SPECIFICATIONS

A. Integrated Communications Outlet Specification

- 1. Each room with telecommunication needs shall have one or more Integrated Communication Outlets (ICO). There should be a minimum of two ICOs per office room for every 100 square feet. Placement of the ICOs must take into consideration door openings, windows and potential desk areas. In general, one ICO should be placed for every 100 square feet of floor space. Consideration shall be given to the placement of outlets with respect to terminal equipment. Consideration shall also be given to present and anticipated utilization of each room. For example, offices and laboratories generally require more ICOs than storage areas or receptions areas.
- 2. The standard Integrated Communications Outlet provided to the user will be equipped with a minimum of two (2) Category 6, RJ45 jacks installed in a 4 port faceplate. All jacks and faceplate hardware shall be Leviton plates or a compatible Panduit Netkey (Leviton QuickPort compatible). Cables can be specified as plenum or non-plenum depending on location and applications.
- 3. The RJ45 jacks will be placed in the first two positions in the faceplate. One of the two jacks will be designated data and the other will be designated voice. Each jack will be served with separate 4 pair, UTP Category 6 cable extending to the appropriate communications room.

In the communications room each cable will be terminated on a modular patch panel dedicated to either data or voice terminations.

4. Faceplate positions 3 and 4 will be reserved for future use and may accommodate additional RJ45 jacks, or fiber optic connector

PART 2: PRODUCTS

2.1 The Horizontal Subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room/closet. It consists of the telecommunications outlet/connector, the horizontal cables, and that portion of the cross-connect in the telecommunications room/closet serving the horizontal cable.

A. Cable Types

1. All UTP cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard (latest amendment and including all applicable addendum) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addendum).
 - a. Copper:
 - The cable manufacturer for 4-pair UTP category 6 shall also meet the following cable specifications: Attenuation: Qualified Cables shall exhibit worst case attenuation less than the values derived using the equations shown in the chart below from 1 megahertz to the highest referenced frequency value.
 - Worst-case qualified cable attenuation performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 megahertz
Worst Case	$\leq 1.82\sqrt{f} + 0.017 \cdot f + \frac{0.20}{\sqrt{f}}$
100 MHz	20.2 dB
200 MHz	29.1 dB
300 MHz	36.6 dB

2. Near End Crosstalk (NEXT) Loss:

Qualified Cables shall exhibit worst case NEXT Loss greater than the values derived using the equations shown in the chart below from 1 megahertz to the highest referred frequency value. Worst-case qualified cable NEXT Loss performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 megahertz
Worst Case Cable NEXT Loss	$\geq 76 - 15 \log\left(\frac{f}{0.772}\right)$
100 MHz	44.3 dB
200 MHz	39.8 dB
300 MHz	37.1 dB

3. Power Sum Near-End Crosstalk (PSNEXT) Loss:

Qualified Cables shall exhibit worst case PSNEXT Loss greater than the values derived using the equations shown in the chart below from 1 megahertz to the highest referred frequency value. Worst-case qualified cable PSNEXT Loss performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE CABLE (PSNEXT) LOSS	$\geq 74 - 15 \log\left(\frac{f}{0.772}\right)$
100 MHz	42.3 dB
200 MHz	37.8 dB
300 MHz	35.1 dB

4. Equal Level Far-End Crosstalk (ELFEXT):

Qualified Cables shall exhibit worst case ELFEXT greater than the values derived using the equations shown in the chart below from 1 megahertz to the highest referenced frequency value. Worst-case qualified cable ELFEXT performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE CABLE (ELNEXT) LOSS	$\geq 70 - 20 \log\left(\frac{f}{0.772}\right)$
100 MHz	27.8 dB
200 MHz	22.7 dB
300 MHz	18.2 dB

5. Power Sum Equal Level Far-End Crosstalk (PSELFEXT):

Qualified Cables shall exhibit worst case PSELFEXT Loss greater than the values derived using the equations shown in the chart below from 1 megahertz to the highest referenced frequency value. Worst-case qualified cable PSELFEXT performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE CABLE (PSELNEXT) LOSS	$\geq 67 - 20 \log\left(\frac{f}{0.772}\right)$
100 MHz	24.8 dB
200 MHz	18.7 dB
300 MHz	15.2 dB

6. Return Loss: Qualified Cables shall exhibit worst case Return Loss greater than the values derived using the equations shown in the chart below from 1 megahertz to the highest referenced frequency value. Worst-case qualified cable Return Loss performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range megahertz	1-300 MHz
WORST CASE RETURN LOSS	
$1 \leq f < 10$	$21 + 4 \log (f)$ dB
$10 \leq f < 20$	25 dB
$20 \leq f \leq$	25 dB
100 MHz	20.1 dB
200 MHz	18.0 dB
300 MHz	16.8 dB

7. Propagation Delay (ANSI/TIA/EIA-568-A-1):

Qualified Cables shall exhibit worst case Propagation Delay less than the values derived using the equations shown in the chart below from 1 megahertz to the highest referenced frequency value.

Worst-case qualified cable Propagation Delay performance for selected frequency points of interest is also provided.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE PROPAGATION DELAY	$< 476 + \left(\frac{36}{\sqrt{fMHz}}\right)$
100 MHz	480 ns
200 MHz	479 ns
300 MHz	478 ns

8. Delay Skew (ANSI/TIA/EIA-568-A-1):

Qualified Cables shall exhibit worst case Delay Skew less than the values specified in the chart below per 100 m from 1 megahertz to the highest referenced frequency value.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE DELAY SKEW	
100 MHz	25 ns
200 MHz	25 ns
300 MHz	25 ns *

9. Longitudinal Conversion Loss (LCL):

For all categories of 100 watts unshielded and screened cables, the worst case calculated LCL for any pair in a 100 meters cable shall not be less than 35 decibels, from 1 megahertz to the highest referenced frequency for each performance category. LCL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent. Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE DELAY SKEW	
100 MHz	35 dB
200 MHz	35 dB*
300 MHz	35 dB*

* Values above 100 megahertz are provided for information only, not required for conformance testing.

10. Longitudinal Transfer Conversion Loss (LCTL):

For all categories of 100 watts unshielded and screened cables, the worst case calculated LCTL for any pair in a 100 m cable shall not be less than 35 decibels, from 1 megahertz to the highest referenced frequency for each performance category. LCTL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent.

Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE DELAY SKEW	
100 MHz	35 dB
200 MHz	35 dB*
300 MHz	35 dB*

* Values above 100 megahertz are provided for information only, not required for conformance testing.

11. Attenuation to Crosstalk Ratio (ACR):

Using “pair-to-pair NEXT Loss”, all Qualified Cables shall exhibit worst case ACR performance for the specified frequency range shown in the following table.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE (ACR)	
1-80	24.1 dB
80-100	24.1 dB
1-100	24.1 dB
100-300	0.5 dB

12. Power Sum Attenuation to Crosstalk Ratio (PSACR):

Using “Power Sum NEXT Loss”, Qualified Cables shall exhibit worst case PSACR performance for the specified frequency range shown in the following table.

System 6 SM	
Frequency Range	1-300 MHz
WORST CASE (PSACR)	
1-80	22.1 dB
80-100	22.1 dB
1-100	22.1 dB
100-300	-1.5 dB

B. Work Area: This section outlines specifications for the work area equipment cords, and telecommunications outlets at the users work area. The connection between the information outlet and the device (computer/telephone) is achieved by means of this subsystem.

1. Work Area Equipment Cords shall meet or exceed the following criteria:

a. Category 6, modular equipment cords shall:

- Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame retardant jacket.
- Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight through with standards compliant wiring.
- Be backwards compatible with lower performing categories.
- Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro inches minimum of gold plating over nickel contacts.
- Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.

- Utilize cable that exhibits power sum NEXT performance.
- Be available in any custom length and standard lengths of 0.9, 1.5, 2.1, 3.1, 4.6, 6.1, 7.6 meters (3, 5, 7, 10, 15, 20, and 25 feet).
- Be made by an ISO 9001 and 14001 Certified Manufacturer.

1) Electrical Specifications:

- Have a DC resistance per lead: 9.38 watts/100 meters maximum.
- Have an input impedance without averaging: 100 watts plus 15 percent from 1 to 100 megahertz, plus 22 percent from 100 to 200 megahertz and plus 32 percent from 200 to 250 megahertz.
- Is 100 percent transmission tested with laboratory grade network analyzers for proper performance up to 250 megahertz. Vendor shall guarantee cords are compatible with Category 6 links.
- Be UL verified (or equivalent) for TIA/EIA Category 6 electrical performance.
- Be UL listed 1863.

b. The 110-to-modular patch cords shall:

- Be 100 percent transmission tested with laboratory grade network analyzers for proper performance (manufacturer shall guarantee cords are compatible with category 5e links).
- Be factory or field assembled using category 5e performing 110 patch plugs and stranded category 5e cable. Field assembled cords shall be made from factory made modular cords and cut in half to attach the 110 plug.
- Be available in 4-pair size with eight-position modular plug.
- Be made from factory assembled modular cords for field assembly or performance cannot be guaranteed.
- Have a DC resistance per lead: 9.38 watts/100 meters maximum. Meet or exceed TIA/EIA category 5e electrical performance.
- Must be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards.

2. Information Outlets [High Density]

a. Category 6: All high density information outlets for 100 watts, 22 to 26 AWG copper cable shall:

- Be available in black, white, gray, ivory and light ivory.
- Be 8-position/8-conductor with coherent pairing of IDC pins.
- Have available a gravity feed (45 degree angled) low profile as well as flush mount design.
- Provide universal application/multi-vendor support.

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- Utilizes tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 250 megahertz.
- Have 310 style insulation displacement connectors with quadrant pair isolation and a pyramid wire entry system. Termination is accomplished with a single conductor impact tool.
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
- Support industry standards for T568A or T568B wiring options on each individual outlet.
- Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
- Beside-stackable for high-density solutions.
- Have a color matching protective, hinged or flexible door to protect the outlet from dust and other airborne contaminants.
- Provide color-coded, slide-in icons available for circuit identification.
- Be constructed of high impact, flame-retardant thermoplastic.
- Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
- Be made by an ISO 9001 and 14001 Certified Manufacturer.

1) Electrical Specifications:

- ANSI/TIA/EIA-568-A and ISO/IEC 11801 Category 6 compliant.
- The following requirements shall also be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

Parameters	Margin over Category 6	Performance at 260 MHz
NEXT Loss	0 dB	46 dB
FEXT	2 dB	37 dB
Insertion Loss (Attenuation)	30%	0.2dB
Return Loss	4 dB	18 dB
LCL	–	40**

* Values above 100 megahertz is provided for information only, margin applicable to swept frequency range of 1-250 megahertz. Not required for conformance testing.

** Not industry specified at this time.

- Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.
 - Be UL LISTED 1863 and cUL C22.2 approved.
 - Have Austel (ACA) certification pending.
 - Siemon Company MAX™ MX6 Series Jacks.
- b. Wiring:
- There is not a preferred brand for Category 6.
 - Use Plenum and PVC where appropriate.
 - All conduit, where needed, must be fire stopped.
 - All wiring needs to be Category 6.
 - All wire needs to be terminated into a Category 6 rated RJ45 jack on the patch panel and at the drop location.
 - All data wiring needs to be terminated using TIA/EIA-568-B standard.
3. Faceplates: All faceplates shall:
- a. Be applicable to both fiber and copper applications.
 - b. Have write on designation labels for circuit identification together with a clear plastic cover.
 - c. Be available in single-gang and double-gang configurations.
 - d. Have as a minimum the standard stainless steel faceplate.
 - e. Have surface mount boxes available for both single and double gang faceplates.
 - f. Be made by an ISO 9001 and 14001 Certified Manufacturer.
 - g. Patch Panels
 - Leviton or Panduit Category 6
 - 1) Quick Port or NetKey (based on application)
 - 2) Standard Patch (based on application)

PART 3: EXECUTION

- A. Site Survey: Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

3.1 PHYSICAL INSTALLATION

A. Industry requirements: The following installation, documentation, component and system industry specifications shall be met or exceeded:

1. ANSI/TIA/EIA-568-B.1 and addendum: “Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements”.
2. ANSI/TIA/EIA-568-B.2 and addendum: “Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted-Pair”.
3. ANSI/TIA/EIA-568-B.3 and addendum: “Commercial Building Telecommunications Cabling Standard – Part 3: Optical Fiber Cabling and Components Standard”.
4. ANSI/TIA/EIA-569-A and Addendum “Commercial Building Standard for Telecommunications Pathways and Spaces”.
5. ANSI/TIA/EIA-606 and Addendum “Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.
6. ANSI/TIA/EIA-607 and Addendum “Commercial Building Grounding and Bonding Requirements for Telecommunications”.
7. ANSI/TIA/EIA-526-7 “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
8. ANSI/TIA/EIA-526-14A “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
9. IEC/TR3 61000-5-2 – Ed. 1.0 and amendments “Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling”.
10. ISO/IEC 11801:2000 Ed1.2 and amendments “ Information technology – Generic cabling for customer premises”.
11. CENELEC EN 50173:2000 and amendments “ Information Technology – Generic cabling systems”.

B. Cable Pathways:

1. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
2. Grounding/Earthing and bonding of pathways shall comply with applicable codes and regulations.
3. Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
4. The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

C. Cable Routing:

1. All horizontal cables, regardless of media type, shall not exceed 90 meters (295 feet) from the telecommunications outlets in the work area to the horizontal cross connect.

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2. The combined length of jumpers, or patch cords and equipment cables in the telecommunications room/closet and the work area should not exceed 10 meters (33 feet) unless used in conjunction with a multi- user telecommunications outlet.
3. Two horizontal cables shall be routed to each work area. At least one horizontal cable connected to an information outlet shall be 4-pair, 100 W unshielded twisted-pair (UTP).
4. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.
5. In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 meters (5 feet) apart.
6. Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 50 millimeters (2 inches).
7. The installation of telecommunications cabling shall maintain a minimum clearance of 3 meters (10 feet) from power cables in excess of 480 Vrms.
8. No telecommunications cross-connects shall be physically located within 6 meters (20 feet) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.
9. For voice or data applications, 4-pair UTP or fiber optic cables shall be run using a star topology from the telecommunications room/closet serving that floor to every individual information outlet.
10. The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP and fiber optic cable during handling and installation.
11. Each run of UTP cable between the horizontal portion of the cross-connect in the telecommunication closet and the information outlet shall not contain splices.
12. In the telecommunications room/closet where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.
13. In a false ceiling environment, a minimum of 3 inches (75 millimeters) shall be observed between the cable supports and the false ceiling.
14. Continuous conduit runs installed by the Contractor should not exceed 30.5 meters (100 feet) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
15. All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.
16. The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables.
17. Maximum conduit pathway capacity shall not exceed a 40 percent fill. However, perimeter fill is limited to 60 percent fill for move and changes.

18. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.
19. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 millimeters (3 inches) above the ceiling grid supporting the tiles.

D. Work Area Termination

1. All UTP cables wired to the telecommunications outlet/connector, shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.
2. The telecommunications outlet/connector shall be securely mounted at planned locations.
3. The height of the telecommunications faceplates shall be to applicable codes and regulations.

E. Pulling Tension

1. The maximum cable pulling tensions shall not exceed manufacturer's specifications.

F. Bend Radius

1. The maximum cable bend radii shall not exceed manufacturer's specifications.
2. In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
3. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

G. Slack

1. In the work area, a minimum of 300 millimeters (12 inches) should be left for UTP, while 1 meters (3 feet) be left for fiber cables.
2. In telecommunications room/closets a minimum of 3 meters (10 feet) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

H. Cable Tie Wraps

1. Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
2. Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent. Siemon Company VCM Series.

I. Grounding

1. All grounding/earthing and bonding shall be done to applicable codes and regulations.

J. Fire protection

1. Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
2. Fire stops shall be done to applicable code.

K. Workmanship

1. All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

3.2 BUILDING TELECOMMUNICATIONS ROOM (Main Service Entrance point)

- A. The building telecommunications room shall be sized to accommodate all cable terminations and equipment, which may include wall mounted termination blocks and equipment. Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment.
- B. This room shall be strategically located and contain the modular patch panels necessary to terminate the riser cable and the horizontal wiring for that floor in the case that this room also serves as the telecommunications room for that floor. This room should be located near the main service entrance point and any computer room located on its floor.
- C. In addition the following items shall be carefully considered:
 1. Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment.
 2. Adequate room for conduit and wire tray entrances should be provided. The design should meet current needs and include an allowance for at least one additional wire tray and for at least one (1) additional conduit. Additional conduit space for the addition of 30 to 50 percent more conduit should be provided.
 3. Sufficient air conditioning shall be provided for equipment cooling.
 4. Adequate AC power shall be provided with ample wall jacks. The A.C. power shall be dedicated 20 amp circuits terminated on duplex wall outlets; they must be served by the same transformer. A minimum of three dedicated circuits should be provided. Adequate work space provided for installers and technicians.

3.3 NETWORK CABLE INTO THE BUILDING TELECOMMUNICATIONS ROOM

- A. The cable into the building telecommunications room shall be designed in cooperation with Verizon, Ohio, Baldwin Wallace University's Telecommunications Department and the end user building coordinator(s).
- B. Trunk locations in existing, co-located building shall be studied for coordination of services. In some cases, it may be desirable to establish interconnecting services between buildings.

- C. Options for fiber entrance points, backbone Local Area Networks and other common point data services shall be considered.
- D. A minimum of two (2) four inch conduits shall be provided for cable entrance.

3.4 OUTSIDE PLANT CABLING

- A. Copper and fiber optic outside plant cabling is often required to provide connectivity between locations on the Baldwin Wallace University Campus. This includes installation and splicing of aerial, buried and underground cables and the associated structure.
- B. Aerial cabling will require extensive design and coordination with the various other utilities, municipalities, State Government, Department of Transportation and property Universities in the area of construction. Coordination for the acquisition of rights of way and pole attachment rights must be coordinated with the appropriate entities.
- C. All aerial cabling and associated structure is to be of the appropriate design for the environment in which it is placed and is to be installed in compliance with applicable local codes as well as Belcore Standards and ANSI/EIA/TIA-758-1.
- D. All buried and underground cabling will require extensive design and coordination with the various other utilities, municipalities, State Government, Department of Transportation and property Universities in the area of construction. Coordination for the acquisition of rights of way and pole attachment rights must be coordinated with the appropriate entities.
- E. All buried and underground cabling and associated structure is to be of the appropriate design for the environment in which it is placed and is to be installed in compliance with applicable local codes as well as Belcore Standards, ANSI/EIA/TIA-758-1

3.5 FLOOR TELECOMMUNICATION ROOM SPECIFICATIONS

- A. Telecommunications rooms on each floor should be strategically located and contain the rack mounted modular patch panels necessary to terminate the riser cable and the horizontal wiring for that floor. The room should be located so that wire run lengths do not exceed the requirements of ANSI/TIA/EIA-568-B.2. If a floor has a main computer room, then the floor telecommunications room should be located in close proximity to the computer room.
- B. In addition, the following items shall be carefully considered:
 - 1. Each floor telecommunications room of a building should be stacked directly over the lower floors telecommunications room and located near the center of the building.
 - 2. Each floor telecommunications room should be stacked over the building telecommunications room if possible.
 - 3. Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment
 - 4. Adequate room for conduit and wire tray entrances shall be provided. The design shall meet current needs and include an allowance for at least one additional wire tray and for at least one additional conduit. Additional conduit space for the addition of 30 to 50 percent more conduit should be provided.

5. Sufficient air conditioning shall be provided for equipment cooling.
6. Adequate AC power shall be provided with ample wall jacks. The AC power shall be dedicated 20 amps circuits terminated on duplex outlets at the rack. All outlets must be served by the same transformer. A minimum of three (3) dedicated circuits should be provided.

C. Closet Layout

1. All racks should have a minimum of 34 inches inch of space behind the rack and 36 inches inches in front of the rack. 24 inches inch should be available on at least one end of the rack.
2. A typical location will have two 19 inches inch racks each with a 3 inches vertical organizer on the left or right side and a 6 inches vertical organizer in between.
3. The back wall of the closet should be covered with ¾ inch painted fire rated plywood for mounting devices such as card readers, security power supplies, CATV, splice cases, telephone lightning protection, etc.
4. The wall to the left or right of the rack based on door location should also be covered in ¾” painted fire rated plywood.
5. Equipment requiring wall mounting greater than 8 inches inches should not be mounted behind racks.
6. Based on the current rack specifications the average closet should be 6 feet by 9 feet with at least 8 feet ceiling height. If the port count exceeds 192 ports either data or voice, a third rack will have to be added.
7. If a third rack must be added, the room will need to be increased to at least 6 feet by 9 feet with at least 8 feet ceiling height.

RACKS AND CABLE MANAGEMENT

PART 1: GENERAL

1.1 SUMMARY

- A. This section includes the following: Floor-standing equipment racks.
- B. Provide cabinets and racks in accordance with the Contract Documents. Where conflicting data is indicated, verify mounting and equipment requirements prior to ordering.
- C. This section contains specific parts selected by University and Telecommunications. In the event that the parts specified are not available, University and Telecommunications shall be contacted to specify replacements.

1.2 COORDINATION

- A. This Contractor shall be responsible for all coordination with the general and electrical Contractor and data and voice vendors to provide a complete operational system.
- B. Coordinate layout and installation of equipment racks with adjacent construction.

1.3 SUBMITTALS

- A. Product Data: For cabinets and equipment racks.
- B. Shop Drawings: Show fabrication and installation details of components for cabinets, equipment racks, and their associated parts and pieces to make a complete system.
- C. Allow sufficient time in project scheduling for University and Telecommunications review.
- D. Submittals shall be checked by the supplier and made as complete systems including all required accessories and any special tools.
- E. Manufacturer's installation and maintenance instructions.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of enclosure through one source from a single manufacturer.
- B. All work shall be in accordance with the latest edition of all applicable State, and Federal regulations and codes. Further, all work shall also be in accordance with EIA/TIA Standards, the BICSI TDMM manual, latest edition and with the manufacturer's recommendations.

1.5 SEQUENCING AND SCHEDULING

- A. Sequence all work to support the installation of the structured cabling system, electrical work and all cable tray systems installation.

PART 2: PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers are listed in subparagraphs for each Part 2 article below.
- B. Other Manufacturers' products must be submitted for University and Telecommunications review for approval.

2.2 MAIN DISTRIBUTION FRAMES (MDF)

- A. Standard Floor Distribution Frame (for rack mounted installations in MDF and IDF rooms): The installer shall use a 7 feet high 19 inches equipment rack.
- B. The racks shall be made by an ISO 9001 and 14001 Certified Manufacturer; X-MARK/CDT Rack System, Chatsworth Products Inc or approved equal. Use X-Mark Cat Number XDR-8419-4 with Vertical Cable Manager X-Mark Cat Number XDR-8403. Ensure product submittal includes all accessories and insures system compatibility.
- C. The rack shall include vertical cable managers mounted on the front of the channels with removable covers that can handle large quantities of cables and patch cords. Cable managers must retain cables even when covers are removed. Covers are modular in design, which eliminates the need to remove full-length covers for each patch cord change.
- D. The rack shall have channels capable of utilizing and re-locating ten high capacities, reusable hook and loop cable managers provided with rack, and have additional managers available in bags of ten (10).

- E. The rack shall have cable access holes on side rails, which allow cables to be routed between adjacent racks.
- F. The rack shall have standard 19 inches ANSI/EIA-310-C mounting holes having a full 45 RMS on front and back of rails. The rack shall utilize black grommets for unused cable openings.
- G. The rack shall have vertical cable management channels 11 inches by 5-½ inches by 7 feet which is located between racks. The channel shall include cable retainers, which can be hinged left or right and be located in any position along the channel.
- H. The rack shall have floor mounting holes and a ground lug for 0 to 6 gauge ground cable provided. Racks
- I. 19 inches open frame, two (2) post relay rack, 12/24 tapped holes, 42U Ortronics or Homaco racks are the standard
- J. All Rack are to be bolted to the floor and attached to the wall with 12 inches ladder rack. All will use 3 inches and 6 inches vertical organizers where necessary.

PART 3: EXECUTION

3.1 PREPARATION

- A. Coordinate requirements for riser bases, raised floor riser feet, anchors, bracing, and blocking to ensure adequate means for installation of racks/cabinets.
- B. Coordinate requirements for electrical cable pathways from overhead cable trays and management systems.

3.2 INSTALLATION

- A. Install racks in compliance with manufacturer's written instructions and shop drawings.
- B. Floor-standing racks/cabinets in the MDF's shall be securely attached to the concrete floor using minimum ¾ inch in diameter hardware utilizing and approved length.
- C. Install equipment racks at locations and heights required. Rows of racks/cabinets shall be placed with a 36 inches (minimum) clearance from the walls on all sides of the rack, unless otherwise indicated on Drawings. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks/cabinets. Where racks/cabinets are shown side by side, securely connect together using manufacturer's ganging hardware to provide a stable system. Supply all miscellaneous parts and pieces to make a complete system.
- D. All racks/cabinets shall be grounded to the ground bus bar in accordance with other sections of this document.
- E. Rack mount screws not used for installing patch panels, keys and other hardware shall be bagged and left with the rack upon completion of the installation.
- F. Vertical cable managers shall be installed on both sides (left and right) of each rack in the MDF/IDF rooms. Horizontal cable managers shall be installed per rack equipment elevation drawings.

3.3 SPECIAL RESIDENCE HALL MINIMUM WIRING REQUIREMENTS

- A. For each bed in a residence hall room there shall be a telecommunications wall outlet providing two RJ-45 jacks for voice and data and a coax connection for cable TV or other video. The use of conduit and/or cable tray is optional, depending on the individual building requirements.

3.4 WALL OUTLETS

- A. For voice and data access, the Integrated Communication Outlets (ICOs) meeting the current Telecommunications Wiring Requirement shall be installed. Currently this is a modular duplex outlet with two RJ-45 jacks connected to Category 6 four pair unshielded twisted pair cable in one module and a blank module for future requirements. Either or both of the RJ-45 cables can be used for a Local Area Network (LAN) connection or for a voice telephone connection.
- B. For cable TV or video access, a coax outlet shall be installed. The Cable TV outlet and the voice/data outlet will be combined in a single or duplex dual gang box configuration

ACCESS CONTROL SYSTEM

PART 1: GENERAL

1.1 WORK INCLUDED

- A. Category 6 Cabling shall be included for access to any new Telecommunications closet. The installation is to be coordinated with C personnel. Specifications for the system will be given at the time of installation.

1.2 RESPONSIBILITY FOR MINIMUM WIRING STANDARDS

- A. The Minimum Wiring Standards were developed by the Baldwin Wallace University Telecommunications Department.
- B. The Minimum Wiring Standards are subject to change and review as telecommunications technology changes.
- C. This document can be changed, modified or updated only by the Baldwin Wallace University Telecommunications Department.

1.3 QUESTIONS OR PROBLEMS

- A. Questions, concerns or additional information about this and any Information Technology policy should be directed to Baldwin Wallace University Facilities.

END OF SECTION 270500

SECTION 280000 – Section Index

281300 ACCESS CONTROL

281600 INTRUSION DETECTION

282300 VIDEO SURVEILLANCE

283111 DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

283111-1 FIRE ALARM INTEGRATION

SECTION 281300 – ACCESS CONTROL

PART 1: GENERAL

1.1 SCOPE OF WORK

A. SCOPE OF WORK FOR DESIGNER AND CONSULTANTS

1.2 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. The following documents from Division 28, Electronic Safety and Security of the Access Control, Surveillance and Security Specifications are also relevant to this section:
 - 1. Section 281600: Intrusion Detection
 - 2. Section 282300: Video Surveillance
- C. Design and operation of the system shall conform to the following referenced codes, regulations, and standards as applicable:
 - 1. National Electrical Code (NEC), edition indicated in the current Ohio Building Code
 - 2. Life Safety Code (NFPA 101), edition indicated in the current Ohio Building Code
 - 3. Ohio Building Code, current edition
 - 4. Electronic Industry Association (ANSI/EIA/TIA)
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. Underwriters Laboratories: UL 294, UL 639, UL 1037, and UL 1076
 - 7. National Fire Protection Association (NFPA)
 - 8. Federal Communications Commission (FCC) 47 CFR Part 15 and 90

1.3 CONTRACTOR QUALIFICATIONS

- 1. The Contractor shall have a fully staffed office and service department located within 100 miles of the Baldwin Wallace University Campus.
- 2. The Contractor shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within four (4) hours of notification of a problem. The Contractor shall be able to perform any and all repairs to the systems they install within twenty-four (24) hours.
- 3. All technicians assigned to install and configure systems in Baldwin Wallace University facilities shall be certified for the proper installation of this equipment and be thoroughly familiar with all aspects of the software and control hardware. The Contractor must have a minimum of three (3) qualified and factory-trained technicians to support this system.
- 4. The Contractor, as a minimum, must carry a current state-issued limited energy (low voltage) license.

1.4 SUBSTITUTIONS AND ALTERNATE METHODS

- A. Because of compatibility issues, the hardware and software manufactured by Lenel and specified herein may not be substituted. Equipment and software shall be provided as specified.
- B. Sensors or door security devices allow substitutions as long as they can be proven equivalent to the basis of design given in this specification. In order for the new product to be accepted as an equivalent, the security Contractor shall follow these steps:
 - 1. Submit a variance request form, attaching a complete list of such substituted products with drawings and product data sheets.
 - 2. Receive an approved variance request form, signed by Baldwin Wallace University. The Contractor is not authorized to install any substitute equipment before receiving an approved variance request form.
- C. Substitute equipment must be a standard part of that system's current product line and should meet or exceed the capabilities of the equipment specified herein. Beta, Specials, or “one time” products will not be acceptable. If proposed substitutions do not meet or exceed the performance levels specified herein, the limitations of this equipment must be highlighted and brought to the attention of the designer and/or consultant. Failure to notify the Designer/Consultant of these limitations, whether intentionally or by oversight, may result in rejection of those components at any time. Should this occur, the Contractor will be required to replace the rejected equipment with pre-approved components that meet or exceed the requirements as specified herein. This will be done at no additional cost to the client.
- D. Alternate methods: When the Contractor proposes alternate methods to a Baldwin Wallace University standard practice indicated in this specification, the Contractor shall follow the same process as for equipment substitutions. The Contractor shall submit a variance request form and obtain approval from Baldwin Wallace University before applying any alternate methods.

1.5 SUBMITTALS

- A. Within twenty (20) business days of receiving contract approval and notice to proceed, the Contractor shall submit to the Designer or Consultant the project submittals. The submittal document includes, at a minimum, the following information:
 - 1. Product numbers, specifications, and data sheets for all equipment and software
 - 2. All security wire product data sheets (The Contractor shall indicate the intended use for all wiring submitted.)
 - 3. Point-to-point or end-to-end wiring diagrams for all devices that are part of the access control system (includes any relays, timers or switches)
 - 4. Single-line drawings representing the entire system
 - 5. Termination details
 - 6. Course outlines for each of the end user training programs (The course outlines shall include the course duration, pre-requisites, and a brief description of the subject matter.)
 - 7. Proposed method of wire marking, panel labeling, zone identification, and terminal strip numbering
 - 8. Project milestone schedule
 - 9. Template for weekly progress report

1.6 ABBREVIATIONS

A. The following abbreviations are used in this document:

ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
AWG	American Wire Gauge
BPS	Bits Per Second
CCTV	Closed Circuit Television
CPU	Central Processing Unit
DPS	Door Position Switch
FCC	Federal Communications Commission
GUI	Graphical User Interface
ID	Identification
I/O	Input/Output
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
ODBC	Open Database Connectivity
PIN	Personal Identification Number
PTZ	Pan/Tilt/Zoom
RAID	Redundant Array of Independent Disks
REX	Request to Exit
SCS	Security Control System
SDRAM	Synchronized Dynamic Random Access Memory
STP	Shielded Twisted Pair
UL	Underwriters Laboratories, Inc.
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
UTP	Unshielded Twisted

1.7 GLOSSARY OF TERMS

A. The following terms are defined for the purposes of this specification:

ACCESS GROUP: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.

ACCESS MODE: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.

ACKNOWLEDGE: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.

ACTION MESSAGES: A set of instructions automatically provided to the operator when an alarm condition is generated.

ADVISORY: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.

ALARM CONDITION: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.

CARDHOLDER: A person who has been issued a valid access card or key fob.

CARD READER: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.

CLEAR: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.

DOWNLOAD: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.

FACILITY CODE: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.

FILE SERVER: Primary host computer in the networked security system which maintains the access control system database.

LINE SUPERVISION: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.

OFF-LINE: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.

PASSWORD: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.

RESET: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.

SECURE MODE: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.

SECURED AREA: A physical location within the facility to which access is controlled by one or more card readers.

SECURED SIDE: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.

TAMPER: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.

TIME INTERVAL: A time stamp of one start time and one stop time within a time period.

TIME PERIOD: A user programmable period of time made up of days of the week and hours in the day.

TROUBLE: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.

UNSECURED SIDE: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.

USER DEFINABLE: An attribute of a security control system function that may be easily tailored by the System Administrator.

WORKSTATION: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

PART 2: PRODUCTS

2.1 INTELLIGENT SYSTEM CONTROLLER (ISC)

- A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components (Card Readers and Input Control Modules). The ISC shall provide full distributed processing of access control and alarm monitoring operations. Access levels, hardware configurations, and programmed alarm outputs assigned at the administration client workstation shall be downloaded to the ISC, which shall store this information and function using its high speed, local 32-bit microprocessor. All access granted/denied decisions must be made at the ISC to provide fast responses to card reader transactions. A fully configured ISC with 32 card readers shall require less than one-half (0.5) seconds to grant access to an authorized cardholder or deny access to an unauthorized cardholder.
- B. The Access Control Field Hardware shall provide a network-based ISC. The network ISC shall be an Ethernet-based panel that has the capability to reside on a local area network (LAN) or wide area network (WAN) without connectivity to a PC serial port. The ISC shall utilize an off-the-shelf network connectivity device to deliver this functionality. Network-based Intelligent System Controllers shall be able to communicate back with the database server through industry-standard switches and routers and shall not have to be on the same subnet.
- C. The ISC is required to continue to function normally (stand-alone) in the event that it loses communication with the security system software. While in this off-line state, the ISC is required to make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be stored in local memory, and then uploaded automatically to the database after communication has been restored.
- D. Approved equipment, no substitutions or equivalents:
Baldwin Wallace University to verify requirements
- E. If an ISC requires a separate communications module for Ethernet connectivity, the communications module shall be provided with the ISC. Communications modules that use a separate power supply not backed by batteries are not acceptable.
- F. Note to Designer(s) or Consultant(s): The designer or consultant shall indicate in the design documents which of the approved ISC will be used, the location for those devices and the required quantities.

The Designer or Consultant shall also indicate any required memory upgrades or communication modules required to connect the ISC to the Baldwin Wallace University WAN.

2.2 READER INTERFACE MODULE (RIM)

- A. The Reader Interface Module shall provide an interface between the ISC and authentication devices. The RIM shall operate with any authentication device that produces a standard Wiegand communication output. The RIM shall include six Form-C relays rated at 5 A at 30 volts DC for door contact supervision, dedicated tamper and power failure circuits, onboard jumpers for 5 volts DC or 12 volts DC reader support, and bicolor status LED support. The RIM hardware shall be UL 294 listed and CE approved.
- B. Approved equipment, no substitutions or equivalents:
Baldwin Wallace University to verify requirements
- C. Note to Designer(s) or Consultant(s): The designer or consultant shall indicate in the design documents which of the approved RIM will be used, the location for those devices and the required quantities.

2.3 INPUT CONTROL MODULE (ICM)

- A. The Input Control Module shall monitor all system alarm inputs.
- B. The ICM shall provide UL 1076 Grade AA alarm input zones to monitor and report line fault conditions, alarm conditions, power faults and tampers. When an alarm input is activated, the associated alarm condition shall be reported to the ISC and subsequently to an alarm monitoring client workstation. Status LED's shall provide information about the sixteen alarm zone inputs, cabinet tamper, and power fault. For each status LED, a slow flash shall imply a "no alarm" condition, a fast flash shall indicate an "alarm condition", and a steady LED shall indicate a "circuit fault" (open, short, ground). The ICM must also be able to operate independently and in conjunction with Output Control Modules (OCM), which will send an output signal to a corresponding output device upon alarm input activation. Once an alarm has been received, the ICM shall activate any or all alarm outputs within the OCM. The OCM shall provide 16 Form-C outputs rated at 5 amps at 30 volts DC. Upon an alarm input from the ICM, the OCM shall transmit an activating signal to a corresponding output device.
- C. All inputs to ICM shall be wired with end-of-line resistors for supervisory conditions.
- D. Approved equipment, no substitutions or equivalents:
Baldwin Wallace University to verify requirements
- E. Note to Designer(s) or Consultant(s): The designer or consultant shall indicate in the design documents the location of each ICM and the required quantities.

2.4 OUTPUT CONTROL MODULE (OCM)

- A. The Output Control Module shall incorporate output relays that are capable of controlling a corresponding output device upon any input activation or on command from the security system and pulsing for a predetermined duration. The duration shall be programmable for each individual relay.
- B. Each OCM shall provide Form-C relays rated at 5 amps at 30 volts DC. The OCM shall control the relays by digital communication. Upon an input from the ICM or command from the System Operator, the ICM shall transmit an activating signal to a corresponding relay. The OCM shall be UL 294 and CE Certified.
- C. Approved equipment, no substitutions or equivalents:
Baldwin Wallace University to verify requirements

- D. *Note to Designer(s) or Consultant(s)*: The designer or consultant shall indicate in the design documents the location of each OCM and the required quantities.

2.5 SECURITY EQUIPMENT ENCLOSURES

- A. All enclosures shall be provided with a key-lockable door and all doors shall be keyed alike. All enclosures shall include a tamper switch for direct supervision of the cabinet door. Cabinet openings shall initiate an alarm condition to the security monitoring system. Hinged NEMA 1 cover enclosures shall be used for indoors application and weatherproof NEMA 4X enclosures shall be used for all outdoor applications. All enclosures shall be UL listed and approved.
- B. For enclosures with a power supply for ISC, RIM, ICM or OCM modules, see paragraph 2.19.

2.6 MAGNETIC DOOR POSITION SWITCH (DPS)

- A. The standard recessed door position switch shall be GE Security 1078C series or approved equivalent. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-lock into a predrilled $\frac{3}{4}$ inch diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V. For delayed egress doors with card access, the recessed door position switch shall be a GE Security 1076D (DPDT). Balanced Magnetic Switches (BMS) or contacts are acceptable in high security applications.
- B. The standard roll-up door position switch shall be GE Security 2200 Series or approved equivalent.
- C. All DPS in impact resistant door shall be surface mounted. For surface mounted applications use the GE Security 1085T series DPS or approved equivalent.
- D. On double doors where each leaf has a DPS, the devices shall be wired in series. Both sensors shall report alarms to the system as a single alarm point.

2.7 TAMPER SWITCH

- A. All security enclosures and all j-boxes with cable splices or terminations shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self-adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. The tamper switch shall be (Baldwin Wallace University to verify requirements) or approved equivalent.

2.8 REX MOTION SENSORS

- A. The REX motion sensor shall be a single device capable of controlling single or dual-leaf doors. The unit shall be ceiling or wall mountable and have adjustable patterns. The unit shall have an LED activity indicator. The device shall have two (2) Form-C relays for outputs.
- B. The REX motion sensor shall be (Baldwin Wallace University to verify requirements) or approved equivalent.

2.9 REX PUSH BUTTONS (Non-ADA)

- A. Where indicated on the drawings, a REX push button (non-ADA) shall be provided to function as a secondary method of door release. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door.
- B. The REX push button (Non-ADA) shall be (Baldwin Wallace University to verify requirements) or approved equivalent.

2.10 REX PUSH BUTTONS (ADA)

- A. Where indicated on the drawings, a REX push button (ADA) shall be provided to function as a secondary method of door release. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door.
- B. The REX push button shall be (Baldwin Wallace University to verify requirements) or approved equivalent with DPDT contacts.

2.11 MAGNETIC CARD ACCESS READER

- A. The magnetic card access reader shall have the following specifications:
 - 1. Bidirectional card swipe
 - 2. Durability of 1 million card swipes per head
 - 3. Weatherproof housing
 - 4. Single bicolor reader status LED
 - 5. Audible indicator beeper contacts
 - 6. DIP-switch selectable data outputs
 - 7. Connections though an RJ-11 connector
 - 8. Track-2 reader type
- B. The magnetic card access reader shall be (Baldwin Wallace University to verify requirements). No substitutions allowed.

2.12 MAGNETIC CARD ACCESS READER WITH KEYPAD

- A. The magnetic card access reader shall have the following specifications:
 - 1. Bidirectional card swipe
 - 2. Durability of one (1) million card swipes per head
 - 3. Weatherproof housing
 - 4. Two (2) single color reader status LED's
 - 5. Audible indicator beeper contacts.

6. DIP-switch selectable data outputs
 7. Connections through an RJ-1 connector
 8. Track-2 reader type
 9. 12-positions keypad
- B. The magnetic card access reader with keypad shall be (Baldwin Wallace University to verify requirements). No substitutions allowed.

2.13 KEYPAD

- A. The keypad for access control applications shall have the following specifications:
1. Protocol: 8 bit word out
 2. Anodized graphics
 3. Weatherproof housing IP68
 4. Twelve (12) keys
- B. The keypad shall be (Baldwin Wallace University to verify requirements). No substitutions allowed.

2.14 KEY SWITCH

- A. The key switch for access control applications shall have the following specifications:
1. Extruded aluminum ¼ inch plate
 2. Momentary contacts DPDT
 3. Tamper proof screws
 4. Cylinders compatible with all Baldwin Wallace University standard cylinders
- B. The key switch shall be (Baldwin Wallace University to verify requirements) or approved equivalent.

2.15 PROXIMITY CARD READERS

- A. The proximity card reader for use throughout this facility shall be a switch plate style reader in low profile weatherized polycarbonate housing suitable for mounting in either an indoor or outdoor environment. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall contain an integral magnet for use with an external magnetic reed switch to provide tamper protection when connected to an external alarm. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate at a frequency of 125 kilohertz and all RF data transmitted between this device and the smart card shall be encrypted for additional protection using a secure algorithm. The reader shall provide an audiovisual indication to signify access granted or access denied. This operation shall be displayed by a high intensity LED light bar which shall change from red, amber, or green based on the status of the operation. The housing shall mount on an industry standard single gang electrical junction box. It shall have a read range of 9 inches when used with a standard proximity access card. The proximity card reader shall be a (Baldwin Wallace University to verify requirements) or approved equivalent.

- B. When indicated in the design drawings, the mullion mountable proximity card reader shall have all of the properties of the Proxpro II but shall be suitable for applications where wall mounting is not permissible. The mullion mount proximity card reader shall be a HID Miniprox or approved equivalent.
- C. All ADA access doors shall have a long-range card reader. The long-range card reader shall be a HID Maxiprox or approved equivalent. All long-range card readers shall be provided with a linear power supply.
- D. Prior to ordering any card readers, obtain written verification of the color preference, model and style requirements. This selection shall be coordinated through the architect, Baldwin Wallace University and consulting engineers so that the visual impacts can be evaluated.

2.16 PROXIMITY ACCESS CARDS

- A. The proximity cards shall be receptive to a 125 kilohertz reader. Body shielding or variable environmental conditions shall have no adverse effect on their operation.
- B. The front surface of the proximity card shall have a glossy face suitable for use with dye diffusion thermal transfer color printers. All cards shall be provided in a generic version with no preprinted artwork or manufacturer logo information printed on the surface. The standard proximity card shall be the HID Proxcard II card.
- C. Key fobs can be used in lieu of access cards when indicated in design drawings or this specification section. The standard key fob shall be an (Baldwin Wallace University to verify requirements).
- D. Access cards and/or key fobs shall be purchased through the facility with code assigned to Baldwin Wallace University. The Contractor shall coordinate the purchase of access cards and key fobs through Baldwin Wallace University.

2.17 ELECTRONIC LOCKING TECHNOLOGY (PROVIDED BY DIVISION 8)

- A. The security Contractor shall coordinate with the door hardware Contractor on the placement of required electronic locking hardware. The door Contractor will provide and install all electric locking hardware with the associated line voltage power supplies. The security Contractor will provide all necessary wire and cable, low voltage power supplies, terminate all connections, and shall interface this equipment with the integrated security system.

2.18 POWER SUPPLY – DOOR LOCKING HARDWARE

- A. The low voltage power supply shall convert a 115 volts AC 60 hertz input to a continuously supplied current of 24 volts DC. The power supply shall be UL listed, NFPA compliant, and have multiple Class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system. The low voltage power supplies for the security system shall be (Baldwin Wallace University to verify requirements) or an approved equivalent.
- B. Power supplies for delayed egress panic devices and electric latch retraction type locks shall be provided by the door hardware Contractor if required by the door hardware manufacturer. This required device has been specified under Division 8.
- C. Power supplies for regular locking hardware, delayed egress panic devices and electric latch retraction type locks shall be installed next to access control panels.

- D. Maintenance free batteries shall be provided with all power supplies for locking hardware. Batteries shall be sized to allow at least four (4) hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- E. All power supplies shall be installed with means of disconnect from line power. The preferable method of disconnect is through a breaker in an electrical panel.

2.19 POWER SUPPLY FOR ACCESS CONTROL PANELS

- A. The low voltage power supply shall convert a 115 volts AC 60 hertz input to a continuously supplied current of 12 volts DC. The power supply shall be UL listed, NFPA compliant, and Class 2 rated. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system. The low voltage power supplies for the access control panels shall be (Baldwin Wallace University to verify requirements) or an approved equivalent.
- B. Power supplies for access control panels shall be located next to the access control panels.
- C. Maintenance free batteries shall be provided with all power supplies for access control panels. Batteries shall be sized to allow at least four (4) hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- D. All power supplies shall be installed with means of disconnect from line power. The preferable method of disconnect is through a breaker in an electrical panel.

2.20 SURGE PROTECTION

- A. All security components installed outdoors or exposed to lightning shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 volts AC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equivalent. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equivalent. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equivalent.

2.21 BARRIER GATE

- A. Barrier Gate: The Barrier Gate shall be a microprocessor-based parking control device designed to restrict access within a vehicle traffic lane by means of an aluminum or wooden gate arm. The Barrier Gate shall provide multiple programming options and mode logic as a lane controller to handle various types of lane configurations. Modes shall be configurable by the user through the use of a keypad on the lane controller device. Under no circumstances shall the user be required to procure new firmware from the manufacturer in order to configure the lane operating mode.
- B. Barrier Gate Controller: The Barrier Gate Controller shall generate and store counts, monitor lane operations, provide related lane status information, and report such information either through a display on the controller in the lane or remotely through an integrated Facility Management System.
- C. Gate Housing: The Barrier Gate cabinet shall be constructed of heavy-gauge aluminum and armored with an element-resistant finish. All reducers and motors shall be mounted onto a single, ¼ inch (6.25 millimeters) unibacket weldment for maximum strength in high load applications. For easy maintenance, the integrated lane controller shall plug into the power board/connection panel inside the gate housing by way of 37 and 25 pin connectors.

- D. Gate Drive Unit and Electrical Specifications: The Barrier Gate shall be driven by a 1/3-horsepower heavy-duty, high output torque, 115 volts AC, single-phase, instant reversing motor connected by double V belts. The integrated lane controller inside the gate provides the intelligence for the gate. The lane controller shall be a microcomputer that provides 11 inputs and 14 outputs, and integrated LCD display, six-button keypad to perform on-board programming and provide a user-friendly information center. It also shall send commands and monitor lane operations. Three built-in and automatically self-tuning vehicle detectors shall be available. These high-speed detectors shall provide a sensitive, tailgate recognition system capable of recognizing two separate vehicles traveling over a detector loop simultaneously.
- E. Diagnostics and metering tools shall be built into the controller. Incorporated into the Controller shall be diagnostic modes to facilitate on site testing of loop detectors, keypad buttons, the configuration module maximum and minimums, communication ports, and the controller inputs and outputs. The controller shall be capable of storing successive inputs of any type and of sequentially processing each. The controller shall contain indicator lights that indicate operational status of the detectors and itself. The Barrier Gate shall be UL listed (Canada/U.S.).
- F. Gate Control: The barrier gate shall be designed to operate with a wide variety of lane devices capable of providing a vend signal to the gate upon valid detection of a patron ID (Ticket, Card, Cashier Terminal, etc...). The optimum vend signal duration is 200 milliseconds, with a minimum duration of 50 milliseconds.
- G. The Barrier Gate shall provide a safety function that shall reverse the gate arm if an object is under the gate arm and comes into contact with the gate arm during a down cycle. The gate arm stays in the up position for a configurable amount of time. In addition, should the detector sense the presence of a vehicle while the gate arm is in a downward movement, the controller shall reverse the direction of the gate arm. The gate arm will reset upon the vehicle clearing the reset loop.
- H. Gate Arm: The standard gate arm shall be constructed of soft pine and finished in highly visible enamel. The gate shall be equipped with a breakaway gate arm flange to ensure a clean break of the gate arm if struck by a vehicle. Alternate materials such as aluminum may be provided, though the breakaway feature would not be applicable. All contract and transient lanes shall be equipped with gate arms. Gate arms shall be straight-arm or bi-fold to suit the parking facility conditions.
- I. The height of the gate arm in the closed position is designed to prevent any vehicle from passing under the arm. This height shall nominally be 40 inches above the roadway surface inclusive of the curb height and depending on the type and shape of the installed gate arm.
- J. Each gate arm shall be equipped with a rubberized bottom edge to protect vehicles should the gate lower upon a vehicle or another object.
- K. Standard Features of the Barrier Gate: The barrier gate shall supply a status message to the FMS including “gate up, gate down”, current loop frequencies, loop presence, lane counts, vend counts and alarms. Should the gate come in contact with an obstruction during the downward cycle, a “safety edge triggered” message shall be sent to the barrier gate. The gate shall be designed to operate as a stand-alone unit. Under no circumstances shall barrier gate operation be dependent upon online connection to an area controller or FMS. Remote control of the gate shall be available to the operator, including: gate up, gate down, tune loops, and other relevant operations from the FMS workstation.
- L. The Barrier Gate Controller shall display and store a history of events that occurred at the lane. This information shall be made available to authorized users to facilitate timely problem diagnosis and probable cause for certain alarm and “offline” conditions. In addition to the event history at the gate, diagnostic messages shall be sent to the FMS including: loop frequency, power-on with memory condition, online and offline status.

M. The barrier gate controller shall detect illegal forward and illegal reverse vehicle direction through a combination of the embedded loop detectors and the lane controller. Should a vehicle proceed through the lane without a valid vehicle vend, the appropriate illegal direction message shall be generated and communicated to the FMS.

N. Design selection: Federal APD G90.

2.22 CABLES FOR ACCESS CONTROL

A. Cables for un-powered security sensors shall have the following specification:

1. Minimum cable gauge: AWG 20
2. Number of conductors: Two (2) stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black and red
6. Voltage rating: 300 volts
7. Cable shield: No cable shields

B. Cables for powered security sensors shall have the following specifications:

1. Minimum cable gauge: AWG 20
2. Number of conductors: 4, stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white, and green
6. Voltage rating: 300 volts
7. Cable shield: No cable shields

C. Cables for access control readers shall have the following specifications:

1. Minimum cable gauge: AWG 22
2. Number of conductors: 6, stranded conductors Conductor type: Tinned copper
3. Cable insulation: Color coded PVC
4. Conductor insulation colors: Black, red, white, green, orange (or brown), and blue
5. Voltage rating: 300 volts
6. Cable shield: Aluminum/polyester foil (overall) with an AWG 24 tinned copper drain

- D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
1. Minimum cable gauge: AWG 24
 2. Number of conductors: Two (2) paired, stranded conductors
 3. Conductor type: Tinned copper
 4. Cable insulation: Polyethylene
 5. Conductor insulation colors: White-blue, blue-white, white-orange, and orange-white
 6. Voltage rating: 300 volts
 7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90 percent coverage) and a AWG 24 tinned copper drain wire
 8. Nominal characteristic impedance: 120 ohms
 9. Nominal capacitance: 12.8 picofarad/feet
 10. Nominal delay: 1.6 nanoseconds/feet
 11. Nominal attenuation: 0.6 decibels/100 feet at 1 megahertz
- E. Cables for door locks and low voltage power supplies shall have the following specifications:
1. Minimum cable gauge: AWG 18
 2. Number of conductors: Two (2), stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: PVC
 5. Conductor insulation colors: Black and red
 6. Voltage rating: 300 volts
 7. Cable shield: No cable shields
- F. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5 percent voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Contractor shall always estimate proper values.
- G. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.

H. Acceptable Manufacturers:

1. Belden
 2. Alpha Wire Company
 3. General Cable
 4. West Penn Wire
- I. UTP Category cables and fiber optic cables: for specifications on all UTP paired category cables and fiber optic cables the Contractor shall follow all requirements on Baldwin Wallace University Telecommunications Standards

PART 3: EXECUTION

3.1 SECURITY DOORS FUNCTIONALITY

- A. The following paragraphs describe the expected functionality of the typical security doors. The Contractor shall use this description to draw the one line diagrams part of the shop drawings as described in Part 1 of this specification. The Contractor shall make sure the proposed wiring for each door type produces the desired functionality for each door type.
- B. All control logic for this functionality shall be accomplished through local input/output events. Global events to accomplish these requirements is not allowed.
- C. *Note to Designer(s) or Consultant(s):* Designer or consultants shall associate each security door to one of the following door types. If the desired functionality is not indicated in any of these types, the designer or consultant shall modify and rename one of the door types and add the required functionality.
- D. DOOR TYPE E-1 (Single, emergency-only exit with delayed egress, non-ADA)
1. Door Type: Single leaf, non-ADA
 2. Door Mode: Emergency only
 3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) UL listed delayed egress panic device
 - b. By security Contractor: One (1) door position switch and one (1) key switch
 - c. By fire alarm Contractor: A Form-C relay for fire alarm release
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: None
 5. Door Operation:
 - a. From the secured side, after pressing the panic device for more than 3 seconds the panic device shall go into an irreversible process that unlocks the door after 30 seconds. The door shall be opened by mechanical means by pressing the panic bar after the 30 seconds.
 - b. From the unsecured side, the door cannot be opened.

6. Key Override: Key override will be provided in the built-in key switch in the panic devices.
 7. Fire Alarm Release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.
 8. Alarm Reset and Door Relock: Panic device shall be reset and re-armed after momentary activation of the key switch. This same action shall be possible from a single click command from any access control workstation with access to this door.
 9. Reported Alarms:
 - a. Door forced open
 - b. Irreversible process started at the exit device
- E. DOOR TYPE E-2 (Double, emergency-only exit with delayed egress, non-ADA)**
1. Door Type: Double leaf, non-ADA
 2. Door Mode: Emergency only
 3. Devices on secured Side:
 - a. By door hardware Contractor: Two (2) power transfer, two (2) UL listed delayed egress panic device, and fire alarm release
 - b. By security Contractor: Two (2) door position switches and one (1) key switch
 - c. By fire alarm Contractor: A Form-C relay for fire alarm release
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: None
 5. Door Operation:
 - a. From the secured side, after pressing any of the panic devices for more than 3 seconds both panic devices shall go into an irreversible process that unlocks both leaves after 30 seconds. Door shall be opened by mechanical means by pressing the panic bar after the 30 seconds.
 - b. From the unsecured side, the door cannot be opened.
 6. Key Override: Key override will be provided in the built-in key switch in the panic devices.
 7. Fire alarm release: Both leaves shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.
 8. Alarm Reset and Door Relock: Panic devices shall be reset and re-armed after momentary activation of the key switch. This same action shall be possible from a single click command from any access control workstation with access to this door.

9. Reported Alarms:
 - a. Door forced open, either leaf as one alarm
 - b. Irreversible process started at the exit device, either leaf as one alarm
- F. DOOR TYPE EO-1 (Single, controlled entry with electric trim, free exit, emergency and operational, non-ADA)
 1. Door Type: Single leaf, non-ADA
 2. Door Mode: Emergency and operational door
 3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) panic device with REX switch and electric trim
 - b. By security Contractor: One (1) door position switch
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans
 5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar. Activation of the built-in request to exit switch in the panic bar shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be unlocked by releasing the lock in the trim after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 6. Key Override: The use of a valid key in the lock's cylinder (if present) shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 7. Fail Mechanism: The door lock shall be fail-secure if door is exterior door and fail-safe if door is interior.
 8. Reported Alarms:
 - a. Door forced open
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis
- G. DOOR TYPE EO-2 (Double, controlled entry with electric trim, free exit, emergency and operational, non-ADA)
 1. Door Type: Double leaf, one leaf active for entry, both leaves active for exit; non-ADA
 2. Door Mode: Emergency and operational door

3. Devices on Secured Side:
 - a. By door hardware Contractor: Two (2) power transfers, two (2) panic devices with REX switch and one of the panic devices with electric trim
 - b. By security Contractor: Two (2) door position switch
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans
 5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf). Activation of the built-in request to exit switch in either panic bar shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be unlocked by releasing the lock in the trim after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 6. Key Override: The use of a valid key in the lock's cylinder (if present) shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 7. Fail Mechanism: Door lock shall be fail-secure if door is exterior door and fail-safe if door is interior.
 8. Reported Alarms:
 - a. Door forced open, either leaf as one alarm.
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis
- H. DOOR TYPE EO-3 (Single, controlled entry with electric latch, free exit, emergency and operational, non-ADA)
1. Door Type: Single leaf, non-ADA
 2. Door Mode: Emergency and operational door.
 3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) panic device with REX switch and electric latch retraction
 - b. By security Contractor: One (1) door position switch
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans

5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar. Activation of the built-in request to exit switch in the panic bar shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be unlocked by retracting the latch in the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
6. Key override: The use of a valid key in the lock's cylinder (if present) shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
7. Fail mechanism: Door lock shall be fail-secure if door is exterior door and fail-safe if door is interior.
8. Reported Alarms:
 - a. Door forced open
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis.
- I. DOOR TYPE EO-4 (Double controlled entry with electric latch, free exit, emergency and operational, non-ADA)
 1. Door Type: Double leaf, one leaf active for entry, both leaves active for exit; non-ADA
 2. Door Mode: Emergency and operational door
 3. Devices on Secured Side:
 - a. By door hardware Contractor: Two (2) power transfers, two (2) panic devices with REX switch and one of the panic devices with electric latch retraction.
 - b. By security Contractor: Two (2) door position switch
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans
 5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf). Activation of the built-in request to exit switch in either panic bar shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be unlocked by retracting the latch in the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 6. Key override: The use of a valid key in the lock's cylinder (if present) shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.

7. Fail mechanism: Door lock shall be fail-secure if door is exterior door and fail-safe if door is interior.
 8. Reported Alarms:
 - a. Door forced open, either leaf as one alarm
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis
- J. DOOR TYPE EO-5 (Single controlled entry/exit with delayed egress, non-ADA)**
1. Door Type: Single leaf, non-ADA
 2. Door Mode: Emergency and operational door
 3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) UL listed delayed egress panic device with electric trim
 - b. By security Contractor: One (1) door position switch (DPDT) and one (1) reader as indicated in floor plans
 - c. By fire alarm Contractor: A Form-C relay for fire alarm release
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One reader or request to exit push button as indicated in floor plans
 5. Door Operation:
 - a. From the secured side, after pressing the panic device for more than 3 seconds the panic device shall go into an irreversible process that unlocks the door after 30 seconds. Door shall be opened by mechanical means by pressing the panic bar after the 30 seconds. Door shall also be opened by mechanical means after a valid transaction at the reader without delay and without setting off any alarms. Door alarms shall be bypassed for a fixed period of time.
 - b. From the unsecured side, the door shall be opened by mechanical means after a valid transaction at the reader or a momentary request to exit signal causing the lock in the trim to be released. Door alarms shall be bypassed for a fixed period of time.
 6. Key override: Key override will be provided in the built-in key switch in the panic devices.
 7. Fire alarm release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than two (2) smoke detectors in the building.
 8. Alarm reset and door relock: Panic device shall be reset after a valid transaction at the reader and it shall be re-armed after the door or the door is closed. This same action shall be possible from a single click command from any access control workstation with access to this door.

9. Reported Alarms:

- a. Door forced open
- b. Irreversible process started at the exit device
- c. Invalid, lost or stolen card presented at the reader
- d. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis

K. DOOR TYPE EO-6 (Double controlled entry/exit with delayed egress, non-ADA)

1. Door Type: Double leaf, non-ADA

2. Door Mode: Emergency and operational door

3. Devices on Secured Side:

- a. By door hardware Contractor: Two (2) power transfers, two (2) UL listed delayed egress panic device with electric trim
- b. By security Contractor: Two (2) door position switches (DPDT) and one (1) reader as indicated in floor plans
- c. By fire alarm Contractor: A form C relay for fire alarm release.

4. Devices on Unsecured Side:

- a. By door hardware Contractor: None
- b. By security Contractor: One reader or request to exit push button as indicated in floor plans

5. Door Operation:

- a. From the secured side, after pressing either panic device for more than 3 seconds both panic devices shall go into an irreversible process that unlocks the door after 30 seconds. Doors shall be opened by mechanical means by pressing the panic bar after the 30 seconds. Doors shall also be opened by mechanical means after a valid transaction at the reader without delay and without setting off any alarms. Door alarms shall be bypassed for a fixed period of time.
- b. From the unsecured side, the door shall be opened by mechanical means after a valid transaction at the reader or a momentary request to exit signal causing the lock in the trim to be released. Door alarms shall be bypassed for a fixed period of time.

6. Key override: Key override will be provided in the built-in key switch in the panic devices.

7. Fire alarm release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.

8. Alarm reset and door relock: Panic devices shall be reset after a valid transaction at the reader and it shall be re-armed after door is closed. This same action shall be possible from a single click command from any access control workstation with access to this door.

9. Reported Alarms:
 - a. Door forced open, either leaf as one alarm
 - b. Irreversible process started at the exit device, either leaf as one alarm
 - c. Invalid, lost or stolen card presented at the reader
 - d. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time in a per door basis

- L. DOOR TYPE EO-10 (Double mode, double reader, emergency and operational, ADA)
 1. Door Type: Double leaf, automatic door. ADA compliant
 2. Door Mode: Emergency and operational door:
 - a. Door has two operating modes, free mode and controlled mode. Modes shall be activated by a schedule.
 3. Devices on Secured Side:
 - a. By door hardware Contractor: Two (2) power transfers, two (2) panic device with REX switch and electric latch retraction, one (1) automatic door opener
 - b. By security Contractor: Two (2) door position switches, one (1) proximity card reader, and one (1) ADA push button
 - c. By fire alarm Contractor: A Form-C relay for fire alarm release
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One proximity reader and one magnetic stripe reader and one (1) ADA push button.
 5. Door operation (Free Mode):
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf). A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically for a fixed period of time.
 - b. From the unsecured side, the door shall be opened mechanically by pulling the outside trims. A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically for a fixed period of time. The electric latches shall be retracted at all times during this mode.
 6. Door operation (Controlled Mode):
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf) or automatically by pressing the ADA push button. Activation of the request to exit device shall bypass all door alarms for a fixed period of time. A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically and bypass all door alarms for a fixed period of time.

- b. From the unsecured side, the door shall be unlocked by retracting the latches in the panic devices after a valid transaction at the reader (either reader). Door shall be opened automatically after a valid transaction at the proximity reader. A valid transaction at the magnetic car reader shall also enable the ADA push button momentary for a fixed period of time, but does not need to open the door automatically unless the ADA push button is pressed while enabled. A valid transaction in any of the readers shall bypass all door alarms for a fixed period of time.
- 7. Either Mode, Key Override: This door shall not have key override.
 - 8. Fire alarm release: Upon activation of the fire alarm system in the building, doors shall be unlocked and door shall be automatically opened until the fire alarm is cleared.
 - 9. Reported Alarms (Controlled Mode):
 - a. Door forced open, either leaf as one alarm
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis
 - 10. Reported Alarms (Either Mode):
 - a. Power supply tamper
 - b. AC failure (if available in power supply)
 - c. Battery low (if available in power supply)
- M. DOOR TYPE EO-12 (Double mode, single reader, emergency and operational, ADA)**
- 1. Door Type: Double leaf, automatic door. ADA compliant
 - 2. Door Mode: Emergency and operational door
 - a. Door has two operating modes, free mode and controlled mode. Modes shall be activated by a schedule.
 - 3. Devices on Secured Side:
 - a. By door hardware Contractor: Two (2) power transfers, two (2) panic device with REX switch and electric latch retraction, one (1) automatic door opener.
 - b. By security Contractor: Two (2) door position switches, one (1) proximity card reader and one (1) ADA push button.
 - c. By fire alarm Contractor: A Form-C relay for fire alarm release
 - 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One proximity reader and one (1) ADA push button.

5. Door Operation Free Mode:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf). A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically for a fixed period of time.
 - b. From the unsecured side, the door shall be opened mechanically by pulling the outside trims. A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically for a fixed period of time. The electric latches shall be retracted at all times during this mode.
6. Door Operation Controlled Mode:
 - a. From the secured side, the door shall be opened by mechanical means by pressing the panic bar (either leaf) or automatically by pressing the ADA push button. Activation of the request to exit device shall bypass all door alarms for a fixed period of time. A valid transaction at the proximity reader or activation of the ADA push button shall open both leaves automatically and bypass all door alarms for a fixed period of time.
 - b. From unsecured side, the door shall be unlocked by retracting the latches in the panic devices after a valid transaction at the reader. Door shall also be opened automatically after a valid transaction at the proximity reader from a user with ADA privileges (extended unlocked time). A valid transaction at the reader from a user with no ADA privileges shall also enable the ADA push button momentary for a fixed period of time, but does not need to open the door automatically unless the ADA push button is pressed while enabled. A valid transaction at the reader shall bypass door alarms for a fixed period of time.
7. Reported Alarms (Controlled Mode):
 - a. Door forced open, either leaf as one alarm
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis.
8. Either Mode, Key override: This door shall not have key override.
9. Fire Alarm Release: Upon activation of the fire alarm system in the building, doors shall be unlocked and door shall be automatically opened until the fire alarm is cleared.
10. Reported Alarms (Either Mode):
 - a. Power supply tamper.
 - b. AC failure (if available in power supply).
 - c. Battery low (if available in power supply).
- N. DOOR TYPE O-1 (Single controlled entry with mortise lock, free exit, non- emergency)
 1. Door Type: Single leaf
 2. Door Mode: Operational door

3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) electric mortise lock with request to exit switch built in.
 - b. By security Contractor: One (1) door position switch
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans
 5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means using the electric mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 6. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 7. Fail mechanism: Door lock shall be fail-secure.
 8. Reported Alarms:
 - a. Door forced open
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis
- O. DOOR TYPE O-2 (Double controlled entry with mortise lock, free exit, non- emergency)
1. Door Type: Double leaf, one active, one inactive
 2. Door Mode: Operational door
 3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) electric mortise lock with request to exit switch built in
 - b. By security Contractor: Two (2) door position switches
 4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: One (1) reader, as indicated in floor plans

5. Door Operation:
 - a. From the secured side, one leaf shall be opened by mechanical means using the electric mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time. Second leaf shall only be opened by mechanical means after other leaf is opened.
 - b. From the unsecured side. One leaf shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
6. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
7. Fail mechanism: Door lock shall be fail-secure.
8. Reported Alarms:
 - a. Door forced open
 - b. Invalid, lost or stolen card presented at the reader
 - c. Door held open, either leaf as one alarm: Contractor to coordinate with the Baldwin Wallace University held open time in a per door basis

P. DOOR TYPE O-3 (Single monitored door with request to exit)

1. Door Type: Single leaf
2. Door Mode: Operational door
3. Devices on Secured Side:
 - a. By door hardware Contractor: One (1) power transfer, one (1) mortise lock with request to exit switch built in
 - b. By security Contractor: One (1) door position switch
4. Devices on unsecured side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: None
5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means using the mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be opened by mechanical means using the door lock.
6. Reported Alarms:
 - a. Door forced open from unsecure side
 - b. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis

Q. DOOR TYPE O-10 (Dual monitored door with request to exit)

1. Door Type: Double leaf
2. Door Mode: Operational door
3. Devices on Secured Side:
 - a. By door hardware Contractor: Two (2) power transfer, one (2) mortise lock with request to exit switch built in
 - b. By security Contractor: Two (2) door position switches
4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: None
5. Door Operation:
 - a. From the secured side, the door shall be opened by mechanical means using the mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time.
 - b. From the unsecured side, the door shall be opened by mechanical means using the door lock.
6. Reported Alarms:
 - a. Door forced open from unsecure side (both leaves reporting as one alarm)
 - b. Door held open: Contractor to coordinate with the Baldwin Wallace University held open time on a per door basis

R. DOOR TYPE O-9 (Single monitored door)

1. Door Type: Single leaf
2. Door Mode: Operational door
3. Devices on Secured Side:
 4. By door hardware Contractor: None
 5. By security Contractor: One (1) door position switch.
6. Devices on Unsecured Side:
 7. By door hardware Contractor: None
 8. By security Contractor: None
9. Door Operation:
 - a. From the secured side or the unsecured side, the door shall be opened by mechanical means using the door lock.

10. Reported Alarms:

- a. Door opened if alarm point is armed
- b. No alarms if alarm point is disarmed

S. DOOR TYPE O-10 (Double monitored door)

1. Door Type: Double leaf

2. Door Mode: Operational door

3. Devices on Secured Side:

- a. By door hardware Contractor: None
- b. By security Contractor: Two (2) door position switches

4. Devices on Unsecured Side:

- a. By door hardware Contractor: None
- b. By security Contractor: None

5. Door Operation:

- a. From the secured side or the unsecured side, the door shall be opened by mechanical means using the door lock.

6. Reported Alarms:

- a. Door opened if alarm point (both leaves reporting as one alarm) is armed
- b. No alarms if alarm point is disarmed

T. DOOR TYPE G-1 (Controlled entry gate)

1. Door Type: Vehicular gate

2. Door Mode: Operational door

3. Devices on Secured Side:

- a. By door hardware Contractor: None
- b. By security Contractor: None

4. Devices on Unsecured Side:

- a. By door hardware Contractor: None
- b. By security Contractor: A gate barrier with safety loops, one (1) pedestal with a card readers as indicated in floor plans.

5. Door Operation:
 - a. From the secured side (reverse entry side), the gate shall not be opened
 - b. From the unsecured side (entry side), the gate arm shall be raised for a fixed period of time after a valid transaction at the reader. Gate alarms shall be by- passed for a fixed period of time.
6. Activation of the safety loop shall not let the gate arm to come down.
7. Reported Alarms:
 - a. Gate barrier enclosure tamper
 - b. Invalid, lost or stolen card presented at the reader
 - c. Gate held open: Barrier arm up after opening time expired; Contractor to coordinate with the Baldwin Wallace University held open time on a per gate basis

U. DOOR TYPE G-2 (Free exit gate)

1. Door Type: Vehicular gate
2. Door Mode: Operational door
3. Devices on Secured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: An exit loop
4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: A gate barrier with safety loops
5. Door Operation:
 - a. From the secured side (exit side), the gate arm shall be raised for a fixed period of time after activation of the exit loop. Gate alarms shall be by-passed for a fixed period of time.
 - b. From the unsecured side (reverse exit side), the gate arm shall not be opened.
6. Reported Alarms:
 - a. Gate barrier enclosure tamper
 - b. Gate held open: Barrier arm up after time opening time expired; Contractor to coordinate with the Baldwin Wallace University held open time on a per gate basis

V. DOOR TYPE G-3 (Controlled entry, free exit gate)

1. Door Type: Vehicular gate
2. Door Mode: Operational door

3. Devices on Secured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: Exit loop
4. Devices on Unsecured Side:
 - a. By door hardware Contractor: None
 - b. By security Contractor: A gate barrier with safety loops, one (1) pedestal with a card readers as indicated in floor plans.
5. Door Operation:
 - a. From the secured side (exit side), the gate arm shall be raised for a fixed period of time after activation of the exit loop. Gate alarms shall be by-passed for a fixed period of time.
 - b. From the unsecured side (entry side), the gate arm shall be raised for a fixed period of time after a valid transaction at the reader. Gate alarms shall be by-passed for a fixed period of time.
6. Activation of the safety loop shall not let the gate arm to come down.
7. Reported Alarms:
 - a. Gate barrier enclosure tamper
 - b. Invalid, lost or stolen card presented at the reader
 - c. Gate held open: Barrier arm up after opening time expired; Contractor to coordinate with the Baldwin Wallace University held open time on a per gate basis

3.2 INSTALLATION PRACTICES

- A. All AC power shall be fed from the building's power source supported by an emergency backup generator where applicable. If no generator is available a UPS device shall be included with the system that will provide continuous power for a minimum of 30 minutes. The source of the AC power feed shall be identified at termination point of equipment.
- B. The card access system shall utilize the existing campus network using approved protocols for communications between the building controllers, client workstations and the central database server.
- C. All power supplies shall be monitored for AC failure. When power supply provides a Form-C relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.
- D. All junction boxes that contain splices or connections shall be equipped with a tamper switch. All junction boxes shall be clearly identified.
- E. *Note to Designer(s) or Consultant(s):* Control panels, power supplies and all other head-end components shall be located in a single, secured room within the building, with local access to staff. In multi-story buildings there may be equipment in such rooms on more than one floor.

**BALDWIN WALLACE UNIVERSITY DESIGN GUIDELINES A CONSTRUCTION STANDARDS
DIVISION 28 – ELECTRONIC SAFETY AND SECURITY**

The room(s) selected to house the electronic access components shall not contain mechanical or elevator controls equipment and shall not be a Telecommunication Room, but shall be a dedicated security room adjacent to a Telecommunications Room in new construction. All components shall be contained in enclosures, each of which shall be mounted on backboard of 4 feet by 8 feet plywood ¾ inch thick painted grey with fireproof paint. Enclosures shall be mounted at locations and heights that ensure ease of service.

- F. All buzzers inside card readers shall be wired to alert users of different door statuses: “Door held open” and “door forced open”, for example.
- G. All inputs shall provide UL 1076 Grade A analog supervised alarm input zones to monitor and report line fault conditions (open, short, ground, or circuit fault), alarm conditions, power faults and tampers. When an alarm input is activated, the associated alarm condition shall be reported to both the ISC and subsequently to the alarm monitoring client workstation. Status LED’s shall provide information about the sixteen alarm zone inputs, cabinet tamper, and power fault. For each status LED, a slow flash shall imply a “No Alarm” condition, a fast flash shall indicate an “Alarm Condition”, and a solid LED shall indicate a “Zone Fault” (open, short, ground, or circuit fault).

3.3 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All penetrations through fire rated barriers shall be provided with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- E. Installation of all UTP Category cables and Fiber Optic cables shall be in accordance with EIA/TIA guidelines and Baldwin Wallace University Telecommunications Standards.
- F. All cable runs shall be continuous from the device to the head-end equipment. Cable splices shall only be permitted when absolutely necessary.
- G. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon “TY-Raps” (Thomas & Betts or equivalent). Lacing of cables shall not be permitted.
- H. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.4 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. Schematic legends shall be placed inside all terminal cabinets to assist with identification of components and connections contained therein.
- B. All access control panels shall include a worksheet attached to the interior of the panel in plastic envelopes. This worksheet shall include the location, type of device and part number of all devices connected to the boards inside the panel. All names used to identify devices in these worksheets shall conform to the Baldwin Wallace University Standardized Hardware Naming Convention.

3.5 ADDITIONAL CONTRACTOR RESPONSIBILITIES

- A. Upon project commencement, the Contractor shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase.
- B. During the installation process the Contractor shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consultants. This set of documents should be clearly annotated with as-built data as the work is performed.

3.6 PROGRAMMING AND SYSTEM CONFIGURATION

- A. The Contractor shall assist Baldwin Wallace University with programming and configuration of the security management system. Programming shall include defining descriptions for access control hardware, doors, alarm monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like.
- B. The Contractor shall develop the graphical maps for the alarm monitoring screens. PPD's Architecture and Engineering team shall provide project floor plan drawings in the form of AutoCAD DWG or DXF file to be used for map creation. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits.
- C. Contractor shall maintain hard copy worksheets which fully document the system installation, programming, and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final acceptance.

3.7 WARRANTEE

- A. During the first year of service the Contractor shall ensure that manufacturer-certified repair and maintenance personnel are available for Emergency Service calls twenty-four (24) hours a day, three hundred sixty five (365) days a year. The maximum on-site response time for emergency services shall not exceed four (4) hours for warranty or non-warranty issues. The Contractor shall be able to perform any and all repairs to the system within twenty-four (24) hours.

3.8 SPARE PARTS

- A. Prior to completion of a project the Contractor shall submit a list of recommended spare parts for this system. These recommendations shall be based upon the Contractor's and manufacturers' experience with this equipment's performance history and critical impact the device has in overall system operations.
- B. All cost estimates submitted for additional equipment shall remain at the same rate provided in the original contract documents.

3.9 CONTRACTOR TESTING

- A. The Contractor shall activate all alarms and other output devices that are in the system to test for proper operation, including supervisory and trouble circuit tests.
- B. After installation and prior to termination, all wiring and cabling shall be checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields. A volts ohms meter shall be utilized for this test. Signal strength greater than 20 megohms shall be required to successfully complete the test.
- C. All testing of UTP Category cable shall be provided in conformance with the requirements established under the Baldwin Wallace University Telecommunications Standards.

- D. The Contractor shall develop a report that indicates a complete listing of all equipment and alarm monitoring points in this facility. This list shall be used as a guide during testing to ensure that all components are inspected.

The personnel conducting these tests shall indicate the following information on this form:

Name of person conducting test

Date of test

Time of test

Results of test

- E. Upon successful completion of tests, the log file(s) generated by this activity shall be printed and submitted along with the testing documents, to the client and consulting engineer for review.

3.10 PREPARATION FOR FINAL ACCEPTANCE TESTING

- A. All components shall be inspected to ensure they have been properly installed, securely attached, and remain clean and unmarred.
- B. All equipment shall be properly adjusted, clearly labeled, and fully operational.
- C. All broken, damaged or modified items such as walls, doorframes, ceiling tiles, etc., shall be replaced or properly repaired to the satisfaction of the client.
- D. All extra or spare materials shall be delivered and stored on the premises, as directed.
- E. Test report of all system components shall be completed and available for inspection as indicated herein.
- F. Four (4) sets of individual factory issued Equipment Manuals containing all technical information on each piece of equipment. Advertising brochures or information instructions shall not be used in lieu of technical manuals and information. Documents to be provided in digital format CD or DVD.
- G. Four (4) sets of individual factory issued Operation Manuals containing all technical information on the system. Advertising brochures or information instructions shall not be used in lieu of technical manuals and information. Documents to be provided in digital format CD or DVD.
- H. Four (4) complete sets of As-Built Drawings: Documents to be provided in digital format CD or DVD. One set of the As-Built Drawings are to be placed in the ground floor access panel for service purposes.
- I. Statement of Guarantee, including the date of termination, and the name/telephone number of person to be called in the event of equipment failure.

3.11 TRAINING AND INSTRUCTION

- A. Before the system is turned over to the Owner, the Contractor shall provide training on the new system. The Contractor shall provide the client with a minimum of two (2) hours of technical training in system setup, maintenance, troubleshooting, and servicing of this system.
- B. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the client and Contractor.

3.12 AS-BUILT DOCUMENTS

- A. As-Built Documents shall be provided as part of this contract. As-Built Drawings shall be a complete set of AutoCAD Release 2006 floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. The original project floor plan disk shall be obtained from the consulting engineer. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required. All addendum information or project revision resulting in drawing changes that occur during the construction period shall be documented and included in the as-built material. All required As-Built Documentation is mandatory and shall be required prior to project closeout. A complete set of prints with all changes shall be submitted to the Engineer's for review. Upon completion of the Engineer's review, the Contractor shall provide an updated CD-ROM disk containing the electronic drawing files and four (4) reproducible set of drawings. This information must include final As-Built conditions and the Engineer's review comments if any.

3.13 FINAL ACCEPTANCE TESTING

- A. After the testing reports, the as-built drawings, and the required manuals have been submitted for review, the Contractor shall coordinate a date for Final Acceptance Testing.
- B. Testing and acceptance of this system will take place in the presence of the Designer or Consultant and Baldwin Wallace University.
- C. Acceptance of the system shall require a demonstration of all system components to evaluate their performance and reliability. Prior to this test the system must have been online for a period of sixty (60) days, with an uptime of no less than 99 percent. Should a major equipment failure occur, the Contractor shall replace the defective component and continue the testing period. Any items discovered during final inspection which require the Contractors attention, shall be promptly addressed. These items will then be re-inspected by the Designer or consultant for approval.
- D. Upon the completion of acceptable Final Acceptance Testing, the Contractor shall submit all finalized project documentation and associated electronic media. Upon approval from Baldwin Wallace University and the Designer or Consultant, Baldwin Wallace University will issue a Letter of Completion to the Contractor indicating the date of such completion. This notice will serve as Client acceptance of this system.

END OF SECTION 281300

SECTION 281600 – INTRUSION DETECTION

PART 1: GENERAL

1.1 SCOPE OF WORK

A. SCOPE OF WORK FOR DESIGNER AND CONSULTANTS

1.2 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

B. The following documents from Division 28, Electronic Safety and Security of the Baldwin Wallace University Access Control, Surveillance and Security Specifications are also relevant to this section:

1. Section 281300: Access Control
2. Section 282300: Video Surveillance

C. The following documents also apply to this section:

1. Division 08, Section 087100: Finished Hardware of the Baldwin Wallace University Standards Manual
2. Baldwin Wallace University Key and Lock Policy
3. Baldwin Wallace University Telecommunications Standards
4. Baldwin Wallace University Information Technology Policies and Standards
5. Baldwin Wallace University Information Technology Security Regulations

D. Design and operation of the system shall conform to the following referenced codes, regulations, and standards as applicable:

1. National Electrical Code (NEC), edition indicated in the current Ohio Building Code
2. Ohio Building Code, current edition
3. Electronic Industry Association (ANSI/EIA/TIA)
4. National Electrical Manufacturers Association (NEMA)
5. Underwriters Laboratories UL 294, UL 639, UL 1037, and UL 1076
6. National Fire Protection Association (NFPA)
7. Federal Communications Commission (FCC) 47 CFR Part 15 and 90
8. Applicable Federal, State, and Local Laws, Regulations

E. A list of vendors/installers approved by Baldwin Wallace University

1.3 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall have a fully staffed office and service department located within a hundred (100) miles of Baldwin Wallace University.
- B. The Contractor shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The Contractor shall be able to perform any and all repairs to the system within twenty-four (24) hours.
- C. All technicians assigned to install and configure this system shall be trained and certified for the proper installation of this equipment. The Contractor must have a minimum of 3 qualified and factory trained technicians to support this system.
- D. The Contractor, as a minimum, must carry a current state-issued limited energy (low voltage) license.

1.4 SUBSTITUTIONS AND ALTERNATE METHODS.

- A. Because the intrusion detection system has to be tied to the existing Baldwin Wallace University infrastructure, only the products listed in the specification shall be used. Equipment and software shall be provided as specified.
- B. Sensors or door security devices allow substitutions as long as they can be proven equal to the basis of design given in this specification. In order for the new product to be accepted as an equal, the security Contractor shall follow these steps:
 - 1. Submit a variance form, attaching a complete list of such substituted products with drawings and product data sheets.
 - 2. Receive an approved variance request form, signed by Baldwin Wallace University. The Contractor is not authorized to install any substitute equipment before receiving an approved variance request form.
- C. Substitute equipment must be a standard part of that systems current product line and should meet or exceed the capabilities of the equipment specified herein. Beta, Specials, or “One Time” products will not be acceptable. If proposed substitutions do not meet or exceed the performance levels specified herein, the limitations of this equipment must be highlighted and brought to the attention of the designer and/or consultant. Failure to notify the designer/consultant of these limitations, whether intentionally or by oversight, may result in rejection of those components at any time. Should this occur the Contractor will be required to replace the rejected equipment with pre-approved components that meet or exceed the requirements as specified herein. This will be done at no additional cost to the client.
- D. Alternate methods: When the Contractor proposes alternate methods to a Baldwin Wallace University standard practice indicated in this specification, the Contractor shall follow the same process as for equipment substitutions. The Contractor shall submit a variance request form and obtain approval from Baldwin Wallace University before applying any alternate methods.

1.5 SUBMITTALS

- A. Within twenty (20) business days of receiving contract approval and notice to proceed, the Contractor shall submit to the designer or consultant the project submittals. The submittal document includes, at a minimum, the following information:
 - 1. Product numbers, specifications, and data sheets for all equipment and software

2. All security wire product data sheets (The Contractor shall indicate the intended use for all wiring submitted.)
3. Point-to-point wiring diagrams for all devices
4. Single-line drawings representing the entire system
5. Termination details
6. Course outlines for each of the end user training programs (The course outlines shall include the course duration, pre-requisites, and a brief description of the subject matter.)
7. Proposed method of wire marking, panel labeling, zone identification, and terminal strip numbering
8. Project milestone schedule
9. Template for weekly progress report

1.6 ABBREVIATIONS

A. The following abbreviations are used in this document:

1. ANSI American National Standards Institute
2. ASCII American Standard Code for Information Interchange
3. AWG American Wire Gauge
4. CCTV Closed Circuit Television
5. CPU Central Processing Unit
6. DPS Door Position Switch
7. FCC Federal Communications Commission
8. GUI Graphical User Interface
9. ID Identification
10. NEC National Electrical Code
11. NEMA National Electrical Manufacturers Association
12. SCS Security Control System
13. SDRAM Synchronized Dynamic Random Access Memory
14. STP Shielded Twisted Pair
15. UL Underwriters Laboratories, Inc.
16. UPS Uninterrupted Power Supply
17. UTP Unshielded Twisted Pair

1.7 GLOSSARY OF TERMS

- A. The following terms are defined for the purposes of this specification:

ALARM CONDITION: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.

CLEAR: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.

DOWNLOAD: To send computer data from the file server to a controller for the purposes of making access decision without the intervention of file server.

LINE SUPERVISION: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.

OFF-LINE: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.

TROUBLE: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.

PART 2: PRODUCTS

2.1 INTRUSION DETECTION PANELS

- A. The only approved intrusion detection panels are:
1. Baldwin Wallace University to verify requirements
- B. Other intrusion detections system could be considered if the Contractor can demonstrate that they will interface seamlessly with the existing system.
- C. All intrusion detection panels shall be provided with an Ethernet communications interface to integrate with the existing systems. If an intrusion detection panel requires a separate communications module for Ethernet connectivity, the communications module shall be provided with the intrusion detection panel. Communications modules that use a separate power supply not backed by batteries are not acceptable.

2.2 MAGNETIC DOOR POSITION SWITCH (DPS)

- A. See specification Section 281300: Access Control, paragraph 2.6.

2.3 ALARM SENSORS AND DEVICES

- A. Note to Designer(s) or Consultant(s): Other than magnetic door position switches there is no design guideline for alarm sensors and devices. The designer or consultants shall recommend alarm sensors and devices based on their expertise and based on the security requirements given by the users to the designers.

2.4 INTRUSION DETECTION EQUIPMENT ENCLOSURES

- A. See specification Section 281300: Access Control, paragraph 2.5.

2.5 TAMPER SWITCH

- A. See specification Section 281300: Access Control, paragraph 2.7.

2.6 SURGE PROTECTION

- A. All intrusion detection components installed outdoors or exposed to lighting shall be provided with surge and lighting protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines.

2.7 CABLES FOR INTRUSION DETECTION

- A. Cables for un-powered security sensors shall have the following specification:

1. Minimum cable gauge: AWG 20
2. Number of conductors: Two (2), stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black and red
6. Voltage rating: 300 volts
7. Cable shield: No cable shields

- B. Cables for powered security sensors shall have the following specifications:

1. Minimum cable gauge: AWG 20
2. Number of conductors: Four (4), stranded conductors
3. Conductor type: Bare copper
4. Cable insulation: Color coded PVC
5. Conductor insulation colors: Black, red, white, and green
6. Voltage rating: 300 volts
7. Cable shield: No cable

- C. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:

1. Minimum cable gauge: AWG 24
2. Number of conductors: Two (2) paired, stranded conductors
3. Conductor type: Tinned copper
4. Cable insulation: Polyethylene
5. Conductor insulation colors: White-blue, blue-white white-orange, and orange-white
6. Voltage rating: 300 volts

- D. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90 percent coverage) and a AWG 24 tinned copper drain wire
 - 1. Nominal characteristic impedance: 120 ohms
 - 2. Nominal capacitance: 12.8 picofarad/feet
 - 3. Nominal delay: 1.6 nanoseconds/feet
 - 4. Nominal attenuation: 0.6 decibels/100 feet at 1 megahertz.
 - 5. Cables for alarm notification devices shall have the following specifications:
 - 6. Minimum cable gauge: AWG 18
 - 7. Number of conductors: Two (2), stranded conductors
 - 8. Conductor type: Bare copper
 - 9. Cable insulation: PVC
 - 10. Conductor insulation colors: Black and red
 - 11. Voltage rating: 300 volts
 - 12. Cable shield: No cable
- E. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5 percent voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Contractor shall always estimate proper values.
- F. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits
- G. Acceptable Manufacturers:
 - 1. Belden
 - 2. Alpha Wire Company
 - 3. General Cable
 - 4. West Penn Wire.
- H. UTP category cables and fiber optic cables: For specifications on all UTP paired category cables and fiber optic cables the Contractor shall follow all requirements on Baldwin Wallace University Telecommunications Standards.

PART 3: EXECUTION

3.1 INSTALLATION PRACTICES

- A. All AC power shall be fed from the buildings power source supported by an emergency backup generator where applicable. All intrusion detection panels shall incorporate battery backup thru onboard charger or external charger/power supply. Either backup configuration shall provide continuous power for a minimum of thirty (30) minutes. The source of the AC power feed shall be identified at termination point of equipment.
- B. All intrusion detection panels shall utilize the existing campus network using approved protocols for primary communications to the central server and UPD dispatch monitoring clients. If necessary, the intrusion detection panel shall use a phone line/dial modem as a secondary redundant communication method.
- C. All intrusion detection systems shall be monitored for AC failure. When the intrusion detection panel or power supply provides an integrated or Form-C relay with low battery signaling, this event or contact shall also be monitored. All contact AC fail and battery low alarms shall be monitored through individual alarm inputs.
- D. All junction boxes that contain splices or connections shall be equipped with a tamper switch. All junction boxes shall be clearly identified.
- E. Note to Designer(s) or Consultant(s): All intrusion detection system equipment shall be located in a single, secured room within the building, with local access to staff. In multi-story buildings there may be intrusion detection system equipment in such rooms on more than one floor. The room(s) selected to house the electronic access components shall not contain mechanical or elevator controls equipment and shall not be a Telecommunication Room, but shall be a dedicated security room adjacent to a Telecommunications Room in new construction. All components shall be contained in enclosures, each of which shall be mounted on backboard of 4 feet by 8 feet plywood $\frac{3}{4}$ inch thick painted grey with fireproof paint. Enclosures shall be mounted at locations and heights that ensure ease of service. Proposed locations for intrusion detection system equipment will be reviewed on a case-by-case basis. Baldwin Wallace University must approve the location of any devices in their respective areas. A variance request must be submitted if the proposed location of a device is within a Telecommunications Room. The request may be approved if structured cabling is used and there is enough space, power and cooling capacity available in the room.
- F. Every intrusion detection system installed shall include at least one keypad with LCD display and a siren.
- G. All intrusion detection systems shall be provided with at least a 20 percent spare zone inputs capacity.

3.2 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All penetrations through fire rated barriers shall be provided with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- E. Installation of all UTP category cables and fiber optic cables shall be in accordance with EIA/TIA guidelines and Baldwin Wallace University Telecommunications Standards.

- F. All cable runs shall be continuous from the device to the head-end equipment. Cable splices shall only be permitted when absolutely necessary. If no addressable intrusion detection devices are used, every device shall be home run to the head end equipment. If it is acceptable to the system designer to have more than one device in the same physical zone, all devices will still be home run and the series connection shall be done at the main intrusion detection panel.
- G. All intrusion alarm zone wiring shall be supervised. End of line resistors shall be located in the last device in the zone. End of line resistors located in the main panel are not acceptable.
- H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon “TY-Raps” (Thomas & Betts or equal). Lacing of cables shall not be permitted. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.
- I. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.3 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. Schematic legends shall be placed inside all terminal cabinets to assist with identification of components and connections contained therein.
- B. All intrusion detection panels shall include a work sheet attached to the interior of the panel in plastic envelopes attached to the inner side of the intrusion detection panel cabinet. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside the panel. All names used to identify devices in these worksheets shall include the Baldwin Wallace University Standardized Hardware Naming Convention.

3.4 ADDITIONAL CONTRACTOR RESPONSIBILITIES

- A. Upon project commencement, the Contractor shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the Contractor shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consultants. This set of documents should be clearly annotated with as-built data as the work is performed.

3.5 PROGRAMMING AND SYSTEM CONFIGURATION

- A. The Contractor shall program all features in the intrusion detection system for stand-alone operation.
- B. The Contractor shall assist the Owner with programming and configuration of the integration between the intrusion detection system and the Lenel On-guard system. Programming shall include defining descriptions for intrusion detection hardware, doors, alarm monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like.
- C. The Contractor shall develop the graphical maps for the alarm monitoring screens. The A&E team shall provide project floor plan drawings in the form of AutoCAD *.dwg or *.dxf file to be used for map creation. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits.
- D. Contractor shall maintain hard copy worksheets which fully document the system installation, programming, and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final acceptance.

3.6 WARRANTY

- E. During the first year of service the Contractor shall ensure that manufacturer certified repair and maintenance personnel are available for Emergency Service calls twenty-four (24) hour a day, three hundred sixty five (365) days a year. The maximum on-site response time for emergency services shall not exceed four (4) hours for warranty or non-warranty issues. The Contractor shall be able to perform any and all repairs to the system within twenty-four (24) hours.

3.7 SPARE PARTS

- A. Prior to completion of this project the Contractor shall submit a list of recommended spare parts for this system. These recommendations shall be based upon the Contractors and manufacturers experience with this equipment's performance history and critical impact the device has in overall system operations.
- B. All cost estimates submitted for additional equipment shall remain at the same rate provided in the original contract documents.

3.8 CONTRACTOR TESTING

- A. The Contractor shall do a walk test of the building testing all sensors in the system. Testing shall check for proper operation and activation, including supervisory and trouble circuit tests.
- B. After installation and prior to termination, all wiring and cabling shall be checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields. A volts ohms meter shall be utilized for this test. Signal strength greater than 20 mega ohms shall be required to successfully complete the test.
- C. All testing of UTP Category cable shall be provided in conformance with the requirements established under the Baldwin Wallace University Telecommunications Standards.
- D. The Contractor shall develop a report that indicates a complete listing of all equipment and alarm monitoring points in this facility. This list shall be used as a guide during testing to ensure that all components are inspected.

The personnel conducting these tests shall indicate the following information on this form:

Name of person conducting test

Date of test

Time of test

Results of test

- E. Upon successful completion of tests, the log file(s) generated by this activity shall be printed and submitted along with the testing documents, to the client and consulting engineer for review.

3.9 PREPARATION FOR FINAL ACCEPTANCE TESTING

- A. All components shall be inspected to ensure they have been properly installed, securely attached, and remain clean and unmarred.
- B. All equipment shall be properly adjusted, clearly labeled, and fully operational.
- C. All broken, damaged, or modified items such as walls, doorframes, ceiling tiles, etc., shall be replaced or properly repaired to the satisfaction of the client.

- D. All extra or spare materials shall be delivered and stored on the premises as directed.
- E. Test report of all system components shall be completed and available for inspection as indicated herein.
- F. Four (4) sets of individual factory issued Equipment Manuals containing all technical information on each piece of equipment. Advertising brochures or information instructions shall not be used in lieu of technical manuals and information. Documents shall be placed in appropriately sized 3-ring binders, properly labeled for content enclosed.
- G. Four (4) sets of individual factory issued Operation Manuals containing all technical information on the system. Advertising brochures or information instructions shall not be used in lieu of technical manuals and information. Documents shall be placed in appropriately sized 3-ring binders, properly labeled for content enclosed.
- H. Four (4) complete sets of As-Built Drawings. Documents to be provided in digital format CD or DVD. One set of As-Built drawings are to be placed in the ground floor access panel for service purposes.
- I. Statement of Guarantee, including date of termination, and the name/telephone number of person to be called in the event of equipment failure.

3.10 TRAINING AND INSTRUCTION

- A. Before the system is turned over to the Owner the Contractor shall provide training on the new system. Provide two (2) minimum hours of technical training in system setup, maintenance, troubleshooting, and service of this system.
- B. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the client and Contractor.

3.11 AS-BUILT DOCUMENTS

- A. As-Built Documents shall be provided as part of this contract. As-Built Drawings shall be a complete set of AutoCAD floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. The original project floor plan disk shall be obtained from the consulting engineer. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required. All addendum information or project revision resulting in drawing changes that occur during the construction period shall be documented and included in the as-built material. All required as-built documentation is mandatory and shall be required prior to project closeout. A complete set of prints with all changes shall be submitted to the Engineer's for review. Upon completion of the Engineer's review, the Contractor shall provide an updated CD-ROM disk containing the electronic drawing files and four (4) reproducible set of drawings. This information must include final As-Built Conditions and the Engineer's review comments if any.

3.12 FINAL ACCEPTANCE TESTING

- A. After the testing reports, the as-built drawings, and the required manuals have been submitted for review, the Contractor shall coordinate a date for Final Acceptance Testing.
- B. Testing and acceptance of this system will take place in the presence of the Designer or Consultant and the Owner.

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- C. Acceptance of the system shall require a demonstration of all system components to evaluate their performance and reliability. Prior to this test the system must have been online for a period of sixty (60) days, with an uptime of no less than 99 percent. Should a major equipment failure occur, the Contractor shall replace the defective component and continue the testing period. Any items discovered during final inspection which require the Contractors attention, shall be promptly addressed. These items will then be re-inspected by the Designer or consultant for approval.
- D. Upon the completion of acceptable Final Acceptance Testing, the Contractor shall submit all finalized project documentation and associated electronic media. Upon approval from the Owner and the Designer or Consultant, the Owner will issue a Letter of Completion to the Contractor indicating the date of such completion. This notice will serve as Client acceptance of this system.

END OF SECTION 281600

SECTION 282300 – VIDEO SURVEILLANCE

PART 1: GENERAL

1.1 SECTION INCLUDES

- A. Cameras
- B. Control equipment
- C. Cable and accessories

1.2 RELATED SECTIONS

- A. Division 08, Section 087100: Finished Hardware
- B. Division 14, Section 142000: Conveying Systems and Elevators
- C. Division 28, Section 281300: Access Control
- D. Division 28, Section 281600: Intrusion Detection
- E. Baldwin Wallace University Campus Design Guideline and Standards Security System Standards, latest edition
- F. Conduit, cable tray, and back boxes for this system shall be furnished and installed by the Electrical Contractor under the supervision of the security Contractor.
- G. See Division 26 for all information relating to the fire alarm system and required relay interface to release emergency delay exit doors. The fire alarm integrator shall provide the control relays as required.
- H. See Division 26 for all specifications governing the performance of work associated with the installation of raceway, system junction and pull boxes and device rough-in boxes for all work shown in the Access Control System refer to the SC series security drawings.

1.3 REFERENCES

- A. NFPA 70, National Electrical Code
- B. National Fire Protection Association; 2005
- C. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces
- D. EIA/TIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications
- E. National Electrical Code (NEC), latest revision and pertinent addendums
- F. National Fire Protection Association (NFPA) Publications, latest revisions and pertinent addendums
- G. Americans with Disabilities Act (ADA)
- H. NFPA 101, National Fire Protection Association
- I. UL 294, Underwriter's Laboratories Access Control Systems

- J. UL 1037, Underwriter's Laboratories Anti-Theft Alarms and Devices
- K. UL 1076, Underwriter's Laboratories Propriety Burglar Alarms Units and Systems
- L. EIA-RS-170, Broadcast Standards
- M. NTSC Color System Standards
- N. Building Officials and Code Administrators International, Inc. (BOCA) National Building Code
- O. Uniform Building Code (UBC)
- P. Local Governing Authorities Having Jurisdiction

1.4 CONTRACT DOCUMENTS

- A. All work of this section shall comply with the requirements of the Conditions of Contract (including: bidding requirements, contract forms, conditions of contract and standard forms), with all sections of division 1, with the drawings, and with all other contractual documents.
- B. Coordinate with other Division sections as required.

1.5 SYSTEM DESCRIPTION

This section specifies the requirements for the Video Surveillance system for Baldwin Wallace University.

A. Scope of Work

1. The work detailed by these specifications and drawings has been specified to meet certain requirements for performance. Some information, such as exact equipment layout, wire routing, additional conduit and power requirements, etc. has been omitted. It shall be the responsibility of the Contractor to translate these specifications and drawings into a complete design package containing all necessary elements for a complete turnkey installation including all material, labor, warranties, shipping and permits.
2. Work shall include the installation and commissioning of the following:
 - a. Video Surveillance System (VSS)
3. Work to include, but not limited to the following:
 - a. Perform camera pre-installation sign-off walk through with Owner and Security Consultant.
 - b. Installation of cameras and camera cabling
 - c. Provide all required software and licenses to the Owner.
 - d. Contractor shall provide continuous on-site supervision of the installation technicians. Onsite supervision shall include: daily supervision of the work, updating work site progress drawings to reflect changes and installations details, preparing weekly progress reports and attendance at site coordination meetings as directed by the Owner and Security Consultant.
 - e. The Contractor shall provide continuous engineering and programming support during the installation as required to accommodate existing conditions and unforeseen conditions that may arise during performance of the work.

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- f. The Contractor shall provide all miscellaneous hardware including cable management devices, termination cabinets, wire and cable labeling materials, fasteners, hangers and brackets as required.
- g. The Contractor will coordinate the delivery and storage of all materials, wire, cable, Baldwin Wallace University Master Construction Specifications equipment and miscellaneous hardware.
4. Description: Provide video communications between points of surveillance indicated on Drawings and central monitoring station.
5. The Contractor shall provide all materials, equipment, labor and all other incidental material, tools, appliances and transportation as required for a complete and functional video surveillance system (VSS) as described herein and supplementary drawings.
6. General elements of the work shall consist of but not limited to:
 - a. Procure all permits and license required to complete this installation.
 - b. Submission of Schedule of Values for all equipment, materials and labor.
 - c. Attend pre-construction/pre-submittal meeting with Owner and Security Consultant to review design package for security and finish hardware.
 - d. Submittal preparation and processing prior to ordering equipment.
 - e. Attend finish hardware submittal review meeting.
 - f. Coordination of conduit system, raceway and power distribution provided by Division 26 Contractors.
 - g. Coordination with all trades and Owner representatives as required facilitating the installation of the security equipment including: Door Hardware, Fire Alarm and Electrical Divisions.
 - h. Provide security system sensors, cable, connectors, wiring, equipment enclosures and all other materials necessary to complete the security system per the design documents.
 - i. Verify conditions and dimensions at the job site prior to installation.
 - j. Coordinate all system programming and camera naming with Owner.
 - k. Perform pre-installation camera position and view sign off with Owner.
 - l. Perform installation according to contract documents and manufacturers recommendations.
 - m. Protect new facilities finishes and equipment.
 - n. Maintain construction materials and refuse within the area of work.
 - o. Clean the work area at the end of each day.
 - p. Perform initial testing and adjustments with written reports.
 - q. Make final adjustments and calibrations as directed by the Owner and Security Consultant.
 - r. Demonstrate all systems and component operations for final acceptance.
 - s. Preparation of O&M manuals and as-built documents for Owner's use.
 - t. Provide training for Owner's security staff, facility personnel and technical staff.

- u. Provide warranty service for a period of one year from acceptance date.
- v. Provide extended maintenance service.

1.6 SUBMITTALS

- A. See Section 013300: Submittal Procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements, including system wiring diagram.
- C. Camera/PPF schedule: As further described in Baldwin Wallace University Telecommunication Infrastructure Standards Section 12.0.2.1 “Camera Model Specifications and Use Requirements” provide a schedule demonstrating that the selected camera and lens at each camera location meets the required use criteria. Schedule shall include all PPF and lens calculations.
- D. Product Data: Provide showing electrical characteristics and connection requirements for each component.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Project Record Documents: Record actual locations of cameras and routing of television cable.
- G. Operation Data: Instructions for starting and operating system.
- H. Maintenance Data: Routine trouble shooting procedures.
- I. The submittal shall be a detailed response describing methods, procedures and specific equipment proposed to conform to the system design detailed in these documents.
- J. Submittals shall consist of product data, shop drawings, samples and detailed completion schedules.
- K. Partial submittals shall not be accepted without prior approval by Owner.
- L. No portion of the work shall commence or equipment ordered until the Owner has approved the submittals.
- M. The Contractor shall not be relieved from any contract-required responsibility by the Owner's approval of submittals.
- N. Nothing in the specification shall relieve the Security Contractor of responsibility in delivering a functioning turnkey security system.

1.7 SUBMITTAL REQUIREMENTS

- A. Product Data:
 - 1. Provide submittals no less than ten (10) working days after notice to proceed.
 - 2. Submit data in 3-ring binder divided into separate section (Access Control, Video Surveillance, etc.) for each system.
 - 3. Equipment lists and equipment data sheets shall be 8-½ inches by 11 inches in size.

4. Each section to include the following:
 - a. List all system components with an assigned item number, manufacturer, model number and quantities of each.
 - b. Manufacturer's literature sheets for all materials and equipment, including warranty information and recommended preventative maintenance and spare part inventory recommendations: Literature containing more than one device shall be clearly marked to delineate item(s) included in the work.
 - c. Clearly indicate color or special finishes.
 - d. List of all cable types including manufacturer's verification and acceptance information.
 - e. General functional description of each system including:
 - 1) Description of operating systems and application software
 - 2) Power requirements and UPS sizing
5. Schedule of Values:
 - a. Contractor shall submit in addition to Division 1 requirements, a Schedule of Values, which includes itemized listing of all equipment, materials and labor required for the installation of the VSS as specified herein for Change Order pricing. Listing shall contain: assign item number, item description, item model number, item quantity, unit cost and extended labor, material and installation cost to provide a complete and functional security system. Submit in electronic format (Microsoft Excel).
6. Shop Drawings:
 - a. Provide Shop Drawings no less than twenty-five (25) working days after notice to proceed.
 - b. Reproducing Contract Documents for shop drawings is not acceptable. Submit three (3) complete sets of shop drawings along with CD-ROM copy to the Security Consultant.
 - c. Produce all Shop Drawings on latest version of AutoCAD. Shop drawings to include the following:
 - 1) Drawing legend sheet describing all symbols used on the drawings
 - 2) Floor plans with all device locations and wiring
 - 3) Wire runs to include tags for type, gauge, quantities and cable identifiers
 - 4) System riser diagram indicating all field devices, riser paths and room designations
 - 5) Block diagram for each system showing: all equipment, interconnections, network connections and data flow
 - 6) Point schedule-defining interconnection of all inputs and outputs for all equipment including fire alarm interface, data connections and other systems
 - 7) Schedule of device power requirements, power source and load calculations

- 8) Elevations of equipment racks with new equipment
 - 9) Elevations of electrical closet(s) with security DGP panel, termination enclosure, wire management, lock power supply(s), UPS, and power routing, etc.
 - 10) Fabrication shop drawings for all custom equipment
7. Samples:
- a. Upon specific request of the Owner and Security Consultant, submit samples of any proposed devices.
8. Resubmitting:
- a. Make corrections or changes in Submittals as required by the Security Consultant's stamped instructions and attached comments and resubmit.
 - b. Identify changes on resubmittals by clouding. Only indicated changes will be reviewed when resubmitted.
 - c. Added drawings shall be clearly identified.
 - d. Contractor shall be responsible for project delays caused by rejected submittals.
 - e. Security Consultant shall be compensated for additional services for submittals rejected more than twice. The amount of such compensation shall be incorporated by change order and withheld from the Contractor's Application for Payment.

1.8 RECORD DOCUMENTATION

- A. Furnish three (3) complete sets of record documents.
- B. Record documents shall include all revised information provided as submittals and reflect as installed revisions.
- C. General Description and Requirements:
 1. Record drawings shall consist of As-Built Drawings and Operation and Maintenance Manuals.
 2. Transmit three (3) copies of a preliminary draft of the Record Documents to the Owner and Security Consultant prior to final acceptance testing and training.
 3. Update all Record Documents to reflect changes or modifications made during final acceptance testing as required.
 4. Submit three (3) sets of final corrected Record Documents to the Security Consultant within thirty (30) days from the date of final acceptance.
 5. As-Built Drawings:
 - a. Furnish three (3) complete sets of As-Built Drawings along with a complete CD-ROM copy.

- b. Maintain on the job site, current up to date as-built drawings and schedule(s) including most recent changes. Included field notes shall be neat and legible. The Contractor shall make any needed changes to this drawing and schedule set as to accurately depict the as-built condition of the security system as it is installed.
- c. As-built Drawings shall, at a minimum, include the following:
 - 1) Floor plan drawings ($\frac{1}{8}''=1'-0''$ scale) indicating device location, with device legends indicating manufacturer and model number for each device
 - 2) Floor plan drawings ($\frac{1}{8}''=1'-0''$ scale) indicating wire routing or approximate routing for existing wiring (Wiring shall be tagged with cable identifier and terminal strip number, which references wiring schedules.)
 - 3) Mounting details for all equipment and hardware.\
 - 4) Functional block diagrams for each system and subsystem.\
 - 5) Wiring details showing: rack elevations, DGP and support equipment elevations, equipment wiring and terminations, and inter-rack wiring
 - 6) Typical point-to-point wiring for each piece of equipment and groups of equipment within the system
 - 7) Schedule of all devices with associated panel termination, zoning, power circuit numbers, etc.
- 6. Operational and Maintenance Manuals (O&M):
 - a. Provide three (3) complete operation and maintenance manuals for all equipment and devices with project title and Contractor's name on cover and spine.
 - b. Submit operation and maintenance manuals in 3 ring binders.
 - c. O&M manuals shall include:
 - 1) Table of contents page with tabbed divider sections for each device or system
 - 2) Tabbed sections shall include: theory of operation, design philosophy, specific functions and system block diagram.
 - 3) List of manufacturer's, their local representatives and subcontractors that performed work on the project; list to include contact names, addresses and phone numbers for each
 - 4) Custom written instructions and procedures for system operation
 - 5) Operator commands
 - 6) Start-up and shutdown procedures
 - 7) Detailed programming descriptions for each system
 - 8) Manufacturer's operation manual for each piece of equipment in the system; product data sheets are not acceptable
 - 9) Custom written quick users guide for inexperienced operators

- 10) System backup disk
- 11) System software licenses
- 12) Equipment list, including a brief description, model, and the total number of each item used in the project
- 13) A separate list of serial numbers for all items used in the system
- 14) Copies of all programming specific to the job, including new code, initial parameters, and settings entered on site, etc.
- 15) Setup procedures for each component in the system
- 16) Maintenance requirements for equipment, inspections, and preventative maintenance schedules
- 17) Final test data (measured levels and other significant operating parameters)
- 18) List of system associated mechanical locking keys and tamper resistant hardware types with key codes.

1.9 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. **Manufacturer Qualifications:** Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within a hundred (100) miles of the Project.
- C. **Supplier Qualifications:** Authorized distributor of specified manufacturer with minimum three years documented experience.
- D. **Installer Qualifications:** Authorized installer of specified manufacturer with service facilities within 100 miles of Project.
- E. **Products:** Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.
- F. **Contractor Qualifications:**
 1. An experienced Contractor shall perform the installation. Contractor shall have at least five (5) years' experience in the installation of security systems of similar size and scope.
 2. All installation personnel shall also be licensed as required by local and/or state jurisdictions.
 3. Contractor shall provide all licensing documentation as part of the bid.
 4. Owner's representative may make such investigations as deemed necessary to determine that the Contractor is responsive, responsible and qualified in the area of work contemplated by the contract. In this regard, the security system installation firm shall furnish to the Owner such information and data as shall be requested for this purpose. Information and data may include (but not necessarily be limited to): Date of organization and/or incorporation and number of years engaged in this business under present firm's names; list of major equipment owned by the company; list of principal personnel who will be involved in the execution of this contract with the experience and qualifications of each person.

5. The Contractor shall provide a Project Manager that shall be constantly in charge of the VSS installation. The Project Manager shall be the same person authorized to make decisions and answer questions asked by the Architect and Owner Representatives. The Project Manager shall also be responsible for system programming, preparation of Operation and Maintenance Manuals, Training, Programs, Schedules and Test Protocols, documentation of system testing, maintenance of Record Drawings and coordination and scheduling of all labor.
6. Provide evidence of site supervisor's qualifications and work history
7. Contractor shall be or have direct relations through their subcontractors, and authorized manufacturer's representatives for all products they furnish or install.
8. Provide documentation that the Contractor and or subcontractor are factory certified to install, program, train and repair all major components or systems to be used in the project.
9. Contractor shall have a local organization capable of providing maintenance and service for the specified system. Facility shall be no more than 100 miles from Owner's site. The security system installation firm shall be capable of providing emergency service on a 24-hour, 7-days a week basis.

1.10 PRODUCT STANDARDS

- A. The Contractor will provide all materials, equipment and installation in compliance with the latest applicable standards from ANSI, FCC, ASTM, EIA/TIA, IEEE, NEC, NFPA, NEMA, REA, and UL including but not limited to:
 1. EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
 2. EIA/TIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications
 3. ANSI T1.404 (DS3) and CATV Applications
 4. National Electrical Code (NEC), latest revision and pertinent addendums
 5. National Fire Protection Association (NFPA) Publications, latest revisions and pertinent addendums
 6. Americans with Disabilities Act (ADA)
 7. In the event of any conflicts between documents referenced herein and the contents of this specification, the Contractor shall notify in writing to Engineer of any such occurrences before the purchase of any equipment, materials and/or installation by the Contractor. The Engineer will notify the Contractor of any actions required to resolve these conflicts. Such actions may include but are not limited to: design changes, equipment, materials and/or installation changes. In any event Contractor shall not supersede specifications and standards from the latest NFPA and NEC publications.
 8. All equipment, materials and articles incorporated in the work covered by this contract are to be new and unused.
 9. The Contractor shall provide at installation time the latest current standard model and/or version of all equipment (hardware and software).

1.11 MAINTENANCE SERVICE

- A. Furnish service and maintenance of surveillance system for one year from Date of Substantial Completion.

PART 2: PRODUCTS

2.1 COMPONENTS

- A. Models (Part Manufacturer/Product Lines Application/Model Choice):

1. IP SECURITY CAMERAS (Baldwin Wallace University to verify requirements)
 - a. Pelco
 - b. SureVision
 - c. Sarix IX Series
 - d. Sarix IM-E Series Environmental
 - e. Sarix IM-V Vandal Resistant
 - f. Sarix IM Mini Domes
2. INDOOR FIXED DOME
 - a. Sarix ID Indoor Domes
 - b. Sarix IM Vandal Resistant
 - c. Sarix IM Mini Domes
 - d. Camclosure IP Fixed IP Dome
3. OUTDOOR FIXED DOME
 - a. Sarix IE Environmental
 - b. Sarix IM Environmental Mini Dome
4. PTZ DOME
 - a. Spectra HD
 - b. Spectra IV H.264
 - c. Spectra IV IP
 - d. Spectra Mini IP
5. APPLICATIONS: Activity Detection; License Plate Reading; Recognition; Identification. Model appropriateness depends on the camera's ability to provide adequate pixels per foot (PPF).

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6. MODEL SELECTION: Specific models are based on business use requirements as determined by the business Owner, Baldwin Wallace University Department of Public Safety. The Baldwin Wallace University Information Technology Operations Group will select the appropriate model to meet these requirements.

a. The model selection process is based on the following criteria:

- 1) Pixels per foot (PPF)
- 2) Lighting conditions
- 3) Environmental Variables
- 4) Analytics requirements
- 5) Network Impact

b. MULTIPixel AVAILABLE CAMERA RATINGS:

- 1) 0.5 MP
- 2) 1.3 MP
- 3) 2.1 MP
- 4) 3.0 MP

***Consult with the Baldwin Wallace University Information Technology Network Operations Video Analyst and the Baldwin Wallace University DPS Manager of Public Safety Systems for final design approval.

c. PANORAMIC IP SCALLOP D7 180: Day time, color, best suited for indoor with consistent ambient lighting; suited for activity detection in wide open spaces. (Does not support motion recording.)***

d. M6-200: Day/night, black and white, with exceptional detail in low lighting conditions. Suited for activity detection in wide open spaces. (Does not support motion recording.) ***

e. SPECIALTY CAMERA (INFRARED IP CAMERA): Pelco, license plate readers, confined areas under very low light. ***

f. ANALOG CAMERA PELCO***

g. DVR PELCO***

h. NVR STRAND NVR P-6 NVR P-8

i. NVR E-24

j. NVR E-32

k. PELCO DIGITAL SENTRY NVR***

l. CABLE VIDEO COMMSCOPE: Category 6 Indoor Flooded, Category 6 Outdoor.

B. PoE SWITCHES: Owner furnished, Owner installed (OFOI)

C. NVR LICENSES: Required for proper surveillance camera operation.

2.2 GENERAL

- A. Manufacturer's name and product lines are given in the specifications for the purpose of establishing a standard of performance, quality, style and compatibility with the existing network and surveillance video infrastructure.
- B. These specifications list approved equipment types and items. In instances where quantities are not detailed, they shall be obtained from the drawings.
- C. Alternatives will only be considered if a unique business requirement cannot be met by the Baldwin Wallace University IT approved product line, and if specified features are fully supported by the existing infrastructure.

2.3 VIDEO SURVEILLANCE SYSTEM

- A. System Description: Provide and install an IP Video Surveillance system including IP cameras, data cabling per Division 27, mounts, domes, dedicated security patch panels and any required components/accessories.
- B. General:
 - 1. Cameras and support wiring to the common equipment location and video processing equipment in the MDF
 - 2. Common equipment location with mounting board, support equipment, wire management and power
- C. Video Cameras:
 - 1. Camera schedule location, camera view, lens and mounting method are for reference purposes. Contractor is responsible for coordinating these details with Owner and Security Consultant.
 - 2. Contractor is responsible for lens calculation prior to installation of cameras; specify fields of view and exact position of cameras.
 - 3. Prior to camera installation, Contractor will verify lens placement to optimize view. Refine for local focus and viewing during installation. Final camera position and lens schedule shall be submitted for Security Consultant's approval.
- D. Camera Signal Transient/Surge Protection:
 - 1. Provide camera transient/surge protection as specified in the drawings and specifications.
 - 2. Protector to guard sensitive electronics against lightning induced surges, electrostatic discharge and ground loop energies.
 - 3. Install at video head end and at all exterior cameras.
 - 4. Connect to nearest communication ground bus or proper building ground.
- E. Video Camera Power Supply(s):
 - 1. Cameras will be PoE. PoE switches will be Owner furnished, Owner installed.

2.4 STATIC CAMERA SYSTEM

- A. Camera resolutions will be determined by the desired Pixels per Foot to achieve the required level of detail at a specified distance from the area of interest in order to meet a specific application. Applications include: Activity Detection; License Plate Reading; Facial Recognition; and Facial Identification
- B. Inherent camera characteristics such as lux ratings, dynamic range; anti-bloom capabilities; and auto black and white mode are solely dependent on the location and environmental conditions of a given deployment.
- C. Provide ground isolation transformers as required to eliminate hum bars and ground loops.
 - 1. Pelco IDE20DN-PMO
 - 2. Baldwin Wallace University Information Technology approved equal.
- D. For outdoor installations, provide adequate surge protection measures to include the following:
 - 1. Float cameras in their housings by using nylon washers.
 - 2. Ground camera casings utilizing building ground.
 - 3. Provide adequate network equipment protection by installing PoE circuit protection such as DTKMRJPOE or approved equal.
- E. NVR-DVR recording resolutions must meet pixel per foot camera requirements.
- F. NVRs must have a Gigabit uplink on the building's network distribution switch.
- G. PoE switch port utilization must not exceed a maximum of twenty-two (22) cameras per switch and less if other devices are drawing power from this switch. 15.4 watts per port is the minimum requirement. Consult with the Baldwin Wallace University Information Technology Network Operations group for PoE switch requirements.

2.5 CAMERA VIDEO AND POWER TRANSIENT/SURGE PROTECTION DEVICE

- A. Provide inline camera video signal and power protection at all outdoor camera locations with grounds connected to closest electrical ground as specified in the drawings and specifications

2.6 CAMERA POWER SUPPLY

- A. Camera power to be provided by Power over Ethernet (PoE)

2.7 WIRE AND CABLE

- A. Shall be Category 6 per Division 27 specifications.

2.8 ACCESSORIES

- A. Rack: Provide free-standing equipment Rack.
 - 1. Size: 7 feet by 19 inches with minimum 6 inches vertical cable managers on each side.

PART 3: EXECUTION

3.1 INSTALLATION

- A. This section covers the general requirements for the installation of the security system by the Contractor.
- B. Install in accordance with manufacturer's instructions.
- C. The Contractor shall be responsible for providing all wire and cable as required for complete and operational system.
- D. All cables must be continuous runs from device location to the final point of termination. No mid run cable splices will be allowed.
- E. The cable installation techniques shall be such that the mechanical and communications characteristics of the cables are not degraded at the time of installation. Any special environmental requirements for equipment shall be specified.
- F. Distribution of the cabling will be accomplished through cable trays, cable runways, conduit raceways, ducts, core holes, extended columns, false half columns and plenums. Horizontal cable segments will be placed in cable trays and when they leave cable trays will be supported by distribution rings or J-hooks. Where cables converge at equipment room locations, they will be supported by cable runways and distribution rings. All cable placements shall be based on the enclosed drawings.
- G. The Contractor shall not place security wiring in the same conduit or raceway with wire for electrical power distribution.
- H. Connectors to all devices in system shall be protected against moisture. Approval of the method shall not relieve the Contractor of full responsibility for proper application and workmanship of the materials in the manner specifically approved. All connector threads shall be treated with an approved silicone lubricant.
- I. The Contractor shall be responsible for providing an approved ground and ground bus bars at all newly installed systems insuring proper bonding to telecommunications facilities. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework. All grounds shall consist of a minimum 6 AWG copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.
- J. Contractor must notify the Owner prior to making any changes in submitted system design and/or installation.
- K. All exposed J-boxes or enclosures shall have tamper resistant features and hardware. Tamper resistant fasteners to be Tamper-Proof pin-in-hex or pin-in-torx button head screws.
 - 1. Use of common wires for input or output circuits is not allowed.
 - 2. Configure all zones to be normally closed loop with an end of line resistor (EOL) at the most distant point of the zone.
 - 3. The Contractor shall obtain Owner's permission before proceeding with any work necessitating cutting into or through any part of building structures such as girders, beams, concrete or tile floors and partition ceilings.

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4. The Contractor shall exercise reasonable care to avoid any damage to Owner's property. Contractor shall be responsible for and repair all damage due to carelessness of workers. Contractor will report to Owner any damage to the building, which may exist or may occur during the occupancy of the quarters.
5. The Contractor shall be responsible for proper electrical grounds.
6. The Contractor shall take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.
7. The Contractor shall install the materials in accordance with the manufacturers' specifications.
8. The Contractor shall promptly correct all defects for which the Contractor is responsible.
9. The Contractor shall insure that all records and reports, City relations, engineering, metering, inspections, testing, quality or service standards and safety measures comply with standards applicable for the State of Ohio.
10. The Contractor shall coordinate all work with Owner's designated representative.
11. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap wire, etc., and dispose of such items on a daily basis.
12. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
13. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
14. The installation crew should include at least one installation supervisor, or lead technician, for onsite management of the project at all times.
15. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
16. The Contractor shall maintain conductor polarity in accordance with industry practices.
17. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the distribution system.
18. The Contractor shall be responsible for labeling all cable, distribution devices, enclosures and outlet locations, according to industry standards. Numbering scheme shall be coordinated with Owner's representative before installation.
19. It shall be the responsibility of the Installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
20. The Contractor shall not roll or store cable reels without an appropriate underlay.

21. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
22. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.
23. The Contractor shall be responsible for testing all cable prior to the installation of the devices. If the Installation Contractor fails to perform this testing operation, the Installation Contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
24. The Contractor shall plug conduits where cabling has been installed by the Installation Contractor in all equipment rooms and other cable entrance locations with re-enterable duct seal of flame retardant putty.
25. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
26. Wiring, materials, and equipment will be delivered and stored in a clean dry space. They will be properly packaged in factory fabricated type containers and protected from damaging fumes, construction debris and traffic until job completion.
27. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
28. All wiring, materials, and equipment must be listed and labeled by a nationally recognized testing laboratory.
29. All installation techniques and fixtures shall result in ease of maintenance and ready access to all components for testing measurements. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used unless specifically approved by Owner. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass. All materials used in installation shall be resistant to fungus growth and moisture deterioration.
30. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.
31. The cable pulling operation shall be performed such that a minimum bending of the cable shall occur in the unreeling and pulling operations. The pulling tension shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable.
32. Jacketing and insulation shall satisfy the Underwriters Laboratories (UL) listed fire rated cable insulation requirements in plenum areas.
33. Any pulling compound or lubricant used in cable installation shall not deteriorate the conductor or the insulation.
34. Parts and components not specifically mentioned in these specifications, which are required to provide a complete unit, shall be included as a part of the equipment to be furnished.

- 35. Nothing in the specification shall relieve respondents of system package design responsibility, including, but not limited to, all equipment furnished under this contract. The successful respondent is, in all cases, solely responsible for the performance of the delivered system, and for furnishing complete system documentation for each and every part of the system.

3.2 INTERFACES WITH OTHER PRODUCTS

- A. Provide interface installation of video surveillance with security access and intrusion detection systems.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of manufacturer's technical representative to prepare and start systems and supervise final wiring connections and system adjustments.

3.4 ADJUSTING

- A. Adjust manual lens irises to meet lighting conditions.

3.5 DEMONSTRATION

- A. Demonstrate system operation and provide two hours of instruction with manufacturer's training personnel.
- B. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

3.6 WEEKLY CONSTRUCTION MEETING

- A. The Security Consultant and/or Owner will hold weekly construction meetings to review the installation schedule. It is mandatory that the Contractor's Project Manager attend each meeting.

3.7 SITE INSPECTION

- A. Continuously verify that the site conditions are in agreement with the Contract Documents and the security system design. Notify Owner's representative immediately of conditions that affect the performance of the installed system.
- B. Coordinate any required work that is not specified in the Contract Documents.

3.8 COORDINATION

- A. Adequate conduit and back boxes are provided for the specified system installation.
- B. Verify value of end of line supervision module with Owner.
- C. Adequate power has been provided for the specified system installation.
 - 1. Verify mounting location of all devices with Owner prior to installation.

3.9 IDENTIFICATION, LABELING, AND DOCUMENTATION

- A. The Contractor shall label all termination devices, panels, enclosures and equipment rooms. The Contractor will mark each unit with permanently attached markings that will not impair the equipment or present a hazard to maintenance personnel.

- B. Place wire identification numbers on each end of all conductors by using sleeve type heat shrinkable markers. Install markers to be readable from left to right or top to bottom. Wire numbers shall be computer printed (Brady TLS2200 with Permasleeve cable marking labels or equivalent). Hand written labels are not acceptable.
- C. Mark all spare conductors.
- D. If changes occur prior to acceptance testing altering the documentation previously furnished, the Contractor shall formally update and reissue the relevant documentation to the Security Consultant and Owner.
- E. Security Consultant and Owner will review all documentation for accuracy and completeness and may reject substandard submittals.
- F. The Contractor shall establish and maintain complete system documentation, including documentation procedures, operational information, configuration information, historical records, and drawings. Documentation shall include the following:
 - 1. Floor plan drawings indicating device locations, unique system point numbers with device legends indicating manufacturers and model numbers for each device.
 - 2. The unique system point number of a device shall identify either through the software or hardware connection, the specific device or group of devices associated with the unique point number in the system.
 - 3. Floor plan drawings indicating conduit and wire routing and junction box locations.
 - 4. Wire routing shall include cable identification and terminal strip numbers.
 - 5. Mounting details for all equipment and hardware.
 - 6. Functional block diagrams for each system.
 - 7. Wiring details showing rack elevations, equipment wiring and terminations and inter-rack wiring.

3.10 SECURITY SYSTEM PROGRAMMING

- A. Security System Programming to include commissioning of all controllers, points and related devices.
- B. All system programming shall take place in the field to verify Owner-designated zones for all devices. Programming shall be developed with Owner's input and shall not be accepted without Owner's approval.

3.11 WARRANTY

- A. The Contractor shall warrant the system for parts and labor for one (1) year. Warranty commences at the time of substantial project completion and acceptance by Owner. Nothing shall be construed to limit this obligation to a shorter period.
- B. Warranty service shall be rendered on-site by request of Owner to repair or replace any defective materials, equipment and workmanship without cost to the Owner, unless the Owner has previously given the Contractor a written acceptance of such condition.
- C. The Owner shall give prompt notice of the defect(s) either verbally or in writing to Contractor.

- D. Contractor shall purchase and provide to Owner one spare camera per type purchased. Spare cameras will be held by Owner for use by Contractor during warranty period. Contractor to replace spare parts used with new. Spare parts are property of Owner.
- E. Perform preventative maintenance during the warranty period, which includes:
 - 1. Quarterly cleaning and inspection of all devices.
 - 2. Quarterly inspection, cleaning and testing of all power supplies/UPS.
 - 3. Quarterly test and replace of batteries as necessary.
 - 4. Clean and vacuum MDF console and rack equipment
 - 5. Service technician performing service/warranty work shall check-in and out for each visit.
 - 6. Provide a written report to Owner documenting any work performed during the warranty period within twenty-four (24) hours of such event. Report shall detail work performed, equipment repaired or replaced, etc.
 - 7. Provide loaner equipment which is equivalent to the malfunction equipment for any equipment not field repairable.
 - 8. Repair or Replacement Service
 - a. Repair or replacement service during the warranty period shall be performed 7 days a week, twenty-four (24) hours a day and with a 4 hour response time.
 - b. Emergency repair or replacement service during the warranty period shall be performed 7 days a week, twenty-four (24) hours a day and with a 2 hour response time.
 - c. If the Contractor cannot restore system operation during the warranty period within 2 business days of the system failure, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.
 - d. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's responsibilities, provided the expansion is performed by an authorized dealer for the affected equipment.
 - e. On-line software and hardware service shall be provided and shall be password protected and controlled by the Owner.

3.12 TECHNICAL VERIFICATION SESSION

- A. Security system walk through and verification shall be provided for the technical staff and shall minimally consist of four (4) each one-hour session.
- B. A complete product manuals and preliminary as-built drawings shall be delivered to the Owner one week prior to the training sessions.
- C. Technical verification and walk through shall consist of:
 - 1. Technical explanation sufficiently thorough that: staff personnel shall be able to identify and trace circuits, analyze malfunctions and make changes as necessary to maintain system operation.

2. Provide printed reference material for each trainee that documents and explains in technical terms:
 - a. System block diagram with technical features
 - b. Method and record of end-to-end testing
 - c. Review of as-built drawings
 - d. Q & A session

3.13 SUBSTANTIAL COMPLETION

- A. Work must meet the following requirements to qualify for the Owner's consideration of Substantial Completion:
 1. All cameras and monitoring devices shall be fully installed, tested and fully operational
 2. Video cameras shall be powered and focused.
 3. End to end testing reports shall be produced.
 4. Technical verification process shall be complete.
 5. Owner may utilize the system for its designed intent.
 6. Contractor will provide a list of remaining work items and approximate completion date.
 7. Contractor will certify in writing that all remaining work is minor in nature and will be completed in less than thirty (30) days.

3.14 TESTING REQUIREMENTS

- A. The Contractor shall perform sample tests in the presence of the Security Consultant and Owner. Performing the testing procedures specified herein assures that the communication cabling and system electronics meets the performance characteristics specified. All testing shall comply with EIA/TIA Standards and that of the equipment manufacturers. If testing indicates that the performance characteristics are not met, the test shall be failed test and any other test that may be affected by the modification and/or repair shall be rerun and verified.
- B. Test equipment will be provided by the Contractor to test and to certify the 100 percent operational condition of all materials and equipment.
- C. The Vendor shall prepare and submit all test procedures and data forms for the pre-installation, post installation and subsystem test to Owner. The test procedures shall have Owner approval before the tests.

3.15 SYSTEM CHECK OUT AND VERIFICATION

- A. Commission all security devices from field up to and including the head-end.
- B. Contractor supplied As Built Drawings shall show security conduit routing and cable labeling.
- C. Review all as-built and testing documentation with Owner. Revise and reissue as required.
- D. Video camera image as received at the head-end is noise free, focused and field of view of view is optimized for intended content.

3.16 ACCEPTANCE OF SYSTEMS

- A. Each area of construction completed and submitted as complete shall meet the following criteria under testing:
1. System must meet all specifications as described in these instructions.
 2. Operational prints, manuals, signal logs, and as built prints must be furnished.
 3. Visual testing and signal verification will be conducted at random locations to determine that equipment performs satisfactorily.
 4. Specifications set forth for construction of the system have been devised in order to insure system compatibility and performance. Compliance to these specifications will be determined during periodic observances of construction. Repeated failure to comply with the specification will be considered before the initial acceptance phase of the plant commences.
 5. Within ten days receipt of the final acceptance notice, the Owner's representatives shall schedule and perform the final inspection. When the work is found acceptable under the contract documents and the contract is fully performed, the project will be declared complete.

END OF SECTION 282300

SECTION 283111 – DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Related documents shall include drawings and general provisions of the Contract, including general and supplementary conditions and applicable sections of Division 1, Division 26, and Division 25 specifications.

1.2 SCOPE

- A. This section shall include guidelines for the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the Fire Alarm and Smoke Detection System as drawn and specified herein.
- B. The intent of drawings and specifications is to result in a complete functional fire alarm and smoke detection system as described herein.
- C. The Contractor shall provide all devices and components required to accomplish this intent whether or not specifically shown or specified.
- D. The complete installation shall conform to the applicable sections of NFPA-72, NFPA-71, Berea, Ohio local code requirements, and the National Electrical Code with particular attention to Article 760.
- E. The work covered by this section of the Specifications shall be coordinated with the related work as specified elsewhere under project specifications.

1.3 QUALITY ASSURANCE

- A. Each and all components of the Fire Alarm System shall be listed as a product of a single Fire Alarm System Manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "UL" Label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall not be acceptable.
- B. All control equipment shall have transient protection to comply with UL 864.
- C. Where fire alarm circuits leave the building, additional transient protection shall be provided for each circuit.
- D. Devices shall be UL listed under Standard #497B.
- E. System control shall be UL listed for Power Limited Applications and all circuits shall be marked in accordance with NEC Article 760-23.

1.4 GENERAL SYSTEM REQUIREMENTS

- A. System Requirements
 - 1. The FAS Contractor shall furnish and install a complete Fire Alarm and Smoke Detection System as described herein and drawn. The FAS Contractor shall wire, connect and make operational each and all components of the system. The system shall include:

- a. Sufficient Fire Alarm Control Panels (FACPs)
 - b. Annunciators
 - c. Manual Stations
 - d. Automatic Fire Detectors
 - e. Smoke Detectors
 - f. Alarm Indicating Appliances
 - g. Miscellaneous Components
 - h. Wiring
 - i. Terminations
 - j. Raceway System
 - k. All other necessary material for a complete operating system including integration into the existing campus Honeywell, FCIFAS system. (Verify Current System Requirements.)
2. The system shall meet all national and local codes.
- B. Fire Alarm System Supplier**
1. The fire alarm shall be supplied by a Distributor authorized by the Fire Alarm System Manufacturer. The supplier's personnel shall be factory trained.
 2. The fire alarm system supplier shall provide point to point wiring diagrams and equipment data sheets for submittal to the local authority. Where required, the fire alarm system supplier shall obtain all permits required for the installation of the system from the local authority.
- C. System Manufacturer**
1. The system and components shall be supplied by one manufacturer who shall have produced similar system for a period of at least three (3) years.
 2. The manufacturer shall be able to refer to similar installations rendering satisfactory service.
- D. System Software**
1. The system shall be capable of self-programming upon initialization.
 2. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.
 3. All software operations shall be stored in a nonvolatile programmable memory within the FACP.
 4. Loss of primary and secondary power shall not erase the instructions stored in memory.
 5. System programming shall be password protected and shall include full upload and download capability.

6. The system shall feature full flexibility for selective I/O control functions based on ANDing, ORing; and NOTing. Timing and special coded operations shall also be incorporated in the resident software programming of the system.
7. Resident software shall allow for full configuration of initiating circuits. The system shall require no additional hardware to change from sensing normally open contact devices to sensing normally closed contacted devices or vice versa. Nor shall the system require additional hardware to change from sensing normally open contact devices to sensing—and distinguishing between—a combination of current limited and non-current limited devices on the same circuit. Nor shall the system require additional hardware for changing from a non-verification circuit to a verification circuit or vice-versa.
8. There shall be no limit, other than maximum system capacity, to the number of intelligent/analog devices which may be in alarm simultaneously.
9. The system shall have the capability of recalling alarm and trouble conditions in chronological order for the purpose of recreating an event history.

1.5 ALARM OPERATION

- A. The actuation of any approved alarm initiating device shall automatically initiate the following operations where furnished as part of the system.
 1. All audible alarm indicating appliances within corresponding building shall sound a fire alarm signal until the System Acknowledge key or the Signal Silence key is depressed.
 2. All visible alarm indicating appliances shall flash continuously until the System Acknowledge key or the Signal Silence key is depressed.
 3. The off-site central monitoring station shall be notified automatically until the System Acknowledge key or the Signal Silence key is depressed.
 4. The alarm shall annunciate on the FAS System.
 5. Shutdown of the corresponding HVAC system equipment shall occur until the System Acknowledge key or the Signal Silence key is depressed.
 6. Activation of all programmed outputs assigned to the initiating device shall occur until the System Acknowledge key or the Signal Silence key is depressed.
 7. Any subsequent zone alarm shall reactivate the alarm indicating appliances.

1.6 ALARM VERIFICATION

- A. The activation of any system smoke detector or sensor shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation.
- B. If, within one (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within one minute the system shall resume normal operation.
- C. The alarm verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately.
- D. The alarm verification operation shall be selectable by zone.

1.7 ALARM INDICATION

- A. The alarm shall be displayed on the FAS workstation as well as on a 80-characters (2x40) LCD display on the local Fire Alarm Control Panel, and, where applicable, the remote annunciator. The top line of 40 characters shall be the point label and the second line shall be the device type identifier.
- B. The system alarm LED shall flash on the control panel and the remote annunciator until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on.
- C. A subsequent alarm received from another zone shall flash the system alarm LED on the control panel and remote annunciator. The LCD display shall indicate the new alarm information. New alarm(s) shall also annunciate on the FAS workstation.
- D. A pulsing alarm tone shall occur within the local building control panel, and where applicable, the remote annunciator until the event has been acknowledged.
- E. A manual evacuation (drill) switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions would occur as described previously.
- F. The system shall have a single key that will allow the operator to display all alarms, troubles, and supervisory service conditions including the time of each occurrence.
- G. Any momentary opening of an initiating or indicating appliance circuit wiring shall cause an audible signal to sound at the Building Fire Alarm Panel, at the FAS workstation and where applicable, the remote annunciator for four seconds indicating a trouble condition.

1.8 ALARM WALK TEST

- A. The actuation of the “enable walk test” program at the control panel shall activate the “Walk Test” mode of the system, which shall initiate the following events:
 - 1. The off-site central monitoring station connection shall be bypassed.
 - 2. Control relay functions shall be bypassed.
 - 3. Walk test shall be selectable by circuit.
 - 4. Alarms received on normal circuits shall cause the control panel to go into alarm and override the walk test mode.
 - 5. The control panel shall show a trouble condition.
 - 6. The alarm activation of any initiation device shall cause the audible signals to activate for two seconds.
 - 7. The panel shall automatically reset itself after signaling is complete.
 - 8. The control panel shall automatically return to normal condition if there is no activity on a walk test circuit for a period of thirty (30) minutes.

1.9 SUPERVISION

- A. The system shall contain Class “A” or “B” (Style “B, C, D, or E”) independently supervised initiating device circuits. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.
- B. Each independently supervised circuit shall include a discrete LED readout to indicate disarrangement conditions per circuit.
- C. The incoming power to the system shall be supervised so that any power failure must be audible and visually indicated at the control panel and the remote annunciator. A green “power on” LED shall be displayed continuously while incoming power is present.
- D. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and the remote annunciator.
- E. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

1.10 POWER REQUIREMENTS

- A. Each control panel or console shall receive 120 volts AC power (as noted on the plans) via a dedicated circuit. Power feed to panel shall fully comply with City of Berea or Cleveland code requirements.

1.11 SHOP DRAWING AND PRODUCT DATA

- A. The system shop drawings shall include complete wiring diagrams for all components of the project. Generic wiring diagrams, which do not apply specifically to the project, are not acceptable. Product data sheets covering all system devices shall be furnished with shop drawings.

PART 2: PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

- A. Panel Function: The Fire Alarm Control Panel shall provide power, annunciation, supervision and control for the detection and alarm system, as well as alarm signaling to alert occupants of a fire or other emergency situations.

Control panel construction shall be modular with solid state microprocessor based electronics. Operation shall be guided via LEDs to simplify operation under any condition.

- B. Local Audible Device: A local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device also shall sound during each “key-press” to provide an audible feedback to ensure that the key has been pressed properly.
- C. Primary Controls: The following primary controls shall be visible through a front access panel:
 - 1. 80 characters liquid crystal display
 - 2. Individual red system alarm LED
 - 3. Individual red pre-alarm LED

4. Individual yellow supervisory service LED
 5. Individual yellow trouble LED
 6. Individual yellow security LED
 7. Green “power on” LED
 8. Alarm Acknowledge touch switch
 9. Supervisory Acknowledge touch switch
 10. Trouble Acknowledge touch switch
 11. Alarm Silence touch switch
 12. Reset touch switch
 13. Manual evacuation (drill)
- D. The control panel interface shall provide the following:
1. Setting of time and date
 2. LED testing
 3. Alarm, trouble and abnormal condition listing
 4. Enabling and disabling of each monitor point separately
 5. Activation and deactivation of each control point separately
 6. Changing operator access levels
 7. Walk Test enable
 8. Running diagnostic functions
 9. Displaying software revision level
 10. Displaying historical logs
 11. Displaying card status
 12. Point listing
- E. Point Lists Menu: For maintenance purposes the following lists shall be available from the point lists menu:
1. All points list by address
 2. Monitor point list
 3. Signal/speaker list

4. Auxiliary control list
 5. Feedback point list
 6. Utility point list
 7. LED/switch status list
- F. Menu Lists: Scrolling through the menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. Menu lists shall be password protected. Acknowledgment for each abnormal condition shall be provided in accordance with NFPA 72 requirements. The System shall display the first unacknowledged condition.
- G. Acknowledge Password Protection: Acknowledge functions shall feature password protection if the user has insufficient privilege to acknowledge such conditions. A message shall indicate insufficient privilege but shall allow the user to view the points without acknowledging them. Should the user have sufficient privilege to acknowledge, a message will be displayed informing the user that the condition has been acknowledged.
- H. Acknowledgement: After all points have been acknowledged, the LEDs shall glow without blinking and the audible signal shall be silenced. The total number of alarms supervisory and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be clearly defined.
- I. Alarm Silencing: When the Alarm Silence button is pressed all alarm signals shall cease operation, except during alarm silence inhibit mode. It shall be possible to selectively program signal circuits as non-silenceable.
- J. System Reset: The system reset button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user through the reset process with simple English language messages including a final message indicating the system has been returned to the normal condition.
- K. Function Keys: Additional function touch switches shall be provided to access status data for the following points.
1. Initiating device circuits
 2. Indicating appliance circuits
 3. Auxiliary relays
 4. Feedback points
 5. All other I/O points
- L. The following status data shall be available.
1. Primary State of point
 2. Zone, Point Address and Card type information
 3. Circuit Status
 4. Current priority of outputs

5. Disable/Enable Status
 6. Automatic/Manual Control Status of output points (Hand-Off/Auto Switches)
 7. Relay Status
 - a. Utility Points: Each control panel shall have dedicated utility point supervisory and acknowledge buttons. Activation of a utility point shall activate the system supervisory service audible signal and illuminate the appropriate utility point LED on the control panel, at the Master Control Console and at the guard shack network control panel. Pressing the appropriate acknowledge button shall silence the audible alarm, while maintaining the LED 'on' indicating the 'off' normal condition. Restoring the condition to its normal position, or locally resetting the acknowledge switch shall extinguish the LED, indicating normal conditions.
- M. Alarm History Log:** The system shall be capable of logging and storing up to 4100 events in the History Log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event's occurrence. The following Alarm History events shall be stored:
1. Alarms
 2. Alarm Acknowledgment
 3. Alarm Silence
 4. System Reset
 5. Alarm Historical log cleared
- N. The following Trouble History events shall be stored:**
1. Trouble conditions
 2. Supervisory alarms
 3. Trouble acknowledgment
 4. Supervisory acknowledgment
 5. Walk Test results
 6. Trouble Historical log cleared
- O. Access Levels:** There shall be four (4) access levels with level 4 being the most secure level. Level 1 actions shall not require a passcode. Passcodes shall be numerical and shall consist of up to six (6) digits. Changes to passcodes shall be made only by authorized personnel.
- P. Printer/CRT Interface Card:** The control panel shall include an output port (RS-232) capable of operating remote CRT's and/or printers from a Central Processing Unit.
- Q. Remote Station Interface:** A digital alarm communicator transmitter, remote station transmitter, or municipal tie shall provide interface with a remote control station for monitoring alarm and trouble conditions. Communication to central station shall be by way of two supervised (Fiber Optic) telephone lines.

- R. FAS Integration: The Fire Alarm System must provide direct communication to the FAS Cyber Stations so that all alarms will annunciate at any workstation where fire alarm monitoring will be needed. To ensure full compatibility all Fire Alarm components will be provided by the FAS Contractor.
- S. Addressable Interface Module: The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point: alarm, trouble, open, short, and device missing/failed.
- T. All addressable devices shall have the capability of being disabled or enabled individually. Up to 126 addressable devices may be multi-dropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.
- U. Alarm Signaling: The Fire Alarm Control Panel shall provide sufficient power and signal circuit capability to meet the requirements of the plans and specifications and to comply with ADA (Americans with Disabilities Act) requirements. The Fire Alarm Control Panel and Power Supplies shall be designed to accommodate all signaling circuits and 20 percent spare capacity. The Fire Alarm Control Panel shall allow for field programming operation of the signal circuits (i.e. March time, zone coded, zone-signal linking, etc.) This capability shall be included in the system firmware with no additional cost to the Owner.
- V. Annunciator Panel: The Fire Alarm Control Panel shall provide an LCD annunciator where drawings indicate remote area annunciation of the corresponding fire alarm signals. The annunciator shall indicate Alarm, Supervisory and Trouble conditions by dedicated LED's and an audible signal. The annunciator shall feature an acknowledge-button which, when depressed, shall silence the audible signal. An 80-character LCD display shall provide the same message as displayed on the corresponding Fire Alarm Control Panel. The annunciator panel shall be capable of alarm silence and system reset functions. The annunciator shall be panel mounted with controls visible through a front access panel and operable only by activating an enable key switch. The annunciator panel shall be Gamewell-FCI Model # LCD-E3.
- W. Cabinets and Consoles: The Fire Alarm Control Panel and annunciator cabinets shall be sized to accommodate all components and modules specified and required for a complete system. Additional space for future expansion shall be provided in the cabinet including, as a minimum, space for:
 - 1. Two addressable interface modules
 - 2. Conventional Interface Modules
 - 3. Building Control Modules
 - 4. Relay Modules
 - 5. Universal Signaling Modules
 - 6. Cabinets shall be capable of surface or flush mounting as indicated.
 - 7. Sheet steel cabinets shall be completely primed and finish painted.
 - 8. The Control Consoles shall accommodate, in one section, power supply, modules and components required for fire alarm control, and system network control and annunciator.
 - 9. All Fire Alarm Control Panels shall be Gamewell-FCI Model # E-3.

2.2 ALARM INITIATING DEVICES

- A. Addressable/Analog Detectors: All addressable/analog smoke and heat detectors as specified below shall be pluggable into their bases. The detector unit shall contain electronics that communicate the detector chamber analog value to determine (normal, alarm, trouble) to the control panel over two wires. The same two wires shall also provide power. Upon removal of the head, the base shall transmit a trouble signal to the control panel. It shall be possible to change out detector heads without having to reprogram or address the unit. The detector's address shall be stored in the base. Detectors that store address information in the head shall not be allowed. Addressable/analog detectors shall be UL listed.
- B. Ionization Type Detectors: Addressable/analog ionization type smoke detectors shall be a two chamber type and shall operate on ionization principal activated by presence of combustion gases. Units shall be restorable with individual indicating lamp. Sensitivity of detectors shall be individually adjustable at the control panel. Stable operation under varying conditions such as vibration, mechanical shock and changes in supply voltage, ambient temperature and barometric pressure. A combustion gas signal verification circuit shall check to avoid false alarm. A visual indication of alarm shall be provided by a LED on the detector.
- C. Photoelectric Type Detectors: Addressable/analog photoelectric smoke detectors shall sense the presence of smoke particles between a light source and a receiver within the detector. Sensitivity shall be set by the manufacturer and provisions shall be included to check the sensitivity at the control panel without generating smoke. The unit shall be equipped with a visible LED for alarm indication. The detector screen and cover shall be easily removable for field cleaning.
- D. Duct Type Detectors: Addressable/analog duct type smoke detectors shall operate on ionization or photoelectric principal, as indicated and previously specified. For mounting on ductwork the detector shall include a sampling tube which shall be field cut to size to cover complete duct width. The unit shall be restorable. The detector shall be cable of stable operation under varying conditions, including vibration, mechanical shock and changes in supply voltage, ambient temperature and barometric pressure. Unit shall be complete with relay as required for fan shutdown, and auxiliary contacts for FAS interface. The unit shall be equipped with a visible LED for alarm indication. The detector screen and cover shall be easily removable for field cleaning.
- E. Addressable Manual Stations: The addressable manual station shall be capable of field programming of its “address” location on an addressable initiating circuit. The manual station shall be fitted with screw terminals for field wire attachment. The manual station shall be non-coded, semi-recessed, and restorable.
- F. Fire System Components Provided by Others: Supervised fire suppression system flow switches, pressure switches and other components provided by others shall be wired to meet the requirements of Division 25. Conduit and wire shall comply with the requirements in other Division 25 sections.
- G. Addressable Monitor Modules: Suitable for monitoring a single conventional initiating device type such as water flow, manual station or non-addressable detectors. Modules shall include cover for surface mounting. The Monitor shall provide for feedback to the FACP for positive confirmation of the controlled devices activity. A Monitor Module shall be provided for interfacing normally open direct contact devices to any of the addressable initiating circuits.
- H. Addressable Output Module: Shall be provided for any devices that require control, activation or feedback during Fire Alarm condition such as stairwell pressurization fans, smoke exhaust, and damper control.

2.3 ALARM INDICATING DEVICES

- A. Visual Alarm Signals: Visual units with flush trims and back boxes shall be provided for all locations as shown on the plans (office areas, etc.). Visual units shall provide 110 candela/second Xenon flash visible at all angles, and shall meet the requirements of the Americans with Disabilities Act (ADA).
 - 1. Visual alarm signals shall be UL listed for fire protection service and shall produce a minimum intensity of 110 candela at all angles with a flash rate of 1 hertz minimum to 3 hertz maximum with continuously applied voltage. The xenon flash tube shall be enclosed in clear or nominal white (i.e., unfiltered or clear filtered white light) lens. The maximum pulse duration shall be two-tenths of one second (0.2 seconds) with a maximum duty cycle of 40 percent. The pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.
- B. Audible/Visual Alarm Signals: Alarm horns shall be electronic type and shall incorporate 110 candela/second Xenon flash units.
 - 1. Audible alarms shall not exceed sound levels of 120 decibels A.
 - 2. The visual alarm shall be mounted with the alarm horn where shown.

2.4 PRINTERS

- A. Printers shall be provided and installed as shown. All printed information shall include time and date. Desktop 80 column printer shall provide a hard copy record of system events.

2.5 GRAPHICS

- A. CAD generated graphics shall be installed on the FAS/SMS system to indicate/display building floor plan(s) and all fire alarm initiating devices.
- B. Additionally CAD generated graphics charts shall be installed at the Fire Alarm Control Panel and Remote Annunciator Panel locations indicating building floor plan(s) and initiating devices with Point ID number. Charts shall be 11 inches by 17 inches (11x17) floor plans reduced from manufacturer's approved floor plan shop drawings, framed beneath non-glare glass for wall hanging.

PART 3: EXECUTION

3.1 INSTALLATION

- A. The FAS Contractor shall provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations.
- B. Detector Installation
 - 1. Detector locations shall be no closer than 4 feet from air supply outlets, nor in beam pockets deeper than 12 inches. No detector shall be purposely recessed in a ceiling.
 - 2. Duct type smoke detectors shall be provided under this section of the specification for mounting by the mechanical Contractor. All conduit, wire and final connections shall be performed by the FAS Contractor.

C. Programming

1. FAS Contractor shall perform all programming of system including local panel programming and network programming.
2. FAS Contractor shall perform the necessary assigning of system points.

D. Wiring

1. The FAS Contractor shall furnish and install in accordance with manufacturer's instruction all wiring, conduit, and outlet boxes for installation of a complete system as described herein and drawn.
2. All wiring shall meet NEC 760 for fire alarm system wiring. All wiring shall be tagged at junction points and shall test free of grounds and shorted between conductors. All additional labor costs incurred by the FAS Contractor's Fire Alarm System Technician to clear wiring faults shall be charged to the installing subcontractor.
3. All final terminations of the field wiring shall be made by or under the direct supervision of the Fire Alarm System Manufacturer's representative. Any damage to the panel as a result of the Contractor terminating wires or powering up the panel without the supervision of an authorized representative of the Fire Alarm Panel Manufacturer shall be charged to the installing subcontractor.

E. Miscellaneous

1. All junction boxes shall be painted red and labeled "Fire Alarm". Color coded wiring shall be maintained throughout the installation.
2. Installation of equipment and devices relevant to other work in the contract shall be closely coordinated with the appropriate subcontractors.
3. The Contractor shall clean all dirt and debris from the interior and exterior of the fire alarm equipment after completion of the installation.
4. The Manufacturer's Authorized Representative shall provide on-site supervision of installation.

3.2 TESTING

- A. The Contractor shall test fully the completed fire alarm system in accordance with NFPA-72 in the presence of the Owner's Representative and under the direction of the factory authorized representative.
- B. Testing shall be provided as required by the local Fire Marshal.
- C. Upon successful completion of tests, the Contractor shall so certify in writing to the Owner's Representative.
- D. Alarm horn sound levels shall be tested during Owner's normal operating conditions to ensure emergency signaling is of an approved sound level over normal ambient noise. The test shall be performed during a 90-day period following the above "Fire Marshal" test on a date to be selected by the Owner.
- E. Technical support and service by factory trained personnel shall be available from the manufacturer's representative.

END OF SECTION 283111

SECTION 283111-1 – FIRE ALARM INTEGRATION

PART 1: GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General Requirements and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Requirements of the following Division 23 and Division 26 sections apply to this section:
 - 1. Basic Mechanical Requirements
 - 2. Basic Mechanical Materials and Methods

1.2 SUMMARY

- A. The intent of this specification is to provide an overall framework to specify an extension of the new and existing integrated automation control system (IACS) which is a fully integrated facility automation system. Operation of the system shall be through a browser-based interface, enabling operators to view graphical site information, change set points, view and acknowledge alarms, and view reports from anywhere on the network.
- B. The integrated automation control system (IACS) shall be capable of combining all specified building subsystems into one overall system, providing a complete, single-seat interface to system operators. Through a graphical, map-driven interface, operators may have complete control of all building subsystems. Further detail will be available on any subsystem by clicking through to a more focused graphic display for a particular subsystem. Building subsystems that are part of this design goal shall include:
 - 1. HVAC Control
 - 2. Lighting Control
 - 3. Integrated Fire Alarm System
- C. The system shall be capable of the following.
 - 1. Access Control
 - 2. Digital Video
 - 3. Power Monitoring
 - 4. Battery Monitoring
 - 5. Network Alarm Monitoring
 - 6. Alarm Monitoring
 - 7. Underground Fuel Tank Monitoring

- D. The system shall be scalable in nature such that the addition of another building subsystem does not require a complete new system, but rather the addition of small I/O modules that connect back to the existing primary controller on the site.
- E. The work included in this phase of the project is a continuation of the initial project phase.

1.3 SUBMITTALS

- A. Product Data: Submit Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes; also include installation and start-up instructions.
- B. Maintenance Data: Submit maintenance instructions and spare parts list for each type of control device. Include that type data, product data and shop drawings in maintenance manual; in accordance with requirements of Division 1.
- C. All documentation, including submittals and as-builts shall be submitted on both hard copy and electronic format, using AUTOCAD latest version and Owner's execution standards.

1.4 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Electrical Standards: Provide electrical components of direct digital control system which have been UL-listed and labeled, and comply with NEMA standards.
 - 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for direct digital control systems.
 - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
 - 4. UL Compliance: Provide control devices which are UL listed as a signal appliance.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. Install system using competent workmen who are fully trained in the installation of temperature control equipment.
- D. Single source responsibility of supplier shall be the complete installation and proper operation of the control systems and shall include debugging and proper calibration of each component in the entire system.
- E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.
- F. Control systems shall comply with UL 916 PAZX and be so listed at the time of bid.
- G. Design and build all system components to be fault-tolerant:

1. Satisfactory operation without damage at 110 percent and 85 percent of rated voltage and at plus 3 hertz variation in line frequency
2. Static, transient and short-circuit protection on all inputs and outputs
3. Protection of communication lines against incorrect wiring, static transients, and induced magnetic interference
4. Network-connected devices to be AC coupled or equivalent, so that any single device failure will not disrupt or halt network communication
5. All real time clocks to be battery-backed for a minimum seventy-two (72) hours.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 2: PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND INSTALLERS

- A. Manufacturers:
 1. Subject to compliance with requirements, provide control system by the following:
 - a. See Baldwin Wallace University Requirements.
- B. Installers: The facility automation system shall be installed by an authorized factory representative or a branch office of the acceptable manufacturer.

2.2 SYSTEM ARCHITECTURE

- A. The system shall be capable of monitoring and controlling up to four (4) million Controllers, each connected in real-time through the customer's existing network back to one or more central monitoring stations. If a network connection is unavailable, then a dial-up telephone connection shall be used.
- B. Network controllers shall have native, direct Ethernet TCP/IP communications back to a central monitoring station, using the customer's existing installed network. A 10bT Ethernet port shall be provided on the controlled for this communications interface. All TCP/IP settings, including IP address, default gateway and subnet mask, shall be stored in non-volatile memory.
- C. Network controllers shall include a built-in web browser, such that all point values may be viewed and controller from a standard browser environment. Custom web pages, password-protected, must be able to be stored within the network controller for access by technicians for troubleshooting and maintenance.
- D. Network controllers shall provide at least 4 serial communications ports. One port shall be configured as a dial-up modem, for back-up communications to the network controller in case the main network connection is unavailable. The remaining ports may be used to connect to third-party subsystems such as fire alarm panels and early warning smoke systems.

- E. Network controller shall accept 120 volts AC power. Its power supply shall include a built-in UPS such that the controller remains fully operational during a power loss. A built-in alarm signals the central monitoring station that the controller is operating on battery power. Provide at least 1-hour battery backup time.
- F. Network controllers shall use small, scalable I/O modules or cards for the cost-effective addition of monitoring points and access control points. Provide expansion capability for at least thirty-two (32) points or doors. Input modules must use universal inputs, accepting a voltage, current, digital, thermistor, counter, or supervised input type.
- G. I/O modules for access control shall include all the inputs and outputs necessary for complete control of a door or portal. Minimum I/O for each door module includes a Wiegand or proximity reader input; three (3) additional supervised inputs, and two (2) Form-C relays (one for the door, and one for a local alarm). Systems that require a separate controller for access control will not be acceptable.
- H. For critical HVAC control applications, the system shall employ small, standalone controllers, designed to be mounted on the equipment they control. These controllers shall communicate back to the primary network controller through a RS-485, two-wire field bus, and minimum speed 19.2 kilobaud. The controllers shall be fully standalone, containing a central processor, memory, and all inputs and outputs needed for the application. In the event of a loss of communications to the network controller, the local controller shall continue to control its equipment, log history values, and buffer alarms. When communications is restored, the alarms will be delivered automatically to the network controller.
- I. All controllers shall be UL listed for Energy Management Systems (UL 916). In addition, access controllers shall be listed for UL 294, access control systems.

2.3 OPERATORS INTERFACE

- A. Day-to-day operation of the system shall be through a standard browser-based interface. Configuration, programming, and optional badging operations shall be performed on dedicated operator workstations.

2.4 OPERATORS WORKSTATION

- A. The system shall support a minimum of 128 PC-based, graphical operator workstations, providing a single-seat interface to all building subsystems. All workstations shall be connected to a central SQL-based database server, ensuring synchronization of all logs and archives, database parameters and configuration. Workstations must use the latest Windows operating system, and must be able to be located anywhere on the Ethernet network without additional network hardware.
- B. The operator workstation shall present all alarms in real-time in an active alarm window, with each alarm color-coded based on priority or type. Alarms from all building subsystems shall be displayed in this window – temperature alarms, power alarms, security breaches, invalid access attempt alarms, etc. Operators must be able to set all alarm thresholds and set points (except Fire Alarm) from a central workstation. Changes to alarm parameters must take effect immediately, with no additional commands required.
- C. Additionally, the system must be able to send alarms via a MAPI email client. All pertinent alarm data must be included in the email – date, point name, description, value, and alarm message/instructions. Email recipients must be defined using standard address book features on the central workstation's email client.
- D. The operator workstation must be optionally capable of providing a primary means to manage card records for access control. Operators must be able to issue cards, edit and delete cards, grant access rights, and create photo ID credentials, from their workstation. Operators must be able to issue batch commands such that all cards from a certain group are locked out of certain sites. These commands must happen immediately, with no additional download commands required.

- E. The operator workstation must provide graphical floor plans of each site, showing point values and critical alarm points dynamically. HVAC values, security values, power and battery values, fire alarm values, must all be shown on the same graphic panel, providing the operator one interface to the system.
- F. If required, Photo ID creation shall be performed at the operator workstation, using either a high-resolution (3 mega-pixels) digital camera, or, live video feed into the workstation. Provide a complete setup including lighting, tripod and backdrop. If a digital camera is provided, the camera must offer a live feedback screen for the operator. Picture images shall be stored in industry-standard JPEG format.
- G. If required, the photo ID sub-system shall also capture and store signatures and fingerprints for each personnel record.
- H. If required, the photo ID sub-system shall provide a badge editing package for designing badge backgrounds. Besides the standard drawing tools, the editor shall also support all common bar code formats, conditional text sizing, cameo images, Chroma-key backgrounds, and conditional object layering.
- I. If required, provide one card printer, with a hopper capacity of fifty (50) badges. The printer shall use the thermal dye-sublimation process to print the badge.

2.5 BROWSER-BASED OPERATION

- A. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any site in the system from anywhere on the network.
- B. The system shall be compatible with Microsoft Internet Explorer 6.0 and higher.
- C. The browser-based interface must share the same graphical displays as the Operator Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall also support commands to change set points, enable/disable equipment and start/stop equipment.
- D. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a copy stored in the system database.
- E. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
- F. Through the browser interface, operators must be able to change schedules – change start and stop times, and add new times to a schedule.
- G. Through the browser interface, operators must be able to create and edit card access personnel records, and assign the card to any and all sites for access, in any combination.
- H. Through the browser interface, operators must be able to view reports of access events and access privileges. Reports must be available based on start and end time, door, area, and person. Invalid attempts must be color-coded red in the report.
- I. Through the browser interface, operators must be able to view live and recorded video from any digital video recorder on the network. The interface must offer an easy method of selecting the camera to view, and for recorded video, must offer selections for start and stop time when searching video clips.
- J. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

- K. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
- L. The system shall be optionally expandable to up to a hundred (10)0 concurrent browser-based users. For this project, provide initially for five (5) concurrent users.

2.6 ALARM MONITORING

- A. The system shall monitor and report alarms to any or all central workstations, within 3 seconds of initial triggering. Alarms shall be buffered and time-stamped in the site's network controller, and sent up to all available workstations for processing. If the alarm is not delivered to at least one workstation, then the controller buffers the alarm and tries again, on a predetermined time pattern. Network controllers must be able to buffer every alarm condition in this manner.
- B. Any input or output point, software point such as a set point or calculated value, or data point from a third-party system must be capable of sending alarms to any central workstation. Up to five (5) different alarm conditions may be configured and attached to each point.
- C. Alarm conditions shall be defined as simple on/off conditions, comparisons to an analog value, comparison to an analog set point, comparison to a supervised circuit (for security alarms) or any combination of the above. Systems that deploy only on/off alarm conditions are unacceptable.
- D. All on/off digital alarms shall be configured such that a Closed circuit condition is normal, and an Open circuit is alarm.
- E. Alarm delivery must be configurable such that different types of alarms may be delivered to different workstations. For example, all power alarms go to the facilities manager, and all access control alarms go to the security officer. Further, alarm delivery must be configurable based on the time of the day and the day of the week. During the day, power alarms are delivered to the power specialist, but at night, they get routed to the security officer.
- F. Intrusion alarms monitored by the system shall be able to be shunted by a time schedule, or automatically shunted locally after a valid card access transaction at the local site.
- G. Toxic gas alarms shall be monitored as analog values if the sensors are in place; if not, they shall be configured as on/off alarms.

2.7 HVAC CONTROL

- A. Provide stand-alone HVAC controllers to monitor and control packaged HVAC units, air handling units, exhaust fans, central chilled water systems, and other environmental systems.
- B. Control sequences shall be programmed in a user-friendly application language, and shall be stored and executed by the local controller. The application language must be able to support the following algorithms.
 - 1. On/Off control
 - 2. PID control
 - 3. Cascading loop control
 - 4. Lead/lag control

- C. Controllers must be able to maintain critical space conditions for temperature and humidity.
- D. Controllers must be able to store point value history for a minimum of 100 samples per point. History must be capable of automatic upload to the central workstation for archiving.
- E. All equipment controlled by the HVAC subsystem shall be able to be controlled from the central workstations, through the graphic display panels, subject to the operator's user privileges.

2.8 ACCESS CONTROL

- A. Access control functions shall be performed through the same primary network controller that manages the HVAC and other subsystems. Systems that require a separate controller with a separate network connection are unacceptable.
- B. System shall be able to control up to thirty-two (32) single-reader doors per controller. System shall also accommodate entry/exit doors, with two (2) readers per door.
- C. System shall support Wiegand or proximity-type cards and readers.
- D. System shall support standard access control keypads, for PIN-only access, and must support card-plus- PIN access for greater security.
- E. System shall support biometric devices such as hand geometry readers, fingerprint readers, and iris scan devices.
- F. Besides the reader input, at least three additional input points must be provided per door. These shall be used for door status, request-to-exit, and an auxiliary input.
- G. All access control alarms – forced entry, door ajar, invalid attempt, and tamper – shall be reported to the central workstations, prioritized, and displayed in the active alarm window for assessment and acknowledgement by the operator.
- H. A common access control card shall be issued for the following:
 - 1. Access to selected remote buildings
 - 2. Access to selected internal controlled areas
 - 3. Fuel delivery
 - 4. Photo ID
- I. When coupled with digital video surveillance, any access control alarm shall automatically display the appropriate camera view of the alarm at any of the central workstations. The operator can then select previous video clips of the same alarm point, including a configurable pre-alarm segment, to assess conditions immediately before the alarm occurred.

2.9 NETWORK ALARM MONITORING

- A. The system shall be optionally capable of monitoring alarm points from network and communications equipment. The alarm points shall be either digital contact input points, or shall be monitored through a serial interface to the site equipment. Where a serial interface is proposed, the supplier must specify which protocol the system will use to monitor the alarms.

- B. Alarms must be displayed and prioritized within the central workstation's active alarm viewer, and will be logged at the central file server.

2.10 VIDEO SURVEILLANCE

- A. Provide a network-based digital video surveillance and recording system. The system shall be comprised of the required number of fixed & movable (Pan/tilt/zoom) digital cameras, and a digital video recorder (DVR) recording unit.
- B. The DVR shall be able to record up to 32 cameras.
- C. The DVR shall be networked using Ethernet TCP/IP with static IP address. All administration, setup, viewing live video, and searching and viewing recorded video shall be accomplished remotely, over the network.
- D. Under normal operation, video recording shall not start unless there is motion seen in the camera view. Software motion masking must be available to define what parts of the view trigger the recording.
- E. Under alarm conditions, video recording must be able to switch to full record mode, bypassing the motion rules.
- F. Frame rates must be settable per camera, and must at least 1 image per second.
- G. Image size and quality must be settable per camera.
- H. The DVR shall include a hard-drive sized for video storage for one month (30 days). Larger hard drives must be available if additional storage is desired.
- I. The DVR must provide a settable network bandwidth limit, to reduce traffic on the overall network.
- J. Through a graphical icon on the central workstation, an operator may call up any DVR unit on the network, and choose to view live video from any camera or cameras (up to 32 per screen). The interface must allow cameras from different DVR units to be displayed on the same screen.
- K. Searching for video clips must be easy and intuitive, and must allow for searching by DVR unit, camera(s), start date, and stop date. Additionally, the search must be able to be further refined by field of motion – return only those clips that have motion in a certain portion of the view.
- L. The DVR units must be seamlessly integrated with the access control and alarm monitoring functions, such that any alarm (door forced open, motion sensor, generator failure, high temp, etc.) must be able to be linked to any camera. When the alarm is triggered, the central workstation interface automatically brings up the live view of the primary camera for that alarm. Up to 4 cameras must be able to be defined per alarm point, and the operator may select the other cameras for complete alarm assessment.
- M. When presented with the alarm video, the operator may choose to review all alarm activity for the particular alarm point, searching by start and stop date. The operator may then select any alarm event and bring up the corresponding video clip.

2.11 LIGHTING CONTROL

- A. The system shall control non-emergency lighting zones through on/off control strategies. The strategies for interior zones will rely upon the occupancy or access control function of the system, such that a valid entry into the site will cause the primary lighting zone to be energized.

- B. Once inside the site, lighting zones will be energized based upon occupancy sensor inputs.
- C. Outside lighting will be controlled through a photocell input.
- D. Lighting circuits shall also be able to be controlled through the central workstation. Commands from the workstation will override the local controller.

2.12 FIRE SYSTEM ALARMING

- A. The system shall be optionally capable of monitoring all alarm points from the building's fire alarm system and early warning smoke detection system, and provide secondary fire annunciation to the central workstations.
- B. When practical, the system shall monitor the fire alarm values through a serial interface to the fire panel. When a serial interface is used, the system shall provide for all conditions of each alarm point – alarm, normal, trouble, fault, and reset.
- C. When a fire alarm or early warning smoke detection alarm is triggered, the system shall perform all necessary fan shutdown and smoke management procedures as appropriate for the site.
- D. Fire alarms shall take priority over other alarms in the system, and at the central workstation, shall automatically display a graphic panel of the site when triggered.

PART 3: EXECUTION

3.1 SCOPE

- A. Provide all other monitoring/control points shown on mechanical drawings.
- B. Provide operator workstations as specified.
- C. Provide laptop computers as specified.

3.2 INSTALLATION

- A. General: Install systems and materials in accordance with manufacturer's instructions and rough-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division 26 sections of these specifications.
- B. Unit Mounted Equipment: Ship control system components to unit manufacturers for mounting and wiring at factory.
- C. Control Wiring: Install control wiring, without splices between terminal points, number- coded or color-coded. Install in neat workmanlike manner, securely fastened. Accessible wiring is defined as that wiring run in mechanical equipment rooms; inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; or above suspended ceilings with easy access. Inaccessible WIRING is defined as wiring run in concrete slabs; walls or ceilings with no access.
 - 1. Install all circuits over 25 volts in electric metallic raceway according to Division 26.
 - 2. Install low voltage circuits under 25 volts in accordance with Division 26.

D. Install the following wiring in conduit:

1. All inaccessible wiring
2. All exposed wiring in occupied areas
3. All exposed wiring below 8 feet above finished floor in mechanical rooms and equipment rooms

E. Install in EMT conduit:

1. All wiring associated with life safety systems.

3.3 ADJUSTING AND CLEANING

- A. Start-up: Start-up, test, and adjust control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch- up paint.
- C. Final Adjustment: After completion of installation, adjust sensors, control valves, motors and similar equipment provided as work of this section.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of FAS.

D. System Operation Check-Out:

1. Upon completion of system installation and after testing and balancing of all FAS systems, set all space temperatures, adjust all devices, control valves, motors, and other equipment provided, place them in complete operating condition, and certify, in writing, that the system is operating properly and that all systems have been checked point-by-point.
2. Trend logs of the following input data shall be submitted to the Architect for review and approval to provide satisfactory operation of the control system:
 - a. Trend logs shall incorporate data logged over a 48-hour period at thirty (30) minute intervals.
 - b. Data shall be combined as to show operation of a complete air handling system over the same logging period.

3.4 CLOSE-OUT PROCEDURES

- A. Owner's Instructions: Provide services of manufacturer's technical representative for two 8-hour days on site to instruct Owner's personnel in operation and maintenance of FAS.
- B. Schedule instruction with Owner; provide at least 7-day notice to Contractor and engineer of training date.
- C. If after preliminary use of the system, and/or training, the increased understanding of the system's features and capabilities necessitates reprogramming to any extent; it is to be performed at no additional cost. During the warranty period, this shall include changes to room names and numbers.

3.5 MAINTENANCE

- A. The FAS Contractor shall present to the Owner a Preventative Maintenance Contract to cover service incidental to the continued proper performance of the FAS and devices during the guarantee period. Provide a minimum of four (4) inspections.

3.6 DEFECTIVE WORK AND MATERIALS

- A. Any material or work found on inspection to be defective or not in strict conformance with requirements of the specifications, or defaced or injured through the acts of fire or elements or any other cause shall be removed immediately from the premises and satisfactory materials or work or both substituted therefore without delay.
- B. If the Contractor does not remove such materials condemned by the engineer within the time limit fixed by written notice, the Owner may cause the same to be done and may store all materials at the expense of the Contractor. If the Contractor does not pay the expense of such removal within ten (10) days thereafter, the Owner may, upon ten (10) days written notice, sell such materials at auction or at a private sale and shall account for the net proceeds thereof, after deducting all costs and expenses that should have been borne by the Contractor.
- C. No previous inspection or certificates of payment shall be held as an acceptance of defective work or materials, or to relieve the Contractor from obligations to furnish sound materials in accordance with contract requirements.

3.7 GUARANTEE

- A. All hardware components, parts, and assemblies, and system software components of the FAS shall be guaranteed against defects in material and/or installation of a period of one year after final written acceptance by the Owner. Expressed warranties are conditionally based on the maintained in accordance with the manufacturer's recommendations. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.

END OF SECTION 283111-1

SECTION 310000 – Section Index

311000 SITE CLEARING

311200 EARTHWORK

311500 TREE PROTECTION

SECTION 311000 – SITE CLEARING

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 Performance Requirements

- A. All waste/demolition material shall become the property of the Contractor and shall be disposed of in accordance with local, state and federal laws.
- B. The Contractor, at the request of the Owner, shall provide documentation substantiating the proper disposal of all waste materials.
- C. All trees/shrubs shall be protected from damage during clearing unless otherwise permitted by the Owner.
- D. All trees/shrubs to be removed shall be removed completely and in a timely manner as to not create an unsightly landscape.
- E. All items denoted as salvageable shall be removed and stored in location designated by the Owner.
- F. All excess topsoil shall remain the property of the Owner and shall be stored in a location designated by the Owner.
- G. The Contractor shall verify that all utilities impacted by Site Clearing activities have been relocated or capped prior to commencement.
- H. Bare soil shall not be left unseeded and mulched for a period not to exceed seven (7) days.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 311000

SECTION 311200 – EARTHWORK

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 Performance Requirements

- A. The Contractor shall be responsible for satisfying any and all erosion and sediment control measures necessary on the project site.
- B. The Contractor shall be responsible for obtaining any local grading permits.
- C. Title 47 of the Division of Environmental Protection, Office of Water Resources (NPDES) shall be followed. All fees associated with permitting shall be considered part of the design fee.
- D. All topsoil stripped from the site shall remain the property of Baldwin Wallace University unless otherwise directed.
- E. All stockpile locations shall be approved by Baldwin Wallace University.
- F. Burning is prohibited on Baldwin Wallace University Property.
- G. Blasting is prohibited on Baldwin Wallace University Property unless otherwise directed.
- H. All waste materials and materials unsuitable for fill or use shall be removed from the property and disposed of in accordance with all state, federal and local laws.
- I. Prior to excavation and placement of fill, the Contractor/Consultant shall contact ONPS Utility or similar agency to locate known utilities in the project area.
- J. Prior to excavation and placement of fill, the Contractor/Consultant shall contact Baldwin Wallace University to review the utility drawings for the area.
- K. Do not interrupt existing utility services without permission from Baldwin Wallace University.
- L. The Contractor shall install and maintain a construction entrance to the project, which will not track materials or debris onto adjoining roadways or facilities.
- M. The Contractor shall employ a qualified independent geotechnical/materials testing laboratory to provide materials testing and inspection services during earthwork operations. Copies of all reports, inspections and test will be forwarded to Baldwin Wallace University.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

3.1 Installation

A. Compaction requirements:

Under structures, steps and pavements	Top 12 inches at 100 percent remaining at 95 percent
Lawn or unpaved areas	90 percent
Walkways	95 percent

END OF SECTION 311200

SECTION 311500 – TREE PROTECTION

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 Performance Requirements

- A. All trees/shrubs and grounds within the drip lines shall be protected from damage, with barricades, during clearing unless otherwise permitted by the Owner.
- B. All trees/shrubs to be removed shall be removed completely and in a timely manner as to not create an unsightly landscape.
- C. Trees/shrubs designated as to be removed and salvaged shall be the property of Baldwin Wallace University and shall be removed and placed as to limit damage.
- D. Placement and storage of all salvaged trees shall be the responsibility of the Contractor unless otherwise noted.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION – NOT USED

END OF SECTION 311500

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 320000 – Section Index

- 321000 DESIGN PHILOSOPHY
- 321216 HOT-MIX ASPHALT PAVING
- 321313 PEDESTRIAN WAYS
- 322000 OUTDOOR FURNITURE
- 323113 CHAIN LINK FENCES AND GATES
- 329200 LAWNS AND GRASSES
- 329300 EXTERIOR PLANTS

SECTION 321000 – DESIGN PHILOSOPHY

Baldwin Wallace University would like to achieve a certain level of visual unity and consistency throughout the campus as new development and renovations occur. In this document the architect will find many things to consider while designing the assigned project.

One of the main concerns focuses on the overall visual appearance of the campus. Unity may be achieved by relating the materials used in exterior improvements with those used in the surrounding buildings and spaces. For example, a more classic style of architecture is prevalent on the downtown campus with many historic buildings, while most buildings on the Evansdale campus are more contemporary in style. Baldwin Wallace University encourages the architect to consider these patterns in new development to attain visual unity between new buildings, existing buildings, and surrounding campus spaces.

This same principle applies to the selection of types of materials for pavement, signage, site furnishings, lighting, etc. For example, repeating the same paving materials and paving patterns creates a uniform cohesive visual appearance. This is not only visually appealing but helps to provide a sense of place and a feeling of continuity for campus visitors.

Plant materials can also play a role in achieving visual unity throughout the Baldwin Wallace University campus. Selecting certain types of plant materials that meet Baldwin Wallace University standards and using those in repetitive patterns can be extremely effective in unifying otherwise unrelated elements. Factors to be considered when selecting plants include size, form, texture, and color as well as growth requirements. Maintenance requirements are also a primary consideration because of limitations to the maintenance budget.

“Way finding”, the ability of visitors, students, and staff to easily find their way around, is another goal for Baldwin Wallace University. Clear easily understood circulation patterns are important. Safety is an issue as well, with vehicular and pedestrian movement separated as much as possible.

The design of exterior improvements should also consider maintenance issues and potential for vandalism. Baldwin Wallace University prefers durable, maintenance-friendly features due to the high usage and expansive nature of the campus grounds that require maintenance.

These guidelines are intended to assist the architect to succeed in integrating new elements into the existing campus structure. As part of the design process, it is important to consider the existing character of materials and elements to achieve a unified visual appearance.

END OF SECTION 321000

SECTION 321216 – HOT-MIX ASPHALT PAVING

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Baldwin Wallace University for hot-mix asphalt paving.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 General Requirements

- A. Baldwin Wallace University normally prefers not to have asphalt prime coat installed due to trucks trafficking the asphalt onto local roadways. Tack coat should be installed when doing asphalt overlays. The Owner has the final decision on utilization of tack coat.
- B. Parking design/installation changes should be coordinated in the design stage.
- C. Buildings and Grounds Parking department will normally do the striping necessary in parking areas.
 - 1. Minimum parking space width = 9 feet
 - 2. Minimum parking space length = 18 feet
 - 3. Aisle widths:
 - a. Perpendicular parking, one-way traffic = 20 feet
 - b. Perpendicular parking, two-way traffic = 24 feet
 - c. Angle parking, one-way traffic = 15 feet
- D. Provide hot-mix asphalt paving according to materials and workmanship as specified below and other applicable requirements of standard specifications of ODOT or the City of Berea.
- E. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
 - 1. Asphalt tack coat, Base Course, and Surface (Wearing) Course: Minimum surface temperature of 40 degrees Fahrenheit and rising at time of placement.

1.3 Quality Assurance

- A. Manufacturer Qualifications: A qualified manufacturer.
 - 1. Manufacturer shall be a paving-mix manufacturer registered with and approved by the ODOT.
- B. Regulatory Requirements: Comply with DOH, City of Berea, and Baldwin Wallace University design standards for asphalt paving work, as applicable.

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- C. Pre-installation Conference: Conduct a conference at the Project site to comply with requirements in Division 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - 1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - 2. Review condition of subgrade and preparatory work.
 - 3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - 4. Review and finalize Construction Schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.4 Submittals

- A. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work. This may involve the ODOT or the City of Berea, as well as Baldwin Wallace University.

PART 2: PRODUCTS

2.1 Asphalt Materials

- A. Tack coat as listed in current ODOT specifications

2.2 Mixes

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction. Baldwin Wallace University typically prefers:
 - 1. Base Course: ODOH Base 2
 - 2. Surface (Wearing) Course: ODOH Wearing 1

PART 3: EXECUTION

3.1 Materials

- A. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gallons/square yard.

3.2 Compaction

- A. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

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3.3 Installation Tolerances

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - Base Course: ½ inch plus, no minus
 - Surface Course: ¼ inch plus, no minus
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straight edge applied transversely or longitudinally to paved areas:
 - Base Course: ¼ inch
 - Surface Course: ⅛ inch

3.4 Asphalt Curbs

- A. Asphalt curbs are normally not preferred by Baldwin Wallace University.

3.5 Field Quality Control

- A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and to prepare test reports.
- B. Contractor shall provide gravel base compaction test by rolling fully loaded stone delivery truck over base stone. Compaction test shall be witnessed by representative of Baldwin Wallace University Buildings and Grounds Department and Baldwin Wallace University's independent testing and inspection agent.

END OF SECTION 321216

SECTION 321313 – PEDESTRIAN WAYS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Baldwin Wallace University for pedestrian ways.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. Division 26, Section 265600: Exterior Lighting (for technical requirements)

1.3 General Requirements

- A. Minimum compressive strength of concrete shall be 4000 pounds per inch with #8 sheet wire reinforcing supported on 2-inch chairs.
- B. Minimum sidewalk shall be 6 feet in width and no less than 5 inches thick.**
- C. All curbing shall be ODOH Type 1 unless otherwise directed by Baldwin Wallace University.
- D. Concrete curing should be done as per industry standards.
- E. Slump specs should be determined by Owner depending on application.
- F. All things related to pedestrian ways should be vandal resistant.
- G. Sidewalks shall be sized based on pedestrian volume and building access for emergency and maintenance purposes.
- H. All openings for ADA concrete curb ramps and sidewalks should be minimum of 6 feet wide.

PART 2: PRODUCTS

2.1 Walkways

- A. Concrete sidewalks and walkways are base standards.
- B. Where decorative paving is desired, tinting of concrete or Techo-Bloc pavers, or approved equal, are preferred. Contractor shall provide a sample before installation.
- C. Exposed aggregate is also acceptable on a limited basis. Pea sized gravel is preferred. Areas prone to freezing should avoided due damage to walkway.
- D. Sidewalks must be slip resistant.
- E. In high visibility areas or entrances, decorative paving in sidewalks such as paving accents or medallions are encouraged.

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- F. Decorative curb cut indicators should be utilized at intersections. These indicators shall be 2 feet by 2 feet pavers or reinforced fiberglass.
- G. Ice melt systems are preferred for steps. Electric and glycol systems are acceptable based on site conditions.
- H. Baldwin Wallace University Preferred Style:



Textured Curb Cut Indicator



Stamped Concrete

2.2 Lighting

- A. See Division 26, Section 265600: Exterior Lighting.
- B. Bollard lights shall be considered for areas where low lighting is needed.
- C. Sample:



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D. Landscape lighting shall be considered around buildings.

E. Light poles shall be capable of holding side mount banners.

1. Concrete light pole – Installation Guide (Please follow these steps.)

- Contact Baldwin Wallace University IT Department regarding: Fiber Optic Network at 440-826-6968.
- Contact Baldwin Wallace University Electrical Department regarding High Voltage Distribution and other university owned utilities at 440-826-2233.
- Contact OOPS at 1-800-362-2764.
- Augured hole to be minimum diameter of 18 inches by 58 inches deep, allowing stone base to adjust for finished elevation. Spoils are to be removed from site.
- Back fill with #411 stone. Mechanically pack every 6 inches.
- Hand hole should face and be square with the sidewalk.
- Finished edge of pole base shall be flush with and 6 inches backset from sidewalk.
- Each pole shall have an 8 feet by 5/8 inches copper clad ground rod with #6 cubic minimum. GEC clamped or welded.
- All ground wires shall be bonded together at the pole using a 5 space ground bar.
- All below grade splices shall be listed for wet location.
- A 4 inches thick concrete ring shall be poured around each pole base. See detail below.

IMPORTANT! PLEASE READ BEFORE HANDLING THE POLES

- 1) Prior to unloading, inspect general condition of poles to be sure no obvious damage has occurred during shipping
- 2) Use the sketches shown below as a guide for unloading the poles. Be sure that crane straps are in good condition
- 3) Always use experienced crane operators following all safety rules.
- 4) When storing poles, it is crucial that the pole is blocked up in a level position so it does not bend under its own weight (see below)
- 5) When installing, raise pole as smoothly as possible referring to the sketches below.
- 6) Call one of our toll free numbers listed below if there are any questions or concerns

HANDLING INSTRUCTIONS FOR AMERICANA POLES 20' (OVERALL LENGTH) & SHORTER

USE EXTRA CARE WHEN HANDLING ACRYLIC COATED POLES. STRAPS MUST BE POSITIONED PROPERLY.

HANDLE THE ANTI-TWO CASTING

* WHEN HEAVY HARDWARE IS BEING ERECTED ON POLE, CONTACT MANUFACTURER FOR LOCATION OF TOP PICK-UP POINT OR REFER TO APPROVAL DRAWING FOR FACTORY INSTALLED PICK UP HOLE.

** WHEN STORING FOR ANY LENGTH OF TIME, POLES MUST BE SUPPORTED SO THAT THEY ARE NOT BENT UNDER THEIR OWN WEIGHT.

*** USE WEIGHTS AT END OF EACH END TO KEEP STORAGE BAR SQUARE

HANDLING INSTRUCTIONS FOR AMERICANA POLES 20' (OVERALL LENGTH) & LONGER

USE EXTRA CARE WHEN HANDLING ACRYLIC COATED POLES. STRAPS MUST BE POSITIONED PROPERLY.

HANDLE THE ANTI-TWO CASTING

* WHEN HEAVY HARDWARE IS BEING ERECTED ON POLE, CONTACT MANUFACTURER FOR LOCATION OF TOP PICK-UP POINT OR REFER TO APPROVAL DRAWING FOR FACTORY INSTALLED PICK UP HOLE.

** WHEN STORING FOR ANY LENGTH OF TIME, POLES MUST BE SUPPORTED SO THAT THEY ARE NOT BENT UNDER THEIR OWN WEIGHT.

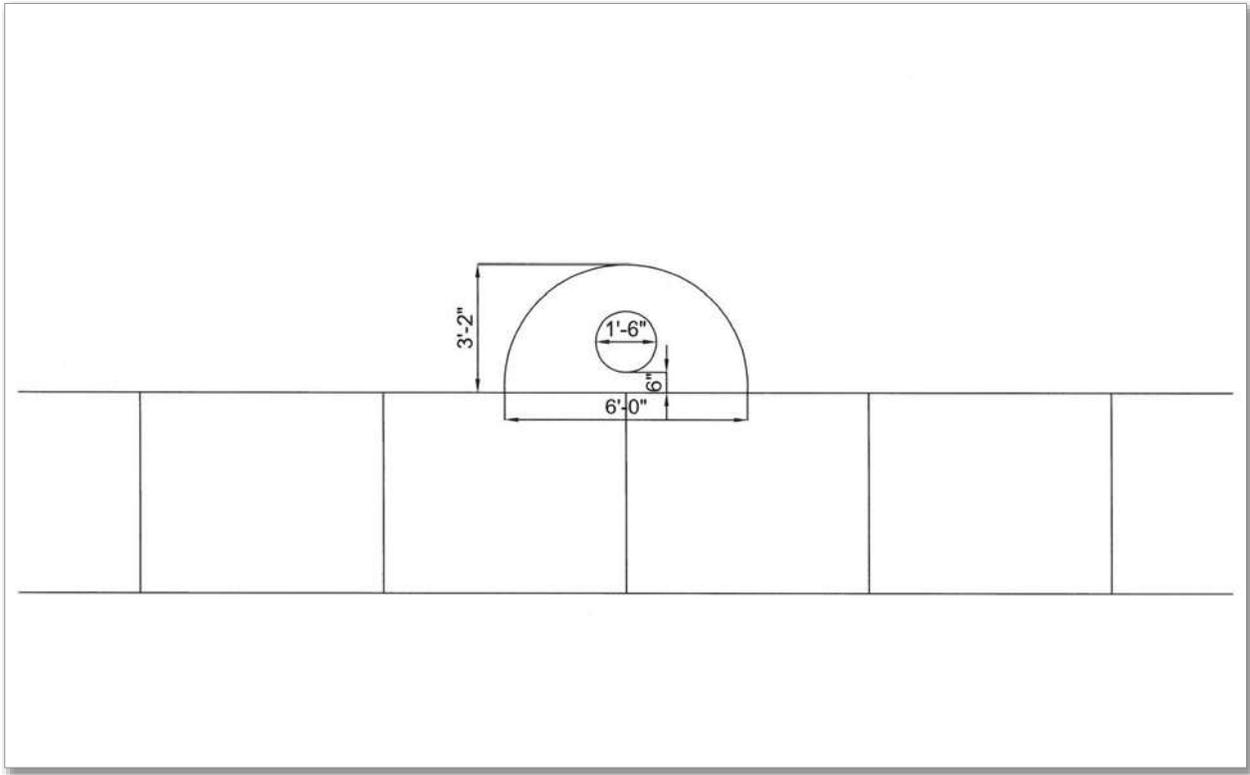
*** USE WEIGHTS AT END OF EACH END TO KEEP STORAGE BAR SQUARE

A	LOCATE ABOVE POINT OF BALANCE
B	RECOMMENDED HOOKING #
C	END OF POLE LENGTH

840 Walkers Line
Burlington, Ontario L7R 3X9
Phone 1-800-268-7809

9200 Energy Lane
Northport, Alabama 35476
Phone 1-800-435-6563

14503 Wallick Road
Atchison, Kansas 66002
Phone 1-800-837-1024



- Concrete shall be a minimum, 4000 pounds per inch, reinforced with #8 wire, pinned to existing sidewalk with four (4) pieces of ½ inch by 12 inches epoxy coated #4 rebar pins and have a broom finish with retrace or finish to match existing sidewalk.
- Place expansion material between pole and cement ring to prevent bonding.
- Collateral damage to landscape shall be prevented at all times. All grassy areas shall be protected with mats underneath all equipment. This requirement may be waived by Baldwin Wallace University Personnel if site conditions warrant.
- Landscape restoration shall be as follows:
 - Newly Graded Subgrades – loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish and other extraneous matter and legally dispose of them off Owner’s property.
 - Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement.
 - Spread approximately one-half the thickness of planting soil mix over loosed subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix. Sow seed at the rate of 6 to 8 pounds/1000 square feet.

PART 3: EXECUTION – NOT USED

END OF SECTION 321313

SECTION 322000 – OUTDOOR FURNITURE

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Baldwin Wallace University for outdoor furniture. **Victor Stanley Ironsites or Victor Stanley Steelsites are the basis for the campus standard.**
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Reference Standards

- A. ADA requirements.

1.3 General Requirements

- A. All outdoor furniture should be secured and resistant to vandalism.
- B. All outdoor furniture should be skateboard resistant.
- C. All outdoor furniture should have a warranty against paint chipping for five (50 years).

PART 2: PRODUCTS

2.1 Outdoor Furniture

- A. Trash receptacles: Victor Stanley products are campus wide.
 - 1. Trash receptacles shall be aesthetically compatible with other exterior furniture.
 - 2. Trash receptacles shall not have locks.
 - 3. Each trash receptacle shall have a plastic spill container on the inside that is easily removable.
 - 4. Trash can to be capable of holding 36 gallon bags. The design should consider trash receptacles that can potentially hold more than 36 gallon bags.
 - 5. Side by side garbage/recyclables are preferred where spacing allows.

6. Samples:



Victor Stanley – Ironsites SD-42



Landscape Forms – Scarborough



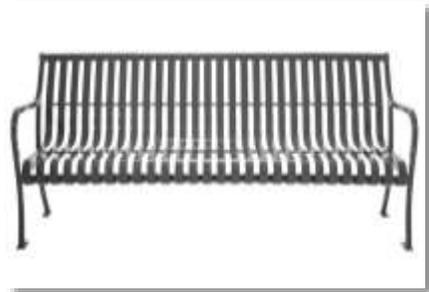
Rubbermaid – Infinity 9W38

B. Benches

1. Wood benches are not preferred.
2. Black wrought iron-look benches are preferred. (**Campus standard is Victor Stanley.**)
3. Benches must be secured to a concrete pad instead of pavers.
4. Benches should not interfere with circulation pedestrian walkways and maintenance equipment.
5. Benches should have arms to prevent skateboarding.
6. Samples:



Landscape Forms - Scarborough



Keystone Ridge - Pullman



Keystone Ridge - Pullman

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C. Tables

1. All tables shall be secured to a hard surface or concrete slab.
2. Chairs must be attached to tables.
3. Wood picnic tables are prohibited. Baldwin Wallace University prefers a composite or metal material. Perforated seats for rain drainage are preferred. Black finish is preferred, all other color selections to be approved by Baldwin Wallace University.
4. Tables must comply with ADA guidelines
5. Samples:



Landscape Forms - Carousel



Summit Supply - T46WEBS

D. Bike Racks

1. All bike racks shall be secured to a concrete slab.
2. Baldwin Wallace University prefers black painted steel finish for bike racks. Contractor shall visit Baldwin Wallace University standard bike rack installation at north side of Telfer Hall.
3. Racks shall be specified with outdoor finishing process.
4. Racks shall be under warranty.
5. Dimensions to be: 23 inches wide by 42 inches high, 9 inches radius or to be determined by site and bike traffic.

6. Samples:



Inverted U Shape Bike Rack

PART 3: EXECUTION – NOT USED

END OF SECTION 322000

SECTION 323113 – CHAIN LINK FENCES AND GATES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of Baldwin Wallace University for permanent chain link fences and gates.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Quality Assurance

- A. Pre-installation Conference: Conduct a conference at the Project site to comply with requirements in Division 1.

PART 2: PRODUCTS

2.1 Chain-Link Fence Fabric

- A. General: All fencing materials to be of new condition. Rusted fence not allowed. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:
 - 1. Galvanized steel fabric – 9 gallons
 - 2. Steel Wire Fabric: Polymer-coated wire.
 - a. Color: Black or Green
 - 3. In areas where aesthetics are of great concern, wrought iron fencing or masonry walls should be considered in lieu of chain link fence.

2.2 Industrial Fence Framing

- A. Posts and Rails: Posts not to exceed 10 feet spacing.
- B. Post Size and Thickness:
 - 1. Top Rail: 1-²/₃ inches
- C. Coating for Steel Framing:
 - 1. Aluminized over steel
 - 2. Polymer coating over metallic coating

2.3 Tension Wire

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A. General: Provide 7 gallons horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric

PART 3: EXECUTION – NOT USED

END OF SECTION 323113

SECTION 329200 – LAWNS AND GRASSES

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Baldwin Wallace University for lawns and grasses.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 Submittals

- A. Product Date: For each type of product indicated.
- B. Material Test Reports: For existing surface soil and imported topsoil.
- C. Maintenance Instructions: Recommended procedures to be approved by Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.3 Quality Assurance

- A. Topsoil Analysis: Furnish soil analysis by a qualified soil testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorous, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.4 Scheduling

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 15 – June 15
 - 2. Fall Planting: August 15 – November 15

1.5 Lawn Maintenance

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established but for not less than the following periods:
 - 1. Seeded Lawns: 60 days from date of Substantial Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
 - 2. Sodded Lawns: 60 days from date of Substantial Completion.

- B. Mow lawn as soon as top growth is tall enough to cut (max 3 inches). Schedule initial and subsequent mowing to maintain the following grass height:
 - 1. Mow grass 3 inches high.

PART 2: PRODUCTS

2.1 Seed (Preferred over sod)

- A. Grass Seed: Blue-grass blend or turf-type fescue. Coordinate with Baldwin Wallace University grounds foreman.

2.2 Turf Grass Sod

- A. Turf Grass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turf Grass Sod Materials" in its "Guideline Specifications to Turf Grass Sodding". Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turf Grass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun: Kentucky bluegrass (*Poa Pratensis*), a minimum of three cultivars
 - 2. Sun and Partial Shade: Proportioned by weight as follows:
 - a. 50 percent Kentucky Bluegrass (*Poa Pratensis*)
 - b. 30 percent chewings Red Fescue (*Festuca Rubra* variety)
 - c. 10 percent perennial Ryegrass (*Lolium perenne*)
 - d. 10 percent Redtop (*Agrostis Alba*)
 - 3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings Red Fescue (*Festuca Rubra* variety)
 - b. 35 percent rough Bluegrass (*Poa Trivialis*)
 - c. 15 percent Redtop (*Agrostis Alba*)

2.3 Topsoil

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. To be determined by the Baldwin Wallace University project representative.

2.4 Inorganic Soil Amendments

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class O, with a minimum 95 percent passing through No. 8 (2.36 millimeters) sieve and a minimum 55 percent passing through No. 60 (0.25 millimeters) sieve.

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- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

2.5 Organic Soil Amendments

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through ½-inch sieve; soluble salt content of 5 to 10 decisiemens/meter; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

2.6 Fertilizer

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid. Standard analysis is 10-20-20.

2.7 Planting Soil Mix

- A. Planting Soil Mix: Consult with Baldwin Wallace University Buildings & Grounds

PART 3: EXECUTION

3.1 Lawn Preparation

- A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 1. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement.
 2. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
- B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 1. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil.
 2. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.

3.2 Seeding

- A. Sow seed at the rate of 6 to 8 pounds/1000 square feet.

3.3 Sodding

- A. Lay sod within twenty-four (24) hours of harvesting.

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3.4 Satisfactory Lawn

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities.
- B. Re-establish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

END OF SECTION 329200

SECTION 329300 – EXTERIOR PLANTS

PART 1: GENERAL

1.1 Scope of Standard

- A. This standard provides general guidance concerning the specific preferences of the Baldwin Wallace University for exterior plants.
- B. Project conditions and requirements vary, thus precluding the absolute adherence to the items identified herein all cases. However unless adequate written justification is provided, then it is expected that these guidelines will govern the design and specifications.

1.2 General Requirements

- A. Do not plant over utilities.
- B. Provide strategic plant selection and placement in relative to lighting and circulation. Coordinate with Baldwin Wallace University grounds foreman for planting depths. Generally, plants to be set with root flare at grade.
- C. Provide adequate drainage in planting beds and lawns.
- D. Provide adequate soil nutrients.
- E. Plant material with a history of problems on the Baldwin Wallace University campus includes:
 - 1. Cornus Florida
 - 2. Juniperus (Ground Cover Juniper)
 - 3. Pinus Mugo Mugo
 - 4. Pyrus Calleryana “Bradford”
 - 5. Vinca Minor
 - 6. Ajuga Raptans
 - 7. Iberis Sempervirens

1.3 Submittals

- A. Material Test Reports: For existing surface soil and imported topsoil.
- B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year.

1.4 Warranty

- A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor’s control.

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1. Warranty Period for Trees and Shrubs: One (1) year from date of Substantial Completion.
2. Warranty Period for Ground Cover and Plants: Six (6) months from date of Substantial Completion.

1.5 Maintenance

- A. Trees and Shrubs: Maintain for the following maintenance period by replacing dead or damaged plants, by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing takes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.
1. Maintenance Period: Six (6) months from date of Substantial Completion.
- B. Ground Cover and Plants: Maintain for the following maintenance period by watering, weeding, fertilizing and other operations as required to establish healthy, viable plantings.
1. Maintenance Period: Six (6) months from date of Substantial Completion.

PART 2: PRODUCTS

2.1 Plants Preference

- A. This is a list of preferred plant material by Baldwin Wallace University. It should be used as a guide for selecting plant material for the Baldwin Wallace University campus. This list is not all inclusive but has been created from these criteria.
1. Disease and insect resistant
 2. Growth rate
 3. Habit
 4. Aesthetics
 5. Leaf and flower color
 6. Landscape value
 7. Low maintenance
- B. Plant List
1. Large Deciduous Trees
 - a. Gleditsia Tricanthos Inermis
 - b. Tilia Cordata
 - c. Quercus
 - d. Betula
 - e. Ulmus

2. Small Ornamental Deciduous Trees
 - a. Malus
 - b. Carpinus
 - c. Prunus
 - d. Cornus Mas
 - e. Magnolia (Late blooming variety)
 - f. Cotinus
3. Large Evergreens
 - a. Picea
 - b. Pinus Strobes
 - c. Tsuga
4. Small Evergreen Trees
 - a. Thuja (Single stem)
 - b. Ilex Opaca
 - c. Juniperus
 - d. Taxus
 - e. Chamaecyparis
5. Flowering Shrubs
 - a. Spiraea
 - b. Abelia
 - c. Itea
 - d. Viburnum
6. Non-Flower and Evergreen Shrubs
 - a. Berberis
 - b. Taxus
 - c. Ilex Crenata
 - d. Thuja
 - e. Chamaecyparis
 - f. Ligustrum

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2.2 Topsoil

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

2.3 Fertilizer

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.4 Mulches

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Shredded hardwood is the standard. Wood chips are acceptable.
 - 2. Finish depth of mulch in planting beds is not to exceed 3 inches.

2.5 Planting Soil Mix

- A. Planting Soil Mix: Topsoil mix with the soil amendments to be approved by the Baldwin Wallace University Buildings and Grounds Department.

2.6 Planting Bed Establishment

- A. Loosen subgrade of planting beds to a minimum of depth 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Spread planting soil mix to a depth of 2 feet but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately one-fourth the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 3 inches of subgrade. Spread remainder of planting soil mix.

PART 3: EXECUTION – NOT USED

END OF SECTION 329300

SECTION 330000 – Section Index

- 333100 Industrial Wastewater Pretreatment
- 333200 Utility Board
- 334100 Storm Water

SECTION 333100 – INDUSTRIAL WASTEWATER PRETREATMENT

PART 1: GENERAL

- 1.1 Any deviance from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 Adhere to current Berea Ordinances, Article 921: “Sewer Regulations” and Article 923: “Industrial Wastes”.
- 1.3 Plan reviews by Berea’s Utility Boards, Pretreatment Program Manager shall be scheduled through Baldwin Wallace University’s Project Manager and Environmental Health & Safety, (EH&S), Department.
- 1.4 A completed Pretreatment Program Facility Questionnaire, project architectural and plumbing plans, and supporting documentation shall be completed by the AE and given to the Baldwin Wallace University Project Manager and EH&S. These documents shall be forwarded by the end of 60 percent Design and Development. The Questionnaire is attached in Paragraph 3.2.
 - A. This documentation shall be provided for all new facility and building construction projects requiring sewer taps to the MUB sanitary collection system.
 - B. This documentation shall be provided for all renovations or upgrades to existing facilities utilizing sanitary sewer taps to the local sanitary collection system and involve renovations to areas or equipment that discharge non-domestic sanitary sewage.
- 1.5 Facilities, buildings and projects that are required to comply with the local Industrial Pretreatment program must provide wastewater pretreatment and monitoring facilities as determined by local authorities.

PART 2: PRODUCTS

- 2.1 Acid Neutralizers, if required for maintaining a wastewater discharges pH between 6.0 and 9.0 standard pH units, shall be passive sump type with limestone media and be installed exterior of the building footprint within a below grade concrete vault accessible by a round manhole cover.
- 2.2 Wastewater monitoring manholes, as required by the Pretreatment Program Manager, shall be provided exterior to the building footprint. Monitoring manholes must meet the approval of local authority and Baldwin Wallace University EH&S and must meet the following minimum requirements:
 - A. Monitoring manholes shall be installed in an easily accessible location. As conditions allow, manhole locations must avoid existing means of egress, paths of pedestrian travel, and roadways.
 - B. Monitoring manholes shall be located and installed to provide laminar flows. Manholes shall be installed the greater of either; a minimum of ten (10) times the inside diameter (ID) of the sanitary sewer or 6 feet downstream from elbows, other manholes, changes in direction, other sewer taps or any other features that disrupt the laminar flow.
 - C. Integral open channel flumes shall be provided in monitoring manholes by installing a pre-cast concrete manhole at the middle of one full length piece of plastic sanitary sewer pipe so that pipe joints are no closer than 3 feet from the influent and effluent sides of the manhole. After installation of the pre-cast manhole, access to the sanitary flow shall be made by cutting away the top 1/3 of the plastic PVC pipe to within 6 inches of the pre-cast concrete manhole interior vertical walls. Concrete shall be used to fill the space between the exterior of the PVC pipe and the interior wall of the pre-cast concrete manhole. Concrete shall be troweled smooth and sloped to drain sewer surcharges back into the PVC pipe opening.

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 33 – Utilities

- D. A Bilco Type K, Model K-4, aluminum, 3 feet by 3 feet, hinged, flat manhole cover or equivalent shall be provided for monitoring manhole access.
- E. Access door hinges shall be installed facing the closest sidewalks or pedestrian ways in proximity of the monitoring manhole. This installation orientation must result in having the open lid being located between the manhole opening and potential pedestrian traffic.
- F. Top ladder rung within manhole shall be located to provide a minimum opening that allows a 2½ feet diameter cylinder into the monitoring manhole.

PART 3: EXECUTION

3.1 If approved by Baldwin Wallace University Facilities Management Personnel, acid neutralizers and wastewater monitoring facilities installed within facilities must be located and installed to provide access at all times for maintenance and monitoring.

3.2 Questionnaire starts on next page.

INDUSTRIAL WASTE QUESTIONNAIRE

GENERAL INFORMATION

Standard Industrial Classification Code (SIC) 8220/Colleges & Universities

Company Name

Mailing Address

Address of Premises

Name and Title of Signing Official

Contact Official

Name

Title

Address

Phone

The information contained in this questionnaire is familiar to me and to the best of my knowledge and belief, such information is true, complete and accurate.

Date

Signature of Official

PLANT OPERATIONAL CHARACTERISTICS

Brief description of manufacturing or service activity on premises:

Principal Raw Materials Used:

Catalysts, Intermediates:

Principal Product or Service (use Standard Industrial Classification Manual if appropriate)

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 33 – Utilities

Type of Discharge: _____ Batch _____ Continuous
 If batch, average number of batches per twenty-four (24) hours _____

Is there a scheduled shutdown?

When?

Is production seasonal?

If yes, explain indicating month(s) of peak production

Average number of employees per shift: _____ 1st; _____ 2nd; _____ 3rd

Shift start times: _____ 1st; _____ 2nd; _____ 3rd

Shifts normally worked each day:

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1 st	_____	_____	_____	_____	_____	_____	_____
2 nd	_____	_____	_____	_____	_____	_____	_____
3 rd	_____	_____	_____	_____	_____	_____	_____

Describe any wastewater treatment equipment of processes in use:

Raw Water Sources:

<u>Source</u>	<u>Quantity</u>	
_____	_____	gallons per day
_____	_____	gallons per day
_____	_____	gallons per day

Describe any raw water treatment process in use:

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 33 – Utilities

List water consumption in plant:

Cooling Water	_____	gallons per day
Boiler Feed	_____	gallons per day
Process Water	_____	gallons per day
Sanitary System	_____	gallons per day
Contained in Product	_____	gallons per day
Other	_____	gallons per day

List average volume of discharge or water loss to:

City Water Sewer	_____	gallons per day
Natural Outlet	_____	gallons per day
Waste Hauler	_____	gallons per day
Evaporation	_____	gallons per day
Contained in Product	_____	gallons per day

Is discharge to sewer: _____ Intermittent: _____ Steady
Temperature _____ Total Suspended Solids (TSS) _____
5 Day BOD _____ pH _____

List plant sewer outlets, size, flow (attach and refer to map):

Is there a Spill Prevention Control and Countermeasure Plan in effect for this plant?

_____ Yes _____ No

Are any of the toxic pollutants listed in Table 1 being used at this facility in manufacturing of the product or is a byproduct which may be discharged? If so, please indicate by a check mark on Table 1.

TABLE – 1

65 TOXIC POLLUTANTS LISTED IN CONSENT DECREE AND
REFERENCED IN 307(a) OF THE CWA OF 1977

Ancenaphthene	Endrin and matabolites
Acrolein	Ethylbenzene
Acrylonitrile	Fluoranthene
Aldrin/Dieldrin	Haloethers
Anitmony and compounds	Halomethanes
Arsenic and compounds	Heptachlor and metabolites
Asbestos	Hexachlorobutadiene
Benzene	Hexachlorocyclopentadien
Benzidine	Hexachlorocyclohexane
Beryllium and compounds	Isophorone
Cadmium and compounds	Lead and compounds
Carbon tetrachloride	Mercury and compounds
Chlordane	Naphthalene
Chlorinated benzenes	Nickel and compounds
Chlorinated ethanes	Nitrobenzene
Chlorinalkyl ethers	Nitrophenols
Chlorinated naphthalene	Nitrosamines
Chlorinated phenols	Pentachlorophenol
Chloroform	Phenol
2-chlorophenol	Phthalate esters
Chromium and compounds	Polychlorinated byphenyls (PCB)
Copper and compounds	Polynuclear aromatic
Cyanides	Hydrocarbons
DOT and metabolities	Selenium and compounds
Dichlorobenzenes	Silver and compounds
Dichlorobenzidine	2, 3, 7, 8, - Tetrachlorodibenzo-
Dichlorethylenes	p-dioxin (TCDD)
2, 4-dichlorophenol	Tetrachloroethylene
Dichloropropane	Thallium and compounds
Dichloropropene	Toluene
2, 4-dimethylphenol	Toxaphene
Dinitrotoluene	Trichloroethylene
Diphenylhydrazine	Vinyl Chloride
Endosulfan and metabolites	Zinc and compounds

List any other toxicants or chemicals known or anticipated to be present in the discharge.

END OF SECTION 333100

SECTION 333200 – UTILITY BOARD

PART 1: GENERAL

- 1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management.
- 1.2 Performance Requirements
- A. All design and components shall comply with governing codes and regulations. The local regulatory agency is the City of Berea.

PART 2: PRODUCTS – NOT USED

PART 3: EXECUTION

- 3.1 The AE needs to meet with UB during the schematic portion of design to confirm location, capacity and availability of the water, storm and sanitary sewer utilities.
- 3.2 Plans and specs should reflect utility work that must be performed by UB or its subcontractors. Typically UB installs and owns all utilities and taps to the meter point for water or tap point for sewers.
- 3.3 Designers shall submit plans to and receive comments and estimates from UB before submitting Construction Documents to Baldwin Wallace University. Use the form in Section 3.6 to initiate this process.
- 3.4 See Section 334100: Storm Water for details.
- 3.5 See Section 333100: Industrial Wastewater Pretreatment for details. The Pretreatment Questionnaire is also included in here in paragraph 3.2.
- A. This questionnaire shall be completed for all new facility and building construction projects requiring sewer taps to the UB sanitary collection system.
 - B. This questionnaire shall be completed for all renovations or upgrades to existing facilities utilizing sanitary sewer taps to UB's sanitary collection system and involve renovations to areas or equipment that discharge non-domestic sanitary sewage.

Request for Estimate

The undersigned hereby requests a written estimate of the cost to provide water/sewer service to the location and for the purpose described below.

Received By: _____

Date: _____

Location: Subdivision _____
Lot no. _____
Street name _____
Address _____
Tax district _____
Tax map no. _____ Parcel no. _____

Purpose: (check all that apply)
• Residential, single-family units _____
• Residential, multi-units* _____
• Industrial/commercial* _____
• Fire services* _____
• Other - describe* _____

*(requires site plan)

Site plan: (check one) Service desired:
• Is attached • Water
• Will be provided • Sewer
• Is drawn on this form • Both
• Is not yet determined • Storm

Definition of special service requirements:
Fire flow: _____ GPM at: _____ PSI residual pressure at (location): _____

Other requirements (explain): _____

I hereby acknowledge receipt of copies of the following Public Utilities Commission of Ohio Rules as provided, and further acknowledge that said rules have been explained to me to my satisfaction.

Initial _____ Rules 5.5 sewer Signed: _____

Initial _____ Rules 5.4, 5.5 water Date: _____

Printed name: _____

Mailing address: _____

Phone number: _____

Baldwin Wallace University will respond to this request in writing within 30 days of our receipt thereof.

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 33 – Utilities

Type of Discharge: _____ Batch _____ Continuous
 If batch, average number of batches per twenty-four (24) hours _____

Is there a scheduled shutdown?

When?

Is production seasonal?

If yes, explain indicating month(s) of peak production

Average number of employees per shift: _____ 1st; _____ 2nd; _____ 3rd

Shift start times: _____ 1st; _____ 2nd; _____ 3rd

Shifts normally worked each day:

	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1 st	_____	_____	_____	_____	_____	_____	_____
2 nd	_____	_____	_____	_____	_____	_____	_____
3 rd	_____	_____	_____	_____	_____	_____	_____

Describe any wastewater treatment equipment of processes in use:

Raw Water Sources:

<u>Source</u>	<u>Quantity</u>	
_____	_____	gallons per day
_____	_____	gallons per day
_____	_____	gallons per day

Describe any raw water treatment process in use:

BALDWIN WALLACE COLLEGE DESIGN GUIDELINES & CONSTRUCTION STANDARDS
DIVISION 33 – Utilities

List Water Consumption in plant:

Cooling Water	_____	gallons per day
Boiler Feed	_____	gallons per day
Process Water	_____	gallons per day
Sanitary System	_____	gallons per day
Contained in Product	_____	gallons per day
Other	_____	gallons per day

List Average Volume of Discharge or Water Loss to:

City Water Sewer	_____	gallons per day
Natural Outlet	_____	gallons per day
Waste Hauler	_____	gallons per day
Evaporation	_____	gallons per day
Contained in Product	_____	gallons per day

Is discharge to sewer: _____ Intermittent: _____ Steady
Temperature _____ Total Suspended Solids (TSS) _____
5 Day BOD _____ pH _____

List plant sewer outlets, size, flow (attach and refer to map):

Is there a Spill Prevention Control and Countermeasure Plan in effect for this plant?
_____ Yes _____ No

Are any of the toxic pollutants listed in Table 1 being used at this facility in manufacturing of the product or is a byproduct which may be discharged? If so, please indicate by a check mark on Table 1.

TABLE – 1

65 TOXIC POLLUTANTS LISTED IN CONSENT DECREE AND
REFERENCED IN 307(a) OF THE CWA OF 1977

Ancenaphthene	Endrin and matabolites
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Aldrin/Dieldrin	Haloethers
Anitmony and compounds	Halomethanes
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Asbestos	Hexachlorobutadiene
Benzene	Hexachlorocyclopentadien
Benzidine	Hexachlorocyclohexane
Beryllium and compounds	Isophorone
Cadmium and compounds	Lead and compounds
Carbon tetrachloride	Mercury and compounds
Chlordane	Naphthalene
Chlorinated benzenes	Nickel and compounds
Chlorinated ethanes	Nitrobenzene
Chlorinalkyl ethers	Nitrophenols
Chlorinated naphthalene	Nitrosamines
Chlorinated phenols	Pentachlorophenol
Chloroform	Phenol
2-chlorophenol	Phthalate esters
Chromium and compounds	Polychlorinated byphenyls (PCB)
Copper and compounds	Polynuclear aromatic
Cyanides	Hydrocarbons
DOT and metabolities	Selenium and compounds
Dichlorobenzenes	Silver and compounds
Dichlorobenzidine	2, 3, 7, 8, - Tetrachlorodibenzo-
Dichlorethylenes	p-dioxin (TCDD)
2, 4-dichlorophenol	Tetrachloroethylene
Dichloropropane	Thallium and compounds
Dichloropropene	Toluene
2, 4-dimethylphenol	Toxaphene
Dinitrotoluene	Trichloroethylene
Diphenylhydrazine	Vinyl Chloride
Endosulfan and metabolites	Zinc and compounds

List any other toxicants or chemicals known or anticipated to be present in the discharge.

END OF SECTION 333200

SECTION 334100 – STORM WATER

PART 1: GENERAL

1.1 Any deviances from the following instructions must be approved during design by Baldwin Wallace University Facilities Management Personnel.

1.2 Performance Requirements

- A. All new work, taking place within the city limits of Berea or in watersheds feeding the City of Berea, shall be in accordance with the Storm Water Ordinances of the City of Berea and Ohio EPA. This article is controlled by the City of Berea.
- B. Best Management Practices (BMP's) are stated within the local publication "Erosion and Sediment Control Handbook for Developing Areas", and can be obtained for the Soil Conservation Service.
- C. Projects which propose disturbing three (3) acres or greater area must submit a site registration application according to the Ohio Department of Environmental Protection (ODEP), Division of Water Resources. Projects which propose disturbing less than three acres should submit a Notice of Intent according to the guidelines stipulated by the ODEP. Fees associated with these activities shall be incurred by the Owner.

PART 2: PRODUCTS

2.1 Piping

- A. All storm water piping shall be RCP or HDPE pipe.

2.2 Inlets & Manholes

- A. All inlets and manholes shall be constructed of reinforced concrete in accordance with the latest WVDOT standards.

2.3 Grates

- A. All grates shall be traffic bearing in accordance with the latest ODOH standards.

PART 3: EXECUTION

3.1 Storm water is intended to be deposited within its originating watershed. Any deviation from this will require permission from Baldwin Wallace University.

END OF SECTION 334100



COMMUNICATIONS INFRASTRUCTURE STANDARDS

COMMUNICATIONS INFRASTRUCTURE STANDARDS

INFORMATION TECHNOLOGY DEPARTMENT – Network Services/Telecommunications

COMMUNICATIONS INFRASTRUCTURE STANDARDS

Closet Layout

- All racks should have a minimum of 34 inches of space behind the rack and 36 inches in front of the rack. 24 inches should be available at the end of the rack.
- A typical location will have two 19 inches inch racks each with a 3 inches vertical organizer on the left or right side and a 6 inches vertical organizer in between.
- The back wall of the closet should be covered with $\frac{3}{4}$ inches painted fire rated plywood for mounting devices such as card readers, security power supplies, CATV, splice cases, telephone lighting protection, etc.
- The wall to the left or right of the rack based on door location should also be covered in $\frac{3}{4}$ inch painted fire rated plywood.
- Equipment requiring wall mounting greater than 8 inches should not be mounted behind racks.
- Based on the current rack specifications the average closet should be 6 feet by 7 feet with at least 8 feet ceiling height.
- If the port count exceeds 192 ports either data or voice, a third rack will have to be added.
 - If a third rack must be added, the room will need to be increased to at least 6 feet by 9 feet with at least 8 feet ceiling height.

Wiring

- There is not a preferred brand for Category 6.
- Use Plenum and PVC where appropriate.
- All conduit, where needed, must be fire stopped.
- All wiring needs to be Category 6.
- All wire needs to be terminated into a Category 6 rated RJ45 jack on the patch panel and at the drop location.
- All data wiring needs to be terminated using TIA/EIA-568-B standard.

Fiber

- A typical building will have 12 single-mode and 12 multi-mode of fiber optic.
- The fiber will be terminated with ST connectors.
- All single-mode fiber optic cables should be pigtail fusion spliced with machine polished pigtails.

Electrical

- At a minimum, two (2) 20-amp circuits should be supplied to the room.
- Each circuit should terminate with a 5-20R.
- If generator power is available, an additional 20-amp circuit should be supplied, terminated with a 5-20R.
- A ground bus bar should be installed on the back wall behind racks.
- All current national electric standards must be met.

COMMUNICATIONS INFRASTRUCTURE STANDARDS

INFORMATION TECHNOLOGY DEPARTMENT – Network Services/Telecommunications

Racks

- 19 inches, open frame, 2 post relay rack, 12/24 tapped holes, 42 U
- Ortronics or Homaco racks are the standard.
- All Racks are to be bolted to the floor and attached to the wall with 12 inches ladder rack.
- All racks will use 3 inches and 6 inches vertical organizers where necessary.

Patch Panels

- Leviton or Panduit Category 6
 - Quick Port or NetKey (based on application)
 - Standard Patch (based on application)

User/End Location

- Leviton Jacks Category 6 Quick Port or Panduit NetKey (Leviton compatible)
 - Blue for Phone
 - Beige for Data
- Faculty/Staff offices with 130 square feet or less require two (2) data ports and one (1) phone port on one wall (farthest wall from door)
- Faculty/Staff offices with more than 130 square feet require two (2) data ports and one (1) phone port on two (2) walls
- Departments will need to designate each office space as either a secretary or adjunct faculty office:
 - If the office is designated for secretary use, then three (3) data ports and one (1) voice port will be required for each drop, based on the square footage requirements listed above.
 - If the office is designated for adjunct faculty use, then at least two (2) locations with two (2) data and one (1) voice will be required for each drop, based on the square footage requirements listed above.
- Flush mount locations should use Leviton Gang Plates with ID.
- Surface mount locations (We have not chosen a standard box.)

Lighting

- Use 2 feet by 2 feet florescent fixtures to provide appropriate light to the room. At least two (2) fixtures to help prevent shadowing and provide redundancy if one (1) light fails.
- The fixture should be controlled by a motion sensor that will turn the fixture on/off based on motion.
- Lighting should be on the generator.

Environmental

- The room should have a ceiling to cut down on dust.
- The temperature of each room should be able to be controlled at 72 to 76 degrees Fahrenheit with 50 to 60 percent humidity.
- Each room should have the ability have an independent thermostat.

COMMUNICATIONS INFRASTRUCTURE STANDARDS

INFORMATION TECHNOLOGY DEPARTMENT – Network Services/Telecommunications

- Each room should have the ability to exhaust hot air.
- BTU produced by the electronics will determine load size of heating and cooling.

Flooring

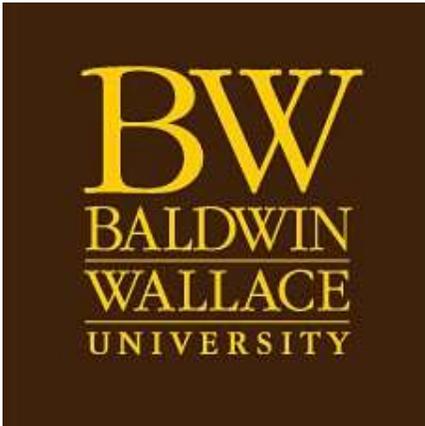
- It is preferred to have a floor that is grounded (Static Free Floor). If static free floor tile is unavailable, a vinyl tile floor should be waxed with an anti-static coating.

Support

- A warranty for defects in workmanship and labor should be covered for the full manufacturer's warranty for the products installed. If a product installed has a 15-year manufacturer's warranty, then we would require a 15 year support warranty for workmanship and labor.

Notes

- Attached should be three (3) drawings.
 - Front Elevation Drawing # 0001
 - Closet Layout 2 Rack Drawing # 0002
 - Closet Layout 3 Rack Drawing # 0003
- If drawings are not attached, contact Baldwin Wallace University Information Technology at (440) 826-7000.



GUIDELINES AND SPECIFICATIONS FOR NEW CLASSROOM CONSTRUCTION OR RENOVATION

Guidelines & Specifications for New Classroom Construction or Renovation

Overview:

This document presents guidelines and specifications regarding new classroom construction and renovation of existing classrooms.

Guidelines and Specifications are organized into the following categories:

1. Acoustics
2. Lighting
3. HVAC
4. Conduit/Electrical/Network
5. Room Layout
6. Presentation equipment
7. Specifications
8. Layout diagrams

1. General/Acoustics/Teaching Wall

- A. Reverberation time to be 0.8 to 1.0 second.
- B. Classrooms (lecture halls) seating more than twenty-five (25) should be acoustically engineered /treated/designed to control for excess reverberation.
- C. Notify Baldwin Wallace University Information Technology of the size of acoustic tiles for projector mounting plates.
- D. Teaching wall is defined as the wall where the main screen is located.
- E. Initial placement of screen can be centered on teaching wall.
- F. Multimedia podium location should be furthest corner from entry door (see diagram) unless windows or other factors limit location.
- G. Electrical/network/AV needs on room cabinetry will be determined through consultation with faculty.

2. Lighting

- A. Window coverings should be available for ambient light control.
- B. Half-bank control (half of each light fixture has the ability to be turned on and off).
- C. No lights within 4 feet of screen location, typically 4 feet from teaching wall or light control for lighting near the screens (LCD or projection).
- D. Light controls at door AND at instructor location.
- E. Wash lighting for writing surface should be recessed to allow for maximum screen size and should be on a separate switch near teaching location.

3. HVAC

- A. Consideration must be given to presentation technologies as sources of heat.
 - a. Particular importance for computer labs
- B. No HVAC controls or monitors on teaching wall for maximized writing surface.
- C. Baldwin Wallace University assumes plenum ceilings for all wiring, etc.

- D. Consideration of the location of ducts, etc. must be given to ceiling mounted presentation technology.
- E. Mitigate HVAC noise, especially in areas where communication equipment (video conference, phone) is to be utilized.

4. Conduit/Electrical/Network

All Baldwin Wallace University A/V control and signal is low voltage.

Option A

- A. Floor box or poke-through at instructor station (see specifications for recommended model numbers).
 - a. Edge of floor box or poke-through 4 feet from walls at teaching location (see diagram).
 - b. One (1) duplex at the instructor's station on separate circuits in floor box or poke-through.
 - c. Access from floor box or poke-through to ceiling – shortest route possible. This may include having conduit placed between floors and walls. Two (2) 1 inch minimum conduit run should be used (in addition to networking/electrical conduit).
 - d. Three (3) network drops to each floor box or poke-through location (computer, laptop and control).

Option B

- B. No floor box or poke-through (A/V wiring is through wall in conduit)
 - a. One (1) duplex power at instructor station location so that cord does not cause a trip hazard.
 - i. Typically 24 inches from corner
 - b. Three (3) network drops at each instructor station.
 - c. Two (2) 1 inch minimum conduit run from instructor station to ceiling access.
 - d. Open duplex box connected to conduit run to ceiling.
 - e. Network should be run in one of the conduits.
- C. Duplex at projector location wired in projector ceiling mount plate (ceiling projector mount plate is Owner provided).
- D. One (1) network drop to projector location.
- E. Power to individual instructional spaces clearly labeled on electrical panel.
- F. Power and data on teaching wall, above writing or screen surface, in situations that warrant wall-mounted short-throw projectors (to be determined by Owners).

5. Presentation Technology

- A. At minimum, one (1) screen/LCD location per room.
- B. Screens/LCDs are to be sized according to the viewing task:
 - a. For viewing video, the minimum screen height is to be 0.125x the distance to the furthest viewer. (Width to be 0.167x the distance to the furthest viewer.)
 - b. For viewing computer text and graphics the minimum screen height is to be 0.167x the distance to the furthest viewer. (Width to be 0.22x the distance to the furthest viewer.)
 - c. For viewing detailed computer images the minimum screen height is to be 0.25x the distance to the furthest viewer. (Width to be 0.33x the distance to the furthest viewer.)

- C. Screens/LCDs should be wall mounted.
- D. Ceiling mount only if cabinets or HVAC interfere with wall mount.
- E. Screens/LCDs are to be mounted so the bottom of the projected image is a minimum of 4 feet above the floor.
- F. Multiple screen/LCD locations in Seminar/conference rooms will be determined on a case-by-case basis.
- G. Multimedia podiums to be supplied by Baldwin Wallace University (mark architectural drawings appropriately). Podium sizes are available in the specifications area.
- H. Wall mounted speaker (see specifications).
- I. Typically, speakers should be mounted on the wall near instructor podium, approximately 8 inches from ceiling.
- J. For certain installations (e.g. conference rooms, multi-purpose rooms, and large teaching spaces) ceiling speakers may be appropriate.
- K. Must include multimedia carts in room layouts and architectural drawings where appropriate.
- L. Baldwin Wallace University projectors, speakers, multimedia carts and equipment for most classrooms are Owner supplied unless specifically budgeted as part of the larger construction project. Consult the CIO for details.

6. Specifications and Recommendations for Hardware and Media Podiums

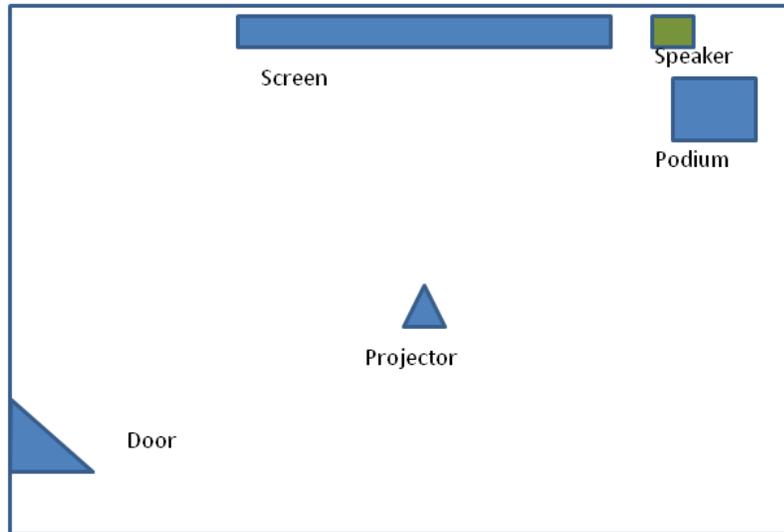
- A. Poke-Thru – Recommended Manufacturer: Wiremold
 - a. We recommend the 6 inches Poke-Thru (these are dependent on floor type):
 - 6ATCPAV – color doesn't matter
 - 6ATPAV – color doesn't matter
 - b. Side Compartments:
 - i. 20 AMP duplex receptacle
 - ii. 682A Device Plate (networking)
 - c. Center Compartment:
 - i. 6DEC Mounting plate (we will supply the device plate for the AV)
 - d. Conduit for center compartment (for the AV) on the two listed above is shown at ¾", but we recommend 1 inches
 - e. Cut sheet – http://www.wiremold.com/shared_content/pdf/ed1543.pdf
 - f. Guide Form specs – http://www.wiremold.com/shared_content/pdf/ed1558.pdf
- B. Floor box – Recommended Manufacturer: FSR Inc.
 - a. We recommend FSR Inc. FL-710 or FL-700 (whatever cover is recommended for the floor/location) or an equivalent. This will give us enough capacity, along with working room in the box.
 - b. Data with A/V accessibility (we will provide A/V plates) and power per requirements
 - c. <http://www.fsrinc.com/floorBoxes.htm>
- C. Speaker – Recommended for teaching spaces
 - a. Option 1 – Normal, non-acoustic or non-music teaching room:

- i. Speaker: EVID 4.2
 - ii. One (1) speaker per normal sized classroom (approximately 25 students)
 - iii. Two (2) speakers for classrooms over 1100 square feet or those that may be odd-shaped.
 - iv. <http://www.electrovoice.com/products/127.html#>
 - b. Option 2 – Conservatory classrooms, acoustic teaching rooms, music teaching rooms:
 - i. Speaker: ZX1i
 - ii. Two (2) speakers per normal sized classroom (approximately 25 students)
 - iii. Two (2) or more speakers for classrooms over 1100 square feet or those that may be odd-shaped.
 - iv. <http://www.electrovoice.com/products/249.html>
 - c. Option 3 – Conservatory spaces, not teaching rooms:
 - i. Each space will be independently designed for the specific use case.
- D. Multimedia Cart – Recommended for teaching spaces
- a. Spectrum Industries
 - i. Compact Presentation Lectern
 - 1. For standard classrooms with no auxiliary equipment
 - 2. Front door will be removed by Baldwin Wallace University Specification Sheet:
<http://www.spectrumfurniture.com/media/productFiles/CPL3.pdf>
 - b. Custom Cart – built as needed

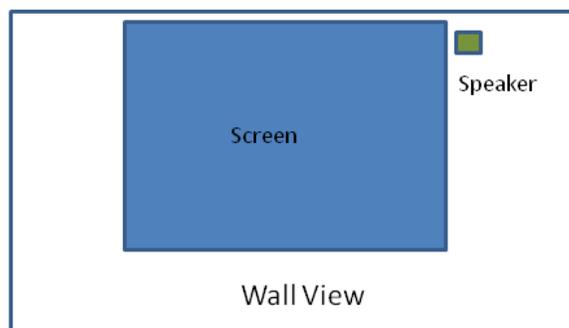
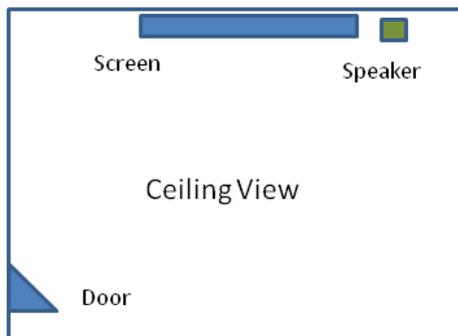
7. Layout Diagram

- A. Screen on teaching wall Podium opposite door

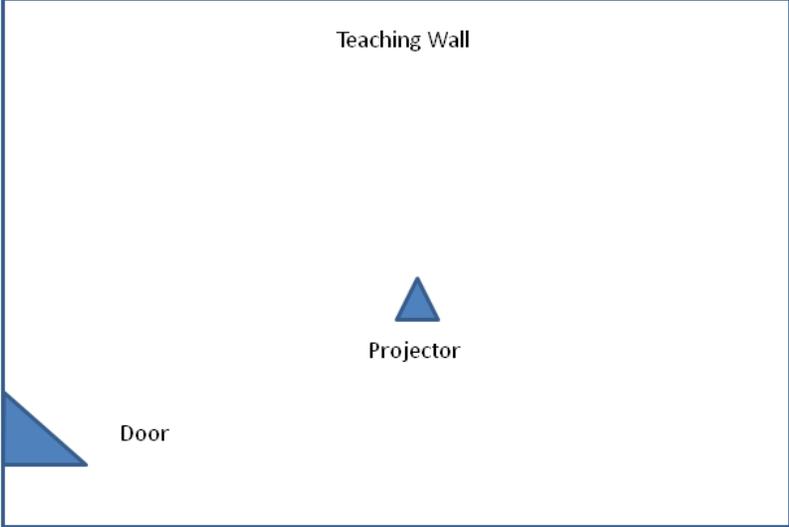
Teaching Wall Configuration – not to scale



Teaching Wall Configuration - Wall Mounted Hardware – not to scale

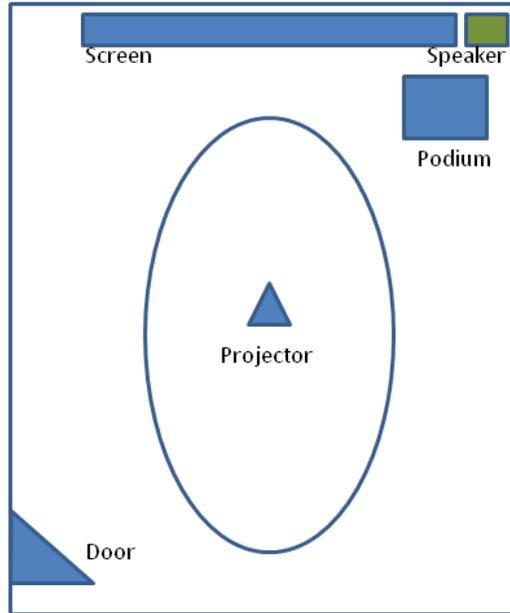


Teaching Wall Configuration - Ceiling mounted hardware – not to scale

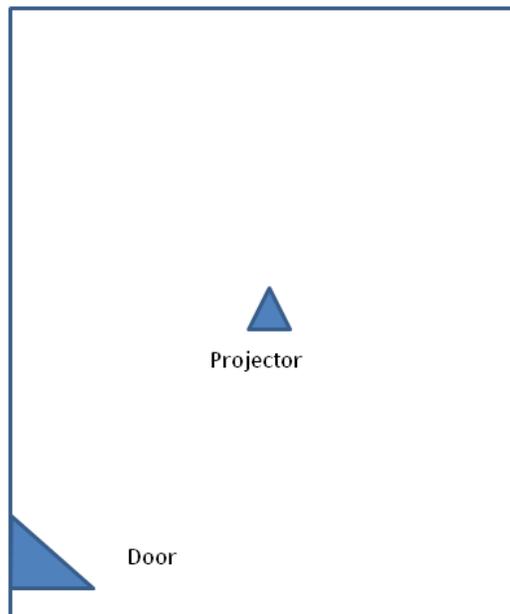


B. Diagram 2 Conference Room
Screen on “short” wall

Conference Room Configuration – not to scale



Conference Room Configuration – Ceiling mounted hardware - not to scale



Conference Room Configuration - Wall Mounted Hardware – not to scale

