



TECHNICAL SPECIFICATIONS

**FRESNO UNIFIED SCHOOL DISTRICT
EMS RETROFIT
at
EATON ELEMENTARY SCHOOL
ROWELL ELEMENTARY SCHOOL
BURROUGHS ELEMENTARY SCHOOL**

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Project 20138, 39, 40



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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.
- B. Owner's Project Requirements, Basis of Design, and Commissioning Plan documentations are included by reference for information only.

1.2 SUMMARY

- A. Section Includes:
 - 1. Building commissioning of the following systems:
 - a. HVAC components and equipment, domestic hot water systems, energy management, control systems.
 - b. HVAC system: Interaction of cooling, heating, and comfort delivery systems.
 - c. HVAC Control System: Control hardware and software, sequence of operations, and integration of factory controls.
 - d. Lighting Control System and interface with daylighting.
 - e. Water heater Title 24 compliant.
 - 2. Building commissioning activities and documentation in support of the 2019 California Energy Code and 2019 California Green Building Standards Code - CALGreen.
 - a. Verify that applicable equipment and systems are installed according to the Contract Documents, manufacturer's recommendations, and industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - b. Verify and document proper performance of equipment and systems.
 - c. Verify that Operation and Maintenance documentation is comprehensive and complete.
 - 3. Verify that Owner's operating personnel are adequately trained.
 - 4. Building commissioning is a process for achieving, verifying, and documenting that the performance of the facilities, systems, and assemblies meet defined objectives and criteria. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Owner's/Architect's design intent.
- B. The Owner, Architect/Engineer, and Commissioning Agent are not responsible for construction means, methods, job safety, or management function related to commissioning on the job site.
- C. Related Work Specified Elsewhere (as applicable):
 - 1. SUBMITTAL PROCEDURES
 - 2. CLOSEOUT PROCEDURES
 - 3. OPERATION AND MAINTENANCE DATA
 - 4. PROJECT RECORD DOCUMENTS
 - 5. PLUMBING
 - 6. HVAC/HVAC CONTROLS

7. ELECTRICAL

1.3 DEFINITIONS

- A. Acceptance - A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the Project meets defined requirements; thus permitting subsequent activities to proceed.
- B. Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included.
- C. Checklists - Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's project requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements. Various checklists are prepared by the Commissioning Agent and the contractor to document equipment; system test completion.
- D. Commissioning - Commissioning is a comprehensive and systematic process to verify that the building systems perform as designed to meet the Owner's requirements. Commissioning during- the construction, acceptance, and warranty phases is intended to achieve the following specific objectives:
 - 1. Verify and document that equipment is installed and started per manufacturer's recommendations; industry accepted minimum standards, and the Contract Documents.
 - 2. Verify and document that equipment and systems receive complete operational checkout by installing contractors.
 - 3. Verify and document equipment and system performance.
 - 4. Verify the completeness of operations and maintenance materials.
 - 5. Ensure that the Owner's operating personnel are adequately trained on the operation and maintenance of building equipment.The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- E. Commissioning Plan - an overall plan developed by the Commissioning Agent that provides the structure, schedule, and coordination planning for the commissioning process.
- F. Control System - A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.
- G. Data Logging - The monitoring and recording of flows, currents, status, pressures, etc., of equipment using stand-alone data recorders separate from the control system or the trending capabilities of control systems.
- H. Deficiency - A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents, does not perform properly or is not complying with the design intent.

- I. Design Intent - A dynamic document that provides the explanation of the ideas, concepts, and criteria that are considered to be very important to the Owner. It is initially the outcome of the programming and conceptual design phases.
- J. Functional Performance Test - test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure set point). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing is not functional testing, in the commissioning sense of the word. Test and balancing primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The Commissioning Agent develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. Functional Performance Tests are performed after pre-functional checklists and startups are complete.
- K. Issues Log - A formal and ongoing record of problems or concerns - and their resolution - that have been raised by members of the commissioning team during the course of the commissioning process.
- L. Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- M. Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.
- N. Non-Compliance - see Deficiency.
- O. Non-Conformance - see Deficiency.
- P. Owner's Design Intent (ODI) - A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes Project goals, measurable performances criteria, cost considerations benchmarks, success criteria, and supporting information.
- Q. Pre-functional Checklist - a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the Commissioning Agent to the contractor. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word "pre-functional" refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist.

- R. Quality Based Sampling - A process for evaluating a subset (sample) of the total population. The sample is based upon a known or estimated probability distribution of expected values; an assumed statistical distribution based upon data from a similar product, assembly, or system; or a random sampling that has scientific statistical basis.
- S. Seasonal Performance Tests - Functional Performance Test that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- T. Simulated Condition - Condition that is created for the purpose of testing the response of a system (e.g.: raising/lowering the set point of a thermostat to see the response of a VAV box).
- U. Startup - The initial starting or activating of dynamic equipment, including completing construction checklists.
- V. System Manual - A system focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase.
- W. Procedure - A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections on the Contract Documents. Performance testing covers the dynamic functions and operations of equipment and systems under full operation. Systems are tested under various models; such as during low cooling loads, high loads, component failures, unoccupied, varying outside air, fire alarm, power failure, etc. The systems are run through all the sequences state.
- X. Training Plan - A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of project operating and maintenance personnel, users, and occupants.
- Y. Trending - The monitoring by a building management system or other electronic data gathering equipment, and analyzing of the data gathered over a period of time. Trending of all equipment control points is required prior to functional testing.
- Z. Verification - The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.
- AA. Warranty Period - Warranty period for the entire project; including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.4 COORDINATION

- A. Perform commissioning services to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.

- B. Commissioning Agent shall provide overall coordination and management of the commissioning program as specified herein.
- C. Commissioning Team: The commissioning process will require cooperation of the Contractor, subcontractors, vendors, installers, Architect/Engineer, Commissioning Agent, and Owner. The commissioning team shall be comprised of the following.
 - 1. Contractor
 - a. Project Manager
 - b. Test Engineer
 - 2. Subcontractors: As appropriate to product or system being commissioned.
 - 3. Commissioning Agent
 - a. Project Manager
 - b. Project Engineers
 - 4. Owner Representative(s)
 - 5. Architect/Engineer
 - a. Architect
 - b. MEP Engineers
 - c. Specialty Consultant(s)
- D. Progress Meetings: Attend construction job-site meetings, as necessary, to monitor construction and commissioning progress. Coordinate with contractor to address coordination, deficiency resolution and planning issues. Plan and coordinate additional meetings as required to progress the work.
- E. Site Observations: Perform site visits, as necessary, to observe component and system installations.
- F. Functional Testing Coordination:
 - 1. Equipment shall not be "temporarily" started for commissioning.
 - 2. Functional performance testing shall not begin until pre-functional, start-up, and test and balancing is completed for a given system.
 - 3. The controls system and equipment it controls shall not be functionally tested until all points have been calibrated and pre-functional checklists are completed.

1.5 QUALITY CONTROL

- A. Qualifications for Commissioning Agents: Engaging commissioning service personnel that specialize in the types of inspections and tests to be performed.
 - 1. Inspection and testing service agencies shall be members of the Building Commissioning Association (BCA).

1.6 SUBMITTALS

- A. Commissioning Agent shall submit the following:
 - 1. Basis of Design and Design Intent.
 - a. Update as necessary during the work to reflect the progress on the components and systems. Forward updates to the Architect/Engineers in a timely manner.
 - 2. Scoping Meeting Minutes.
 - 3. Commissioning Plan: Submit within 30 calendar days of authorization to proceed.

- a. Update as necessary during the work to reflect the progress on the components and systems. Forward updates to the Architect/Engineers in a timely manner.
4. Commissioning Schedule: Submit with Commissioning Plan.
 - a. Update as necessary during the work to reflect the progress on the components and systems. Forward updates to the Architect/Engineers in a timely manner.
5. Functional performance test forms: Submit minimum 30 calendar days prior to testing.
6. Deficiency Report and Resolution Record: Document items of non-compliance in materials, installation or operation. Document the results from start-up/pre-functional checklists, functional performance testing, and short-term diagnostic monitoring. Include details of the components or systems found to be non-compliant with the drawings and specifications. Identify adjustments and alterations required to correct the system operation, and identify who is responsible for making the corrective changes.
 - a. Update as necessary during the work to reflect the progress on the components and systems. Forward updates to the Architect/Engineers in a timely manner.
7. Final Commissioning Report: Compile a final Commissioning Report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process. Indicate the actual performance of the building systems in reference to the design intent and contract documents. Include completed pre-functional inspection checklists, functional performance testing records, diagnostic monitoring results, identified deficiencies, recommendations, and a summary of commissioning activities.
8. O&M Submittals:
 - a. Training plan: Training plan shall include for each training session:
 - Dates, start and finish times, and locations;
 - Outline of the information to be presented;
 - Names and qualifications of the presenters;
 - List of texts and other materials required to support training.
 - b. O&M Database.

1.7 RESPONSIBILITIES

- A. The general responsibilities of various parties in the commissioning process are provided in this subsection. The specific responsibilities are in the Technical Specifications.
- B. All Parties:
 1. Follow all quality requirements in the Contract Documents.
 2. Attend commissioning kickoff meeting and additional coordination meetings as necessary.
- C. Architect (A/E):
Construction Phase
 1. Attend the commissioning coordination meeting and selected commissioning team meetings.
 2. Perform normal submittal review, construction observation, as-built drawing review; O&M manual review, etc., as contracted.

3. Provide design narrative documentation to Commissioning Agent.
4. Coordinate resolution of system deficiencies identified during commissioning; according to the Contract Documents.
5. Review and approve the O&M manuals.

D. Mechanical and Electrical Engineers (A/E)

Construction Phase

1. Perform normal submittal review, construction observation, as-built drawing review, etc.; as contracted. One site observation should be completed just prior to system startup.
2. Provide any design narrative and sequences documentation requested by the Commissioning Agent. The engineers shall assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing detailed testing procedures.
3. Attend the commissioning meetings as necessary.
4. Participate in the resolution of system deficiencies identified during commissioning; according to the Contract Documents.
5. Review and approve the O&M manuals.

Occupancy and Operations Phase

- a. Participate in the resolution of non-compliance, non-conformance, and design deficiencies identified during commissioning during warranty period commissioning.
- b. Attend lessons learned session.

- E. Commissioning Agent: The Commissioning Agent will verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the Owner's Design Intent. When a random sample does not meet the requirement; the Commissioning Agent will report the failure in the "Issues Log".

Construction Phase

1. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Coordinate the commissioning work and; with the General Contractor and Owner/CM, help integrate commissioning activities into the Master Schedule.
3. Revise the Commissioning Plan as necessary.
4. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
5. Request and review additional information requested to perform commissioning tasks; including O&M materials, contractor startup and checkout procedures.
6. Before startup; gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained in writing to be able to write detailed testing procedures.
7. Review and approve contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
8. Write and distribute construction checklists. Prepare and maintain completed construction checklist log.

9. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitution relating to the commissioning process. Assist in resolving any discrepancies.
10. Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
11. Approve construction checklist completion by selected site observation and spot-checking.
12. Recommend approval of systems startup by reviewing startup reports and by selected site observation.
13. Review test and balancing execution plan.
14. Oversee sufficient testing of the HVAC control system.
15. Recommend approval of air and water systems balancing by spot testing by reviewing completed reports and by selected sit observation.
16. With necessary assistance and review from installing contractors; write the performance test procedures for equipment and systems; including energy management control system trending, stand-alone data logger monitoring or manual performance testing.
17. Analyze any performance trend logs and monitoring data to verify performance.
18. Coordinate, witness, and recommend approval of manual performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
19. Maintain a master Issues Log and a testing record. Provide the commissioning team with progress reports, test results, and recommended actions.
20. Witness all or part of all Owner contracted tests or tests by manufacturer's personnel over which the Commissioning Agent may not have direct control. Document these tests and include this documentation in Commissioning Record in O&M manuals.
21. Review equipment warranties to ensure that the owner's responsibilities are clearly defined.
22. Oversee and approve the training of the owner's operating personnel.
23. Complete and maintain a commissioning record and building systems book(s).
24. Review and approve the preparation of the O&M manuals.
25. Provide a final commissioning report.
26. Coordinate the development of a systems manual.
27. Prepare a standard trend logging package of primary parameters that will provide the operations staff clear indications of system function in order to identify proper system operation and trouble shoot problems. The Commissioning Agent shall also provide any needed information on interpreting trends.

Occupancy and Operations Phase

- a. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
- b. Return to the Site/Project on or about 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction

contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

- c. Assist in the development of a preventative maintenance plan, a detailed operating plan or an energy and resource management plan or as-built documentation.
- d. Attend and facilitate lessons learned session.

F. Owner or Owner's Representative (CM)

Construction and Acceptance Phase

1. Attend a commissioning coordination meeting and other commissioning team meetings.
2. Perform the normal review of contractor submittals.
3. Furnish a copy of all Construction Documents, Addenda, Change Orders, and approved submittals.
4. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
5. Provide the Owner's Design Intent documentation to the Commissioning Agent and contractor for information and use.
6. Provide the Basis of Design documents; prepared by the Architect and approved by the Owner to the Commissioning Agent and operation and maintenance training plan.
7. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

Occupancy and Operations Phase

- a. Assist the Commissioning Agent as necessary in the seasonal or deferred testing and deficiency correction required by the specifications.
- b. Attend lessons learned session.

G. Owner's Project Manager (PM)

Construction Phase

1. Manage the contract of the Architect/Engineer and the General Contractor.
2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
3. Provide final approval for the completion of the commissioning work.

Occupancy and Operations Phase

- a. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.
- b. Attend lessons learned session.

H. Contractor: Contractor, their subcontractors, and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning process activities including, but not limited to the following:

Construction Phase

1. Perform customary quality control on all work performed under this contract.
2. Prepare O&M manuals, as-built drawings, construction observation, etc. according to the Contract Documents; including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
3. Provide startup procedures for all equipment prior to equipment startup/testing.
4. Attend one commissioning coordination meeting at the beginning of construction.
5. Facilitate the commissioning coordination of the commissioning with the construction schedule.

6. Ensure that all subcontractors and vendors execute their installation, testing, and startup responsibilities as defined in this section and the technical specifications.
7. Provide submittals as required elsewhere in the contract including all changes thereto.
8. Participate in intermittent commissioning discussions held during weekly construction meetings.
9. Attend one commissioning meeting to coordinate equipment functional testing approximately 60 days prior to startup of the first piece of major equipment. Meeting will be chaired by the Commissioning Agent and may include various owner representatives including the CM, A/E, and PM.
10. Provide training of owner personnel as identified in contract specifications.
11. Provide trend logs and trend reports of all equipment control points to aid in demonstration of proper control sequence of operations prior to functional testing.

Occupancy and Operations Phase

- a. Ensure that subcontractors complete all quality requirements identified in the contract specifications.
 - b. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings as the project progresses.
 - c. Perform all guarantee work for materials furnished under the contract for the time specified in the contract; including all warranties and curing all latent defects within the time period provided in the contract.
- I. Vendors/Subcontractors
1. Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project's scope and budget.
 2. Provide requested information regarding equipment sequence of operation and testing procedures as required in contract specifications.
 3. Provide copy of all quality assurance test results/reports for equipment installed by factory representatives.

PART 2 – PRODUCTS

2.1 TEST EQUIPMENT

- A. Instrumentation shall meet the following standards:
1. Be of sufficient quality and accuracy to test and measure system performance within the tolerances required to determine adequate performance.
 2. Be calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.
 3. Be maintained in good repair and operation condition throughout the duration of use on this project.
- B. All standard testing equipment required to perform startup, initial system checkout, and required functional performance testing shall be provided by the contractor for the equipment being tested. Any specialized testing equipment not required to perform contract work will be provided by the Commissioning Agent.
- C. Data logging equipment or software required to test equipment will be provided by the Commissioning Agent, but shall not become the property of the Owner.

2.2 COMMISSIONING PLAN

- A. The Commissioning Agent is to develop a Commissioning Plan identifying the quality assurance processes to be implemented by the Owner. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
1. Commissioning during construction begins with an initial commissioning meeting conducted by the Commissioning Agent where the commissioning process is reviewed the project commissioning team members.
 2. Additional meetings will be required throughout construction; scheduled by the Commissioning Agent through the Owner or CM with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
 3. Equipment documentation is submitted to the Commissioning Agent through the Owner or CM during the normal submittal process; including detailed startup procedures.
 4. The pre-functional checklists are to be completed by the contractor prior to startup to demonstrate equipment is ready for startup.
 5. Pre-functional checklists, equipment startup, trend logging and reporting, and test and balancing must be completed before functional performance testing.
 6. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
 7. The contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkout are performed. The Commissioning Agent approving test and balancing, and checklists and startup plans. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.
 8. The Commissioning Agent develops and implements equipment and system performance test procedures. These procedures are approved by the Owner and CM.
 9. The performance tests are executed by the contractor under the direction of the Commissioning Agent with the assistance of the facility staff. All documentation is by the Commissioning Agent.
 10. The Commissioning Agent reviews the O&M documentation for completeness and provides the commissioning record for the O&M manuals.
 11. Commissioning is to be completed before substantial completion.
 12. The Commissioning Agent assists in the development and reviews and pre-approves the training program provided by the contractor.
 13. Deferred testing is conducted as specified or required.

2.3 EQUIPMENT / SYSTEMS TO BE COMMISSIONED

- A. The following equipment /systems will be commissioned in this Project:
1. Domestic water system - plumbing (Level 3)
 2. HVAC ductwork and distribution system (Level 4)
 3. HVAC equipment (Level 4)
 4. HVAC instrumentation (Level 4)
 5. HVAC test and balance (Level 5)
 6. Interior and Exterior Lighting and Controls (Level 3)

Note: Levels defined in 3.4 PERFORMANCE TESTING AND VERIFICATION

PART 3 – EXECUTION

3.1 MEETINGS

- A. Commissioning Coordination Meeting - Within 60 days of the Notice to Proceed (NTP), the Commissioning Agent, through the Owner/CM, will schedule, plan, and conduct an initial commissioning meeting. The contractor and its responsible parties previously identified shall attend.
- B. Commissioning Agenda Discussions - At various times during the course of construction, commission related agenda will be discussed during the weekly project meetings along with other quality related discussions. These discussions will be held weekly during the final 3 months of construction.
- C. Functional Testing Meetings - Prior to HVAC equipment startup a commissioning meeting will be conducted to coordinate commissioning activities with equipment startup and testing.

3.2 COMMISSIONING PROCESS

- A. The following activities outline the commissioning tasks and the general order in which they occur.
 - 1. The Commissioning Agent shall coordinate all activities.
 - a. Design Review and Documentation.
 - b. Documentation of Basis of Design and Design Intent.
 - c. Design Development Review.
 - 2. Construction Document Review.
 - 3. Commissioning Scoping Meeting.
 - 4. Commissioning Plan.
 - 5. Submittals Review.
 - 6. Start-Up/Pre-Functional Checklists.
 - 7. Functional Performance Testing.
 - 8. Short-Term Diagnostic Testing.
 - 9. Deficiency Report and Resolution Record.
 - 10. Operations and Maintenance Training.
 - a. O&M Manual.
 - b. Training.
 - c. O&M Database.
 - 11. Record Documents Review.
 - 12. Final Commissioning Report and Documentation.
 - 13. Deferred Testing.
 - a. Unforeseen Deferred Tests.
 - b. Seasonal Testing.
 - c. End-of-Warranty Review.

3.3 SUBMITTALS

- A. The Commissioning Agent will provide appropriate contractors with a specific request for the type of submittal documentation the Commissioning Agent requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum; the request will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequence of operation, O&M data, performance test procedures, trend data, and logs/reports, control drawings, and details of owner contracted tests. In addition; the installation and checkout materials that are actually

shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the commissioning agent. All documentation requested by the Commissioning Agent will be included by the subcontractors in their O&M manual contributions.

- B. The Commissioning Agent will review and approve submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the performance of the equipment, and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance and only secondarily to verify compliance with equipment specifications. The commissioning agent will notify the Owner/CM of items missing or areas that are not in conformance with Contract Documents and which require resubmission.
- C. The Commissioning Agent may request additional design narrative from the NE and controls contractor, depending on the completeness of the Owner's Design Intent documentation and sequences provided with the plans and specifications.
- D. These submittals to the Commissioning Agent do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the contractor; though the Commissioning Agent will review and approve them.

3.4 PERFORMANCE TESTING AND VERIFICATION

- A. Requirements - All systems shall be performance tested and verified to demonstrate that each is operating according to the documented design intent and contract documents. Performance testing facilitating bringing the systems from a state of individual equipment level completion to full dynamic system operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 - 1. Level 1 - The Commissioning Agent will periodically observe and inspect the installation of the building systems and may review project documentation to verify operational requirements meet the ODI.
 - 2. Level 2 - The Commissioning Agent will perform Level 1 activities and review inspection reports, test reports, and project deficiency lists prepared by others to verify operational requirements are met.
 - 3. Level 3 - The Commissioning Agent will perform Level 2 activities and inspect, witness testing, and/or operations of the system to verify operational requirements are met. These activities will be performed independently of the contractor.
 - 4. Level 4 - The Commissioning Agent will perform Level 2 activities and will witness contractor performance testing of the system. Contractor shall test up to 20% of the system to prove operational requirements are met. The test sections shall be chosen at random by the Commissioning Agent to ensure uniformity of the system. Failure of any test section shall require retesting of that section and an additional test section equivalent in scope. Coordination will be required to avoid impact to the construction schedule.
 - 5. Level 5 - The Commissioning Agent will perform Level 2 activities and will witness contractor performance testing of the system. Contractor shall test up to 100% of the system to prove operational requirements are met. Failure of any test section shall require retesting of that section. Coordination will be required to avoid impact to the construction schedule.

- B. Coordination and Scheduling - The contractor shall provide sufficient notice regarding their completion schedule for the pre-functional checklists, startup of all equipment, test and balancing, and controls systems completion to allow the performance verification to be scheduled. The commissioning team shall oversee, witness, and document the performance of all equipment and systems. The Commissioning Agent in association with the contractor/subcontractors and facility staff shall execute the tests. Performance verification testing shall be conducted only after the contractor has documented the systems are complete and operational; meeting contract requirements. The control system shall be sufficiently tested and approved by the Commissioning Agent before it is used and trend data/logs and reports provided to verify performance of all components or systems. The air and water balancing shall be completed before performance testing of air or water related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.
- C. Development of Test Procedures - Before test procedures are finalized; the contractor shall provide the A/E and the Commissioning Agent all requested documentation and a current list of changes affecting equipment or systems; program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical specifications, the Commissioning Agent shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each contractor/subcontractor or vendor, as appropriate, shall provide assistance to the Commissioning Agent in developing the final procedures. Prior to finalization, the A/E shall review and concur with the test procedure.
- D. Test Methods
1. Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The Commissioning Agent may substitute specified methods or require an additional method to be executed other than what was specified, with the approval of the Owner/CM. The Commissioning Agent will determine which method is most appropriate for tests that do not have a specified method.
 2. Simulated Conditions - Simulating conditions shall be allowed; though timing the testing to experience actual conditions is encouraged whenever practical.
 3. Overridden Values - Overriding sensor values to simulate a condition; such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.
 4. Simulated Signals - Using a signal generator which creates a simulated signal to test and calibrate transducers and direct digital control constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overridden values.
 5. Altering Setpoints - Rather than overriding sensor values; and when simulating conditions is difficult, altering Setpoints to test a sequence is acceptable.
 6. Indirect Indicators - Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the test parameters, that the indirect readings through the control system represent actual conditions and responses.
 7. Setup - Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The contractor/subcontractor(s) assisting the Commissioning Agent in executing the

test shall provide all necessary materials, system modifications, etc, to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the contractor/subcontractor(s) shall return all affected equipment and systems to their approved operating settings.

- E. Problem Solving - The burden of responsibility to solve, correct, and retest malfunctions/failures is with the contractor.

3.5 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

- A. Documentation - The Commissioning Agent shall witness and verify/pre-approve the documentation of the results of all functional performance tests.
- B. Non-Conformance
 - 1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Agent. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
 - 2. Cost of retesting a performance test shall be borne by the contractor.
 - 3. The contractor shall submit in writing to the CM at least as often as commissioning meetings are being scheduled. The status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.
 - a. The Commissioning Agent retains the original non-conformance forms until the end of the project.
 - b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the contractor.
- C. Approval - The Commissioning Agent notes each satisfactory demonstrated function on the test form. Final approval of the performance test by the Owner is made after review by the Commissioning Agent.

3.6 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If a test cannot be completed due to the building structure, required occupancy condition, or other deficiency, the functional testing may be delayed upon recommendation of the Commissioning Agent and the approval of the Owner. These tests are conducted in the same manner as the seasonal tests as soon as possible.
- B. Seasonal Testing:
 - 1. Schedule, coordinate, observe, and document additional testing for seasonal variation in operations and control strategies during the opposite season to verify performance of the HVAC system and controls. Complete testing during the warranty period to fully test all sequences of operation.
 - 2. Update O&M manuals and Record Documents (As Built Drawings) as necessary due to the testing.
- C. End-of-Warranty Review: Conduct end of warranty review prior to the end of the warranty period. Review the current building operation with the facility maintenance staff. The review shall include outstanding issues from original or seasonal testing. Interview facility staff to identify concerns they may have with building operation.

Provide suggestions for improvements and assist owner in developing reports or documentation to remedy problems.

1. Update O&M manuals and Record Documents (As Built Drawings) as necessary due to the testing.

3.7 SYSTEMS MANUAL / OPERATIONS AND MAINTENANCE MANUALS / DATA

A. Commissioning Record and O&M Manuals.

1. The Commissioning Agent will prepare a Systems Manual documenting the commissioning process and identifying operational requirements and parameters for future retesting. The systems manual will include:
 - a. O&M manuals prepared by the General Contractor.
 - b. The Commissioning Plan.
 - c. System reports including design narratives and criteria including sequences. Each system shall contain the startup plan and report, approvals, corrections, construction checklists, completed performance tests, trending and analysis, training plan, and recommended recommissioning schedule.
 - d. Final Commissioning Report including an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the Commissioning Agent regarding the adequacy of the equipment, documentation, and training meeting the contract Documents in the following areas: 1) equipment meeting the equipment specifications, 2) equipment installation, 3) performance and efficiency, 4) equipment documentation and design intent, and 5) operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc., shall also be listed. Each non-compliance issue shall be referenced to the specific performance test, inspection, trend log, etc. where the deficiency is documented. The performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, Building Automation System trend logs, data loggers, etc.) and include observations and conclusions from the testing.

3.8 TRAINING OF OWNER PERSONNEL

- A. The contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated through the CM with the Commissioning Agent.
- B. The contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:
 1. Provide to the Commissioning Agent through the CM a training plan sixty (60) days before the planned training covering the following elements:
 - a. Equipment
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Subject covered (description, duration of discussion, special methods, etc.)
 - f. Duration of training on each subject

- g. Instructor for each subject
 - h. Methods (classroom lecture, manufacturer's quality video, site walk-through. actual operational demonstrations, written handouts, etc.)
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
 3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.

END OF SECTION

SECTION 23 00 00 - GENERAL MECHANICAL PROVISIONS

PART 1: GENERAL

1.1 GENERAL CONDITIONS:

- A. The preceding General and Special Conditions and Division 1 requirements shall form a part of this Section with the same force and effect as though repeated here. The provisions of this Section shall apply to all of the Sections of Divisions 22 and 23 of these Specifications and shall be considered a part of these sections.

1.2 CODES AND REGULATIONS:

- A. All work and materials shall be in full accordance with current rules and regulations of all applicable codes. Nothing in these Drawings or Specifications is to be construed to permit work not conforming to these codes. Should the Drawings or Specifications call for material or methods of construction of a higher quality or standard than required by these codes, the Drawings and Specifications shall govern. Applicable codes and regulations include, but are not necessarily limited to, the following:
1. California Code of Regulations (CCR):
 - a. Title 8, Industrial Relations
 - b. Title 24, Part 1, Administrative Regulations
 - c. Title 24, Part 6, California Energy Code, 2019 Edition
 - d. Title 24, Part 11, California Green Building Code, 2019 Edition
 2. California Building Code – CBC - 2019
 3. California Mechanical Code - CMC - 2019
 4. California Plumbing Code - CPC - 2019
 5. California Fire Code - CFC - 2019
 6. California Electrical Code - CEC - 2019
 7. Air Diffusion Council - ADC
 8. American Gas Association - AGA
 9. Air Movement and Control Association - AMCA
 10. American National Standards Institute - ANSI
 11. Air Conditioning and Refrigeration Institute - ARI
 12. American Society of Heating, Refrigerating, and Air Conditioning Engineers - ASHRAE
 13. American Society of Mechanical Engineers - ASME
 14. American Society for Testing and Materials - ASTM
 15. American Water Works Association - AWWA
 16. Cast Iron Soil Pipe Institute - CISPI
 17. National Electrical Manufacturers Association - NEMA
 18. National Fire Protection Association - NFPA
 19. National Sanitation Foundation - NSF
 20. Occupational Safety and Health Act - OSHA
 21. Plumbing and Drainage Institute - PDI
 22. Sheet Metal and Air Conditioning Contractors National Association - SMACNA
 23. Underwriters' Laboratory – UL
 24. International Electrical and Electronics Engineers (IEEE)
 25. ASHRAE 15.1

26. American Institute of Architects (AIA) Master spec.
27. Facilities Operations manual 4200.10
28. Technical Reference for Facilities Operations 4202.02
29. National Board of Pressure Vessel Inspectors.
30. Americans with Disabilities Act of 1990.
31. Local Codes

1.3 PERMITS AND FEES:

- A. The Subcontractor shall take out all permits and arrange for all tests in connection with his work as required. All charges are to be included in the work. Permits for equipment connected to a particular system are to be considered as part of the work included under each system. All charges or fees for service connections, meters, etc. shall be included in the work.

1.4 COORDINATION OF WORK:

- A. Layout of materials, equipment and systems is generally diagrammatic unless specifically dimensioned. Some work may be shown offset for clarity. The actual locations of all materials, piping, ductwork, fixtures, equipment, supports, etc. shall be carefully planned prior to installation of any work in order to avoid all interference with each other, or with structural, electrical, architectural or other elements. Verify the proper voltage and phase of all equipment with the electrical plans. If discrepancies are discovered between drawing and specification requirements, the more stringent requirement shall apply. All conflicts shall be called to the attention of the Architect and the Engineer prior to the installation of any work or the ordering of any equipment. No work shall be prefabricated or installed prior to this coordination. No costs will be allowed to the Subcontractor for any prefabrication or installation performed prior to this coordination.
- B. Mandatory Coordination and Shop Drawings:
 1. Prepare or have prepared high level detailed Shop Drawings in plan view, with cross-sections as necessary, indicating the proposed installation plan for all HVAC, mechanical, fire sprinkler, and plumbing installations for the project. These Drawings should depict actual elevations and linear dimensions, as well as all routing changes, transitions, major offsets, deck and structural attachments deemed necessary to accomplish the installation. Individual Shop Drawings may be prepared for each trade working within the designated space or area; however, the coordination of the consolidated installation shall remain the responsibility of the Contractor. These Shop Drawings shall be provided to each Subcontractor having Work in each area for coordination. Any fittings, offsets or other changes due to coordination shall be at no additional cost to District.
 2. Whereas the Drawings are diagrammatic, showing only the general arrangement of the systems, Contractor shall have responsibility for the fitting of materials and equipment to other parts of the equipment and structure, and to make adjustments as necessary or required to resolve space problems, preserve service room, and avoid architectural and structural elements and the Work of other trades. Contractor may be required to identify certain areas to relocate installations within the spaces depicted on the Drawings, e.g., ductwork and/or piping may be shifted within the space shown to accommodate other systems. Such functional relocations

shall not be deemed a change to the requirements of the Contract. In the event a major re-routing of a system appears necessary, Contractor shall prepare and submit for approval, Shop Drawings of the proposed rearrangement.

3. Because of the diagrammatic nature and small scale of the Drawings, all necessary offsets, adjustments, and transitions required for the complete installation are not shown. Contractor shall carefully investigate the conditions affecting all the Work and shall arrange such Work accordingly, furnishing such fittings, equipment, valves, accessories, etc., as may be required to meet such conditions, at no additional cost to the District.
4. Resolve differences or disputes between subcontractors and materials suppliers concerning coordination, interference, or extent of work between sections. The Contractor's decisions, if consistent with the Contract Documents, shall be final. The Architect and their Consultants are not required to coordinate work between sections and will not do so. Any changes required that affect the design intent shall be presented to and approved by the Architect and Engineer of Record.
5. The coordinated Shop Drawings must be signed off by HVAC, Plumbing, Fire Sprinkler, Electrical, Framing, Ceiling Installation, and Data and Low Voltage Subcontractors.
6. The signed off Shop Drawings shall be submitted to the District's Representative for review and approval prior to commencement of installation.
7. Provide reviewed Shop Drawings to each Subcontractor having Work in each area.

1.5 GUARANTEE:

- A. Guarantee shall be in accordance with the General Conditions. These Specifications may extend the period of the guarantee for certain items. Where such extensions are called for, or where items are normally provided with guarantee periods in excess of that called for in the General Conditions, the certificate of guarantee shall be furnished to the Owner through the Architect/Engineer. Equipment that is started and operated prior to acceptance shall have the guarantee extended to cover that period. Owner guarantee shall start at acceptance.

1.6 QUIETNESS:

- A. Piping, ductwork and equipment shall be arranged and supported so that vibration is a minimum and is not transmitted to the structure.

1.7 DAMAGES BY LEAKS:

- A. The Subcontractor shall be responsible for damages caused by leaks in the temporary or permanent piping systems prior to completion of work and during the period of the guarantee, and for damages caused by disconnected pipes or fittings, and the overflow of equipment prior to completion of the work.

1.8 EXAMINATION OF SITE:

- A. The Subcontractor shall examine the site, compare it with Plans and Specifications, and shall have satisfied himself as to the conditions under which the work is to be

performed. No allowance shall subsequently be made in his behalf for any extra expense to which he may be put due to failure or neglect on his part to make such an examination.

1.9 COMPATIBILITY WITH EXISTING SYSTEMS:

- A. Any work which is done as an addition, expansion or remodel of an existing system shall be compatible with that system.

1.10 MATERIALS AND EQUIPMENT:

- A. Materials and equipment shall be new unless otherwise noted. Materials and equipment of a given type shall be by the same manufacturer. Materials and equipment shall be free of dents, scratches, marks, shipping tags and all defacing features at time of project acceptance. Materials and equipment shall be covered or otherwise protected during construction as required to maintain the material and equipment in new factory condition until project acceptance.

1.11 SUBMITTALS:

- A. Shop Drawings: Within 30 days of contract award, the Subcontractor shall submit six copies of shop drawings for all materials, equipment, etc. proposed for use on this project (this includes deferred approval items). Material or equipment shall not be ordered or installed until written review is processed by the Engineer. Any item omitted from the submittal shall be provided as specified without substitution.

All shop drawings must comply with the following:

1. Shop drawings are required for all material and equipment items and shall include manufacturer's name and catalog numbers, dimensions, capacities, performance curves, and all other characteristics and accessories as listed in the specifications or on the drawings. Descriptive literature shall be current factory brochures and submittal sheets. Capacities shall be certified by the factory. FAX submittals are not acceptable.
2. All shop drawings shall be submitted at one time in a neat and orderly fashion in a suitable binder with title sheet including Project, Engineer and Subcontractor, table of contents, and indexed tabs dividing each group of materials or item of equipment. All items shall be identified by the specification paragraph number for which they are proposed. All equipment shall also be identified by the mark number as indicated on drawings.
3. All capacities, characteristics, and accessories called for in the specifications or on the drawings shall be high-lighted, arrowed, circled or underlined on the shop drawings. Calculations and other detailed data indicating how the item was selected shall be included for items that are not scheduled. Data must be complete enough to permit detailed comparison of every significant characteristic which is specified, scheduled or detailed.
4. Electronic Submittals: Where allowed by Division 01, electronic submittals are acceptable providing the following requirements are met. Electronic submittals which do not comply with these requirements will be rejected.
 - a. Submittal shall be a single file in PDF format, with bookmarks for table of contents and each tab, and sub-bookmarks for each item.
 - b. All text shall be searchable (except text that is part of a graphic).

- c. Submittal shall include all items noted in 1 through 3 above, except a binder is not required.
 - d. Electronic submittals shall be processed through normal channels. Do not submit directly to the Engineer unless the Engineer is the prime consultant for the project.
 - e. Contractor shall provide Owner and Owner's Representative with hard copies of the final submittal. Coordinate exact number required with Owner through Architect/Engineer.
- B. Substitutions: Manufacturers and model numbers listed in the specifications or on the drawings represent the standard of quality and features desired (where equipment is scheduled on the drawings, any equipment submitted other than scheduled equipment is considered a substitution). Unless otherwise noted, alternate manufacturers may be submitted for review by the Engineer. Calculations and other detailed data indicating how the item was selected shall be included. The Subcontractor shall assume full responsibility that substituted items or procedures will meet the specifications and job requirements and shall be responsible for the cost of redesign and modifications to the work caused by these items. At the Engineer's request, furnish locations where equipment similar to the substituted equipment is installed and operating along with the user's phone numbers and contact person. Satisfactory operation and service history will be considered in the acceptance or rejection of the proposed substitution.
- C. Review: Submittals will be reviewed for general conformance with the design concept, but this review does not guarantee quantity shown, nor does it supersede the responsibility of the Subcontractor to provide all materials, equipment and installation in accordance with the drawings and specifications. The Subcontractor shall agree that shop drawing submittals processed by the Engineer are not Change Orders; that the purpose of shop drawing submittals by the Subcontractor is to demonstrate to the Engineer that the Subcontractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. The Subcontractor shall agree that if deviations, discrepancies or conflicts between shop drawings and design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed. If a resubmittal is required, submit a complete copy of the Engineer's review letter requiring such with the resubmittal.

1.12 MANUFACTURER'S RECOMMENDATIONS:

- A. All material, equipment, devices, etc., shall be installed in accordance with the recommendations of the manufacturer of the particular item. The Subcontractor shall be responsible for all installations contrary to the manufacturer's recommendations. The Subcontractor shall make all necessary changes and revisions to achieve such compliance. Manufacturer's installation instructions shall be delivered to and maintained at the job site through the construction of the project.

1.13 SCHEDULING OF WORK:

- A. All work shall be scheduled subject to the review of the Architect, Engineer and the Owner. No work shall interfere with the operation of the existing facilities on or

adjacent to the site. The Subcontractor shall have at all times, as conditions permit, a sufficient force of workmen and quantity of materials to install the work contracted for as rapidly as possible consistent with good work, and shall cause no delay to other Subcontractors engaged upon this project or to the Owner.

1.14 OPENINGS, CUTTING AND PATCHING:

- A. The locations and dimensions for openings through walls, floors, ceilings, foundations, footings, etc. required to accomplish the work under this Specification Division shall be provided under this Division. The actual openings, coring through existing concrete or masonry walls, floors, ceilings, foundations, footings, etc., and saw cutting of concrete floors or asphaltic concrete required to accomplish the work under this Specification Division shall be provided under this Division. Patch these surfaces to match existing. Cutting or coring shall not impair the strength of the structure. Any damage resulting from this work shall be repaired at the Subcontractor's expense to the satisfaction of the Architect.

1.15 ACCESS DOORS:

- A. Provide access doors as required where equipment, piping, valves, ductwork, etc. are not otherwise accessible. Access doors shall match the wall or ceiling finish and fire rating as indicated on the Architectural drawings. 16-gage steel frame and 14-gage steel door with paintable finish, except in ceramic tile, where door shall be 16-gage stainless steel with satin finish. Continuous hinge. Key and cylinder lock (except quick-opening type for Emergency Gas Shutoff Valve). Deliver doors to the appropriate subcontractor for installation. Milcor. Unless otherwise noted, the minimum sizes shall be as follows:

1 valve up to 1-1/2"	12" x 12"
1 valve up to 3"	16" x 16"

1.16 HOUSEKEEPING PAD:

- A. Housekeeping pads shall be 6" high concrete, 3000 PSI strength, unless otherwise noted. Pad shall extend 6" beyond the largest dimensions of the equipment, unless otherwise noted. The top edge of the pad shall have a 3/4" chamfer. The pad shall have #4 reinforcing bars at 12" on center, each way, located at the mid-depth of the pad. If not poured at the same time as the floor slab with pad rebar tied to floor rebar, the pad shall be anchored as follows: Drill 1" diameter, 4" deep hole in floor. Fill hole with "Por-Rok", then insert 8" long, #4 rebar into hole. Provide a minimum of 4 of these anchors per pad, but no more than 4 feet apart in either direction. Anchor points shall be 12" from the edge of the pad.

1.17 CONCRETE ANCHORS:

- A. Steel bolt with expansion anchor requiring a drilled hole - powder driven anchors, adhesive anchors and concrete screws are not acceptable. Re-use of screw anchor holes shall not be permitted. Minimum concrete embedment shall be 4-1/2 diameters. Minimum spacing shall be 12 diameters center to center and 6 diameters center to edge of concrete. Post-installed anchors in concrete used for component anchorage shall be pre-qualified for seismic application in accordance with ACI 355.2 and ICC-ES AC193. Post-installed anchors in masonry used for component

anchorage shall be pre-qualified for seismic applications in accordance with ICC-ES AC01. Maximum allowable loads for tension and shear shall be as determined by Calculation in compliance with ACI 318-14, Chapter 17, and the anchor's ICC or IAPMO evaluation report. Hilti, Powers, Red Head.

1.18 EQUIPMENT ANCHORING:

- A. All equipment shall be securely anchored in accordance with ASCE 07-16, Chapter 13, as amended by CBC Section 1617A.1. All equipment mounted on concrete shall be secured with a concrete anchor as shown on drawings at each mounting point.

1.19 SEISMIC SUPPORT AND RESTRAINT DESIGN SERVICE:

- A. All mechanical systems (equipment, ductwork, piping, etc.) shall be provided with supports and seismic restraints in accordance with the "Seismic Restraint Components for Suspended Utilities", 2020 Edition, as published by Mason West Inc., OPM-0043-13, or other OSHPD pre-approved system, and in accordance with ASCE 07-16, Chapter 13, as amended by CBC Section 1617A.1. Brace spacing shall be reduced by 50% for cast iron, plastic, no-hub, or other non-ductile piping. A copy of this manual shall be kept on site at all times during construction.
- B. Contractor shall obtain the services of a Seismic Design service to provide engineered seismic supports and restraints for the project. Mason Industries, or pre-approved equal. **Note: Use of the "12 inch rule" does not exempt Contractor from this requirement.**
 - 1. All seismic designs, including designs using OSHPD pre-approvals, shall be submitted as project specific engineered designs sealed and signed by a licensed California structural engineer. All seismic designs shall include project / application specific seismic design demand calculations. Said seismic design demand calculations shall account for seismic forces in all applicable direction including axial, lateral, vertical tension, vertical compression, etc. Designs shall account for prying, eccentricity, uneven loading, weak axis bending, etc.
 - 2. Seismic restraint layouts for piping, ductwork and electrical raceways shall be furnished on shop drawings or added to the contractor's shop drawings and shall include:
 - a. The number, size and location of seismic braces.
 - b. Maximum support loads and seismic loads at the seismic brace locations.
 - c. Reference to specific details or pages from the OSHPD pre-approved system (OPM).
 - d. **If use of the "12 inch rule" is intended by Contractor, design service shall verify locations where it is intended to be used is feasible and specifically identify these locations on the shop drawings, along with appropriate hanger details.**
 - 3. Installations not addressed by the OPM approval must be designed, detailed and submitted along with the shop drawings.
 - 4. Submit seismic restraint layout drawings and special details for approval of the project structural engineer per the requirements listed in the OSHPD pre-approval (OPM).

5. Seismic restraint layout drawings shall bear the stamp and signature of the registered professional structural engineer licensed in the state of California who designed the layout of the braces.

1.20 ASBESTOS CONTAINING MATERIALS AND ASBESTOS REMOVAL:

- A. No materials or material coatings containing asbestos shall be allowed on this project.
- B. All asbestos removal shall be by Owner. Asbestos is to be removed before the work is started. If the Subcontractor discovers asbestos which has not been removed, the Subcontractor shall immediately cease work in that area and promptly notify the Owner. Where the removal of asbestos shingles is necessary, the Subcontractor shall advise the Owner regarding the location and quantity of shingles to be removed.

1.21 SYSTEM IDENTIFICATION:

- A. Above Grade Piping: Provide markers on piping which is either exposed or concealed in accessible spaces. For piping systems, other than drain and vent lines, indicate the fluid conveyed or its abbreviation, either by pre-printed markers or stenciled marking, and include arrows to show direction of flow. Pre-printed markers shall be the type that wrap completely around the pipe, requiring no other means of fastening such as tape, adhesive, etc. Comply with ANSI A13.1, ASME and ANSI for colors. Locate markers at ends of lines, near major branches and other interruptions including equipment in the line, where lines pass through floors, walls or ceilings or otherwise pass into inaccessible spaces, and at 50' maximum intervals along exposed portions of lines. Marking of short branches and repetitive branches for equipment connections is not required.
- B. Below Grade Piping: Bury a continuous, pre-printed, bright-colored, metallic ribbon marker capable of being located with a metal detector with each underground pipe. Locate directly over buried pipe, 6" to 8" below finished grade.
- C. Equipment: All equipment shall be identified with a plastic laminated, engraved nameplate which bears the unit mark number as indicated on the drawings (e.g. AC-4) and identifies the area or space served by the equipment. Provide 1/2" high lettering - white on black background. Nameplates shall be permanently secured to the exterior of the unit.
- D. Valves: Provide stamped brass valve tags with brass hooks or chains on all valves of each piping system, excluding check valves, valves within equipment, faucets, stops and shut-off valves at fixtures and other repetitive terminal units. Prepare and submit a tagged-valve schedule, listing each valve by tag number, location, pressure rating and piping service. Deliver to Owner through Architect.

1.22 CLEANING:

- A. Progressively and at completion of the job, the Subcontractor shall thoroughly clean all of his work, removing all debris, stain and marks resulting from his work. This includes but is not limited to building surfaces, piping, equipment and ductwork,

inside and out. Surfaces shall be free of dirt, grease, labels, tags, tape, rust, and all foreign material.

- B. At the end of each work day, the Subcontractor shall cover all open ends of piping and ductwork with protective plastic.

1.23 ACCEPTANCE TESTING:

- A. The Subcontractor shall perform, document and submit all acceptance testing as required by California Code of Regulations, Title 24, and as noted on the Certificate of Compliance form (MECH-1C), where applicable. Submit a copy of the documentation to the Engineer for review (hardcopy or electronic), prior to submitting to Administrative Authority.

1.24 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Printed: Three copies of Operation and Maintenance Instructions and Wiring Diagrams for all equipment and parts list for all faucets, trim, valves, etc. shall be submitted to the Engineer. All instructions shall be clearly identified by marking them with the same designation as the equipment item to which they apply (e.g. AC-3). All Wiring Diagrams shall agree with reviewed Shop Drawings and indicate the exact field installation. All instructions shall be submitted at the same time and shall be bound in a suitable binder with tabs dividing each type of equipment (e.g. Pumps, Fans, Motors, etc.). Each binder shall be labeled indicating "Operating and Maintenance Instructions, Project Title, Subcontractor, Date" and shall have a Table of Contents listing all items included.
- B. Verbal: The Subcontractor shall verbally instruct the Owner's maintenance staff in the operation and maintenance of all equipment and systems. The controls subcontractor shall present that portion of the instructions that apply to the control system. The Engineer's office shall be notified 48 hours prior to this meeting.

1.25 RECORD DRAWINGS:

- A. The Subcontractor shall obtain one set of blue line prints for the project, upon which a record of all construction changes shall be made. As the work progresses, the Subcontractor shall maintain a record of all deviations in the work from that indicated on the drawings. Final location of all underground work shall be recorded by depth from finished grade and by offset distance from permanent surface structures, i.e. building, curbs, walks. In addition, the water, gas, sewer, underfloor duct, etc. within the building shall be recorded by offset distances from building walls. The original drawings will be made available to the Subcontractor from which he shall have a set of reproducible drawings made. The Subcontractor shall then transfer the changes, notations, etc. from the marked-up prints to the reproducible drawings. The record drawings (marked-up prints and reproducibles) shall be submitted to the Engineer for review.

PART 2: PRODUCTS (not used)

PART 3: EXECUTION (not used)

END OF SECTION

SECTION 23 09 23 - BUILDING AUTOMATION SYSTEMS (BAS)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The intent of this document is to describe a system that is complete in every respect without further cost to the Owner. Anything not shown on the drawings or indicated in the specifications, and required for complete operating systems, shall be included as part of this Work. This will also include all connections to new services.
- B. All parts of the plans and specifications fully apply when applicable to work of this Division. No attempt has been made to divide the work between the various trades or subcontractors.
- C. OPERATION: The entire Building Automation System (BAS) shall be comprised of a network of interoperable, stand-alone digital controls communicating on the Niagara N4 open protocol communication network to a host computer communicating via the internet to the FUSD host computer. The BAS shall communicate to third party systems such as chillers, boilers, air handling systems, energy metering systems, other energy management systems, access control systems, fire-life safety systems and other building management related devices with open, inter operable communication capabilities.
- D. Work specified by others:
 - 1. HVAC Subcontractor:
 - a. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 - b. Access doors where required.
 - c. Installation of impression wells and pressure taps.
 - d. Installation of flow switches.
 - e. Installation of automatic control valves.
 - f. Installation of pressure taps and associated shut-off cocks. Pete's plugs shall be installed next to each temperature and pressure sensor.
 - 2. Electrical Subcontractor:
 - a. Electrical work shall, in general, comply with the following:
 - 1) Electrical work may include both line-voltage and low-voltage wiring, as required.
 - 2) All electrical work shall comply with the latest California Electrical Code and local electrical codes.
 - 3) All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
 - 4) All magnetic starters for mechanical equipment shall be furnished with integral 120V control transformers, sized to handle the additional VA needed for the controls - pilots, EP valves, etc. All motor starters to be NEMA rated; no IEC rated starters.
 - 5) The motor starter supplier shall provide auxiliary contacts as required for interlock by BAS Contractor; the supplier shall estimate an allowance of at least one auxiliary contact per starter. All interlock and control wiring shown on the electrical prints is by the electrical subcontractor.

1.2 QUALITY ASSURANCE

- A. Minimum Contractor Qualifications:
1. BAS Contractor; programs software and ensures network compatibility with all hardware as specified within, and the following requirements:
 - a. Hold a Niagara N4 Framework Certification for at least two years, obtained from a Tridium certified training facility, no exceptions.
 - b. Shall have installed a minimum of three functioning networked systems.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.
 2. Controls Contractor: Installs all hardware controls as specified within, and the following requirements:
 - a. A minimum of three installed and operational Building Automation Systems (BAS) with the Niagara N4 Framework within the last five years.
 - b. A minimum of five years' experience in servicing a networked BAS.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.
- B. Response Requirements: The BAS Contractor shall provide a 24-hour emergency response service with a dedicated telephone number. The BAS contractor shall guarantee a 2-hour maximum response time by a Niagara N4 certified service technician. Fresno Unified reserves the right to obtain services and repairs from any BAS company when the 2-hour response time has been exceeded. The BAS contractor agrees by submittal of his/her bid to pay a late penalty to the District at a rate of \$75 per every half-hour interval exceeding the 2-hour response limit. The District reserves the right to implement a late penalty on a call-by-call basis, depending on the nature of the emergency service call, at the District's discretion.
- C. Accountability: The District intends to document all service calls to ensure service provided has met the District's expectations as specified. Substandard service or conduct may result in the District certifying the Contractor as non-responsive and potentially eliminate the Contractor from bidding on future projects. During the warranty period, if the BAS is not fully functional and requires a service call, the District shall not be limited by any exclusivity arrangement between the BAS or Controls Contractor at any time.

1.3 CODES, STANDARDS, ORDINANCES AND REGULATIONS

- A. All work and materials shall be in full accordance with the latest rules and regulations of applicable codes as amended and adopted by any governmental agency which has jurisdiction over this work. Nothing in these Plans or Specifications is to be construed to permit work not conforming to these codes. Should the Plans or Specifications call for material, methods, or construction of a higher quality or standard than required by the above rules, the higher quality shall govern.

1. When not contradicting the above, the manufacturers' recommendations along with applicable parts of the following documents shall be the basis for quality and technique of installation.
 - a. Title 24, California Administrative Code, all parts.
 - b. Applicable publications of the National Fire Protection Association (NFPA), and the National Electrical Code (NEC).
 - c. Applicable publications of the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).

1.4 SITE CONDITIONS AND LOCATIONS

- A. The general location and arrangement of system hardware is shown on the drawings. Information on the drawings relative to existing services is approximate only. Minor adjustments required to conform to actual locations shall be made without additional cost to Owner. The Controls Contractor shall, as work progresses, verify the dimensions of the spaces available for the installation of the work and he shall assume full responsibility for the proper locations of each portion thereof.
- B. The construction documents are generally diagrammatic and the locations indicated may be approximate only. They do not show every offset, bend, or elbow required for installation in the space provided. The Controls Contractor, therefore, shall install all equipment, conduit runs and the like as follows:
 1. Adhere to the location indicated as near as possible.
 2. Maintain ample head room and access in all passageways, clearance around all equipment and under conduit runs for unrestricted passage and for easy servicing of all apparatus, equipment, devices and the like.
 3. Provide access for maintenance of all equipment.

1.5 SUBMITTALS

- A. Control Submittal: Within 30 calendar days after award of the contract, and before any materials of this Section are delivered to the job site, submit:
 1. The BAS Contractor shall submit .caf files for each device, and a description of operation and schematic drawings of the System to the Architect/Engineer/Owner for approval before starting work on-site. At least two sets of submittals shall be sent through channels.
 2. Product data submittals must be complete and in a single bound document for all items supplied in this Division. Each document shall be bound with an index and marked with the equipment identification as specified in the Plans and Specifications.
 3. Provide complete control shop drawing including equipment, control devices, point to point connections with terminal numbers, and any details necessary for a complete control drawing.
 4. List of name plates to be engraved, showing each name plate wording and location.

1.6 REMOVAL AND SALVAGE

- A. Pre-Demolition conference: Contractor shall schedule a walk-through meeting with Energy Management Department to conduct an inventory on items to be removed and salvaged from the existing building under construction.

- B. Inventory List: The Contractor shall complete and submit an inventory list of items that have been removed and salvaged to the Energy Management Department and store items in a cool dry and protected area.
- C. Delivery: Delivery of the salvaged items shall be determined by the Energy Management Department and the Contractor.
- D. Remove and Reinstall: Detach items from existing location and store them for re-installation in a strategic area of operation to be determined.
 - 1. Identify areas of occupancy to remain in-use and functional.
 - 2. If existing BAS is required to be removed, relocated, or abandoned, before proceeding with the demolition provide temporary power and communication that bypasses the area of demolition and that maintains the continuity of the BAS to other occupied parts of the site or building construction.
- E. Schedule of Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure on-site operations of the occupied areas of the BAS are not interrupted.
 - 2. If there is to be an interruption in the operation of the existing BAS, Contractor shall notify Architect & District Project Manager and indicate how long the services will be interrupted in writing.

1.7 CLOSE-OUT DOCUMENTS

- A. Record Documents:
 - 1. At completion of project, BAS Contractor shall provide to the Architect/Engineer all As-Built drawings, communications and controller map, wiring diagrams, equipment specifications, Operations and Maintenance Manuals and other documentation as required to describe the system. At least two sets of operations and maintenance manuals with “as-built” drawings, parts lists, etc. shall be provided at job completion.
 - a. Hard copies shall be stamped with “Record Drawings”.
 - b. Provide all Record Documents on a cloud-based drive or physical drive; including pdf files and CAD files using AutoCAD 2008 or latest version.
 - 2. During progress of the work, maintain an accurate record of all changes made in the systems from those shown on the drawings, specifications and submittals.
 - 3. Revise Shop Drawings and provide on reproducible media and in DWG format compatible Windows operating systems and AutoCAD 2008 or latest version.
- B. Communications and Controller Map: To include the following;
 - 1. A detailed communication routing map showing entering and exiting locations
 - 2. A detailed list of controller locations by room number and location.
 - 3. Permanently attach the communication routing map and controller locations inside the NAC control panel.
- C. Operations and Maintenance Manuals: Upon completion of the work, a complete bound book containing the following information shall be submitted to the Architect/ Engineer:

1. Complete catalog and performance data on all control devices, including all documents included in submittals.
2. Complete manufacturers' operating and maintenance instructions on all control devices.
3. Complete wiring and control diagrams for all equipment and systems, including list of materials, description of operation and system flow diagrams.
4. Manufacturers' warranty certificates on all equipment.
5. Contractor's warranty letter.

1.8 GUARANTEE

- A. The Contractor shall warrant in writing all work performed under this contract for a period of two years from the date of notice of completion.
- B. When notified of a system failure relating to the work performed under this contract, the Contractor will be responsible for all investigation, diagnoses, repair, revision or replacement necessary to correct the condition.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT DESCRIPTION

- A. The Building Automation System (BAS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. System shall be Johnson Controls FX-80 Web based front end with Johnson Controls devices and controllers. BACnet, N4 must reside in controller and Open licensing shall be included in each FX-80 device. Programming of the FX-80 and creating all required dynamic graphics shall be included in this section.
- B. The BAS shall consist of the following:
 1. Local Display Devices – PC Touchscreen.
 2. Portable Operator Terminals – Laptop with required software installed.
 3. Distributed User Interfaces.
 4. Network processing, data storage and communications equipment.
 5. DC Controllers (HVAC etc).
 6. Other components required for a complete and working BAS.
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices. Controllers shall be provided a 10% spare point capacity for all necessary applications.
- D. System architectural design shall eliminate dependence upon any single device for alarm generation and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Acceptable Systems:
 1. Facility Explorer by Johnson Controls is the District Standard using the BACnet MSTP protocol to integrate into the District's existing server (JCI).
 2. No substitutions allowed.

2.2 CONDUIT AND WIRING

- A. Control Contractor shall provide and install all low voltage conduit and wiring for DDC system as required for a complete and operating system. Conduit and wiring shall conform to Division 16 requirements.
- B. Wiring:
1. BACnet communications cable shall be Connect Air: W223C-2144FCBJC 22-3C (Blue Jacketed). Install per manufacturer's recommendations. No splices, Tee's, or cuts of any kind will be allowed. Identify both ends at terminal blocks, field devices, and sensors. All wiring that is routed below grade shall be W221P-1003PE (Outdoor Polyethylene BACnet-Black).
 - a. Communication Loop and sensors must be run in separate conduits and junction boxes.
 - b. The outside air sensor must be brought into the NAC I/O at all times.
An outside air sensor brought into a controller is not acceptable.
 2. Sensor wire shall be: Connectair Part # W181P-2040PRB 18-2 (Purple).
 3. Analog Output shall be: W184C2059PINK 18-4 (Pink).
 4. Thermostat wire shall be Connect Air: W224C-2020WHT 22-4C (White Jacketed).
 5. Cable routed in accessible ceiling spaces shall comply with EIA/TIA standards for communications cabling. Communication bus wire shall be W223C-2144FCBJC 22 3C (Blue Jacketed) Connect Air, blue jacketed shielded cable.
- C. Conduit: Conduit shall be minimum 1 inch diameter except that minimum conduit size for 120 volt power shall be 3/4-inch. For underground conduit, provide 100% spare capacity by installing a second conduit (empty) along all conduit routes. All conduits shall be sized as follows: Size per the CEC (NEC with California Amendments) and then oversize by one size. All conduits shall be RGSC (Rigid galvanized steel conduit) only. All fittings shall be steel/not malleable or aluminum.

2.3 BAS ARCHITECTURE

- A. Automation Network
1. The automation network shall be configured as a Client/Server network with a web server operating on the Clients LAN/WAN. The web browser interface is extended over the LAN/ WAN. Monitoring and control of the BAS is available using the web browser interface.
 2. The automation network shall include the option of a PC industry standard of Ethernet TCP/IP.
Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
 3. The BAS shall network multiple user interface clients, system controllers and systems supervisors(s) as required for systems operation.
 4. The automation network option shall be capable of operating at a communication speed of at least 100 Mbps or more.
 5. The automation network option will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the

enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network:

1. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 to 76,800baud.
2. Digital Controllers shall reside on the control network via BACnet MSTP.

C. Integration:

1. Hardwired
 - a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - b. There will be one separate physical point on each system for each point to be integrated between the systems.
2. Direct Protocol (Integrator Panel)
 - a. The BAS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS system and 3rd party manufacturers' control panels. The BAS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, and power monitoring system.
 - b. All data required by the application shall be mapped into the BAS system, and shall be transparent to the operator.
 - c. Point inputs and outputs from the controllers shall have real-time interoperability with BAS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

2.4 USER INTERFACE

A. Browser Based Interface

1. The system shall be capable of supporting an unlimited number of clients using standard Web browser such as Internet Explorer™, Google Chrome and Mozilla Firefox. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the Building Automation System (BAS), shall not be acceptable.
3. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, notice of access failure shall be displayed. Security using authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

- c. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - d. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - e. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules and setpoints in a graphical manner.
 - 2) Commands binary objects to start and stop.
 - 3) View logs and charts.
 - 4) View alarms.
 - f. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.
4. Alarms
- a. Alarm feature shall allow user configuration of criteria to create, route, and manage alarms and events. It shall be possible for specific alarms from specific points to be routed to specific alarm recipients. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - 1) Allow configuration to generate alarms on any numeric, binary, or data point in the system.
 - 2) Generate alarm records that contain a minimum of a timestamp, original state, acknowledged state, alarm class and priority.
 - 3) Allow the establishment of alarm classes that provide the routing of alarms with similar characteristics to common recipients.
 - 4) Allow a user, with the appropriate security level, to manage alarms - including sorting, acknowledging, and tagging alarms.
5. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - 1) All points in the BAS
 - 2) All points in each BAS application
 - 3) All points in a specific controller
 - 4) All points in a user-defined group of points
 - 5) All points currently in alarm
 - 6) All BAS schedules
 - 7) All user defined and adjustable variables, schedules, interlocks and the like.
 - b. Reports shall be exportable to .pdf, .txt, or .csv formats.
 - c. The system shall allow for the creation of custom reports and queries.
6. Schedules
- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Regular schedules
 - 2) Repeating schedules

- 3) Exception schedules
 - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
 - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars.
 - d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days. Holidays and special days shall be user-selected with the pointing device or keyboard.
7. Password
- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, Based on an assigned password.
 - b. Each user shall have the following: a user name, a password, and access levels.
 - c. The system shall provide the capability to require a password of minimum length and require a combination of characters and numerical or special characters.
 - d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - e. The system shall provide unlimited flexibility with access rights. A minimum of four levels of access shall be provided along with the ability to customize the system to provide additional levels.
 - f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user.
 - i. All log data shall be available in .pdf, .txt, and .csv formats.
8. Historical Data Collection
- a. All numeric, binary or data points in the system database shall allow their values to be logged over time (trend log). Each historical record shall include the point's name, a time stamp including time zone, and the point's value.
 - b. The Network Area Controller (NAC) shall have the ability to store its historical data records locally and periodically to a remote server on the network (archiving).
 - c. The configuration of the historical data collection shall allow for recording data based on change of value or on a user-defined time interval.
 - d. The configuration of the historical data collection shall allow for the collection process to stop or rollover when capacity has been reached.
 - e. A historical data viewing utility shall be provided with access to all history records. This utility shall allow historical data to be viewed in a table or chart format.
 - f. The history data table view shall allow the user to hide/show columns and to filter data based on time and date. The history data table shall allow exporting to .txt, .csv, or .pdf file formats.
 - g. The historical data chart view shall allow different point histories to be displayed simultaneously, and also provide panning and zooming capabilities.

9. Audit Log
 - a. For each log entry, provide the following data:
 - 1) Time and date.
 - 2) User ID
 - 3) Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
10. Database Backup and Storage
 - a. The user shall have the ability to back up the System Controller databases.

2.5 AUTOMATION NETWORK

A. Network Server (NIC)

1. F.U.S.D. District N4 server is existing, BAS Contractor shall have the responsibility of bringing the firmware to current revisions. Any structures on the site with existing BAS that require this to match shall also be included in this project.
2. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.
 - a. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - b. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
 - c. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
 - d. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 - e. The server provides central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
 - 1) Routing of alarms to display, printer, email and email compatible pagers
 - 2) View and acknowledge of alarms
 - 3) Query alarm logs based on user-defined parameters
 - f. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs.

B. Network Area Controller (NAC) or JACE

1. The NAC must provide the following hardware features as a minimum:
 - a. Communications
 - 1) One 10/100 Mb Ethernet Port – RJ-45 connection
 - 2) Digital controllers that are hardwired shall reside on the BACnet MSTP control network.

- 3) Two RS-485 ports (up to 57,600 baud) shall be standard. Gateways or non-Johnson drivers not allowed.
 - 4) All required protocol drivers are included. BACnet, Modbus and N4 shall be resident as standard without additional costs, additional hardware External gateways shall not be acceptable.
 - b. Inputs/Outputs
 - 1) Four form C SPDT relay outputs rated for 24 VAC/DC @ 2Amps resistive each with individual LED indicators
 - 2) Six Universal Inputs for 10K NYC, 4-20 mA, 1-10 V, Dry contact
 - 3) Additional I/O modules shall be allowed if needed
 - c. Battery Backup
 - 1) Battery backup provided for all on board functions including I/O
 - 2) Battery is monitored and trickle charged
 - 3) Battery maintains processor operation through power failures for a pre-determined interval, and then writes all data to flash memory, shuts the processor down, and maintains the clock for five years.
 - d. Environment
 - 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 150°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.
 - e. Device License
 - 1) FX80 shall be licensed for 100 devices with a one year Software Maintenance Agreement (SMA).
 2. The Network Area Controller (NAC) shall be a fully user-programmable device capable of providing all of the capability described in Section 2.3 Part A.
 3. Automation network – The Network Area Controller (NAC) shall reside on the automation network. Each NAC shall support one or more sub-networks of controllers.
 4. User Interface – Each Network Area Controller (NAC) shall have the ability to deliver a web based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 5. Power Failure – In the event of the loss of normal power, The Network Area Controller (NAC) shall continue to operate for a defined period after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.
 - a. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
 - b. Certification – All controllers shall be listed by Underwriters Laboratories (UL).
- C. Application Specific Controllers (ACS's)
1. The ASC devices must provide the following hardware features as a minimum:
 - a. Communications:

- 1) General and expansion controllers, and sensors by Johnson controls, shall be installed where specified and shown on portable classroom installations.
 - 2) BACnet/IP MS/TP Router to be used in area as needed.
- b. Environment:
- 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 158°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.

2.6 SOFTWARE PROGRAMMING/TOOLS

A. Network Area Controller Toolset

1. Device embedded toolset shall provide the following capabilities in a graphical environment using a standard Web browser:
 - a. Device and point management
 - b. Scheduling, alarming and trending setup
 - c. Creation and binding of graphics
 - d. Time management
 - e. User management
2. Toolset provides additional engineering capabilities including:
 - a. Editable table based point listings.
 - b. Automatically generated graphics for standard applications.

B. Device Program Editor

1. Definition of application and logic and display operation shall be available in a completely graphic environment.
2. Definition of operator device characteristics, Digital Controllers (DC) panels, individual points, applications, and control sequences shall be performed in a drag and drop programming environment.
3. All temperature and equipment control strategies, energy management routines, scheduled operations and local device status indicators shall be definable by the operator. User password access and language options shall be definable by the operator.
4. Event definition, prioritization, logging and reporting options are definable by the operator.
5. Application logic shall provide for stand-alone applications as well as distributed applications that are automatically downloaded from master controllers to a network of controllers.
6. The programming environment shall provide help menus and instructions for each operation and/or application performed, for all programming library functions, and for the programming language itself.
7. Libraries of standard application modules shall be provided, such as temperature, humidity, and flow control. These modules may be used as “building blocks” in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences.

2.7 LOCAL CONTROL PANELS

- A. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control components shall be UL inspected and listed. Control panels shall be fully enclosed, with sub-panel, hinged door, and slotted flush latch. Control panels shall exist on all equipment specified and shall be UL listed as a complete fabricated system. UL listings shall be shown on final drawings.
- B. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- C. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- D. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- E. All wiring shall be neatly installed in plastic trays or tie-wrapped.
- F. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

PART 3 - EXECUTION

3.1 PREPARATIONS

- A. Prior to Installation: Inspect the installed work executed under other Sections which affect the installation of the controls. Report unacceptable conditions to the Engineer. Do not begin work until unacceptable conditions have been corrected. Installation of the controls shall constitute acceptance of existing conditions.
- B. Coordination: Coordinate work with work specified under other Sections to ensure proper and adequate interface of work. Equipment and systems drawings are generally diagrammatic unless dimensions are indicated. Drawings and details shall be checked for interference's with structural and other conditions prior to performing work.
- C. The Contractor shall be responsible for safety and good condition of his materials and equipment until final acceptance by the Owner. He shall erect and maintain suitable barriers, protective devices, lights and warning signs where required.

3.2 INSTALLATION

- A. General:
 1. When applicable installation procedures are shown or specified in other sections, those procedures shall be followed.
 2. Provide all supports and hangers, etc., as required to install the equipment as specified or shown on the drawings. All equipment shall be supported, braced and cross-braced to comply with current CBC and CMC.

3. Sealing: Wherever any part of the control system has to pierce the roofing, openings through the roof shall be flashed absolutely watertight.
4. Arrange and support piping and equipment so that vibration is at a minimum and is not transmitted to or through building structure.

3.3 CONDUIT AND WIRING

- A. Control wiring and conduit shall be the responsibility of this section and be installed as follows:
 1. In equipment rooms/attics – Conductors shall be run in conduit. Final connection to equipment shall be flexible conduit.
 2. Concealed in new building construction (wall/inaccessible ceilings) - Conductors shall be run in conduit.
 3. Roof mounted/exterior equipment yards - Conductors shall be in conduit. All flexible conduit shall be seal-tite with weatherproof connections. Equipment on grade and detached from the building a distance greater than 36" shall have underground control conduit routed to equipment.
 4. Above accessible ceiling spaces - Control cable will be allowed to be installed without conduit in accessible areas above ceilings as follows:
 - a. Plenum rated cable is an approved type for the application.
 - b. Cable is bundled/organized in management devices routed square with building lines (no diagonals) and kept clear of electrical devices (i.e., ballasts, transformers, etc.) that could cause interference.
 - c. Conduit sleeves are provided between accessible ceiling spaces (i.e., across soffits, gypboard ceilings, etc.) as required to maintain future access to cable.

3.4 CONTROL PANELS AND DEVICE LOCATIONS

- A. All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed UL listed control panels with hinged locking doors. All control devices equipment located in exposed areas subject to outside weather conditions shall be mounted inside weatherproof enclosures.
- B. Location of each panel is to be convenient for adjustment and service. Submit locations of all panels to the engineer with shop drawings.

3.5 IDENTIFICATION

- A. The label wording shall match that used on the drawings and provide clearly readable printed labels for each control component inside a panel. When applicable, additional identification needed shall be documented on the Shop Drawings.
- B. Engraved nameplates shall be provided on the face of each panel and beneath each actuator and control device not in a panel describing its use.
- C. All electrical devices within the panel shall be wired to a terminal strip within the panel. An "electric terminal" numbering system shall be applied to all terminals with aforementioned numbers matching terminals shown on Shop Drawings.

3.6 CLOSING-IN OF UNINSPECTED WORK

- A. General: Do not allow or cause any of the Work of this Section to be covered up or enclosed until it has been inspected, tested, and approved by the Mechanical Engineer and by all other authorities having jurisdiction.
- B. Uncovering: Should any of the Work of this Section be covered up or enclosed before it has been completely inspected, tested, or approved, do all things necessary to uncover all such work. After the Work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the Work to its original and proper condition at no additional cost to the Owner.

3.7 PROGRAMMING

- A. The Direct Digital Control (DDC) operational program will be provided by the BAS Contractor. The Contractor shall provide any testing program he feels necessary to fully test the operation of the various components.

3.8 SYSTEM INSTRUCTION AND RECORD DRAWINGS

- A. The BAS Contractor shall schedule a minimum of 40 hours of training to train the District's Energy Management Department in the use and care of the system. This training shall occur after all commissioning of the control system is completed.
- B. Instruction period shall be started after instruction books, service manuals and record drawings have been submitted to and approved by the Architect/Engineer and shall be at hours (regular and non-regular) arranged by the Architect/Engineer.
- C. Service manuals shall include oiling, cleaning and servicing data, compiled in clearly and easily understood form and in a durable binder. Data shall show all serial numbers of every piece of equipment and complete list of replacement parts.

3.9 TESTING AND ACCEPTANCE

- A. The commissioning period starts when the following conditions are met:
 - 1. The BAS system and all involved HVAC equipment have been installed, connected to the EMS system and ready to operate.
 - 2. A commissioning meeting has been conducted with representatives of contractors involved, Fresno Unified School District Energy Management Department Technician & HVAC Supervisor/Mechanic, General Contractor, Mechanical Contractor, and the Control System Contractor.
 - 3. Consensus is reached, by the representatives at the above referenced meeting that it is appropriate for the commissioning process to start. The operational program shall be loaded into the DDC system by the Control Systems Contractor.
- B. During the commissioning period, the Control System Contractor will maintain a commissioning file of the printed reports from the building. The District shall verify all commissioning tests.

- C. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed. System balance, if required, shall have been completed.
- D. The Contractor shall furnish a complete and operating system. The Contractor shall also verify, in the presence of the District, the system accuracy and proper function of each controlled device and sensor. The following items shall be successfully demonstrated prior to acceptance by the District:
 - 1. All system outputs, including controllers, relays and other control devices, shall be addressed and start/stop functions demonstrated.
 - 2. All inputs shall be displayed and all event-initiated functions shall be demonstrated.
 - 3. Demonstrate program integrity and power restore sequence during and after a power failure and restoration.
 - 4. Deliver all As-Built drawings, wiring diagrams, equipment specifications, As-Built communications routing map, Operation and Maintenance Manuals and other documentation as required to describe the system.
 - 5. A wiring schematic shall be permanently attached to the inside door panel of each control device.
 - 6. A detailed As-Built communications wiring loop routing map shall be permanently attached to the front end door panel and a copy shall be provided to the Maintenance Department.
 - 7. Complete operator training in the use, programming and operation of the system.
 - 8. The system will not be considered complete until all system graphics are operational and accurate.

3.10 COMMISSIONING THE SYSTEM

- A. The District reserves the right to employ a third party commissioner at the District's expense.
- B. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed.
- C. The commissioning process will be completed and the training process shall start when the following conditions are met:
 - 1. No "alarm" or "condition reports" are being generated by the DDC system for seven (7) calendar days (168 hours) due to incomplete or inaccurate installation, program, or programming.
 - 2. All adjustments and "fine tuning" of the system shall also be included in the training process.
 - 3. The system has been approved by the General Contractor, and accepted by the Mechanical Engineer and District.
- D. The Training Process: Shall consist of the following:
 - 1. System use, operation and field trouble shooting to be provided to the District's Energy Management Department's personnel. Training must be a total of 40 hours of hands on, as well as phone support when needed. The 40

hour training can be used in any time allotment agreed upon by the Controls Contractor and the District EMS Control Center until hours are depleted.

2. The District reserves the right to stop the clock at any time during the training process if there has been a discovery that impedes the complete full and accurate operation of the BAS installed. This includes the software programming, hardware components, sensors, or mechanical equipment and issues therein until they have been resolved.

END OF SECTION

SECTION 23 09 24 BUILDING AUTOMATION SYSTEM (BAS) ADDITIONAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL MECHANICAL PROVISIONS

- A. The preceding General Mechanical Provisions shall form a part of this Section with the same force and effect as though repeated here.

1.2 SCOPE

- A. General: This section includes adds supplemental requirements to Section 23 09 23.
- B. All control valves, actuators, front-end controllers, local unit controllers and zone temperature sensors shall be Johnson Controls, without substitution, to match District Standard. Front end controllers shall be Johnson FX, local unit controllers shall be Johnson PCG, without substitution, to match existing District Standard.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS DEVICES

- A. BACnet Multi-Network Router: Contemporary Controls BASRT-B, BACnet Multi-Network Router to provide stand-alone routing between BACnet networks such as BACnet/IP, BACnet Ethernet and BACnet MSTP. One 10/100 Mbps Ethernet port, One MS/TP port. Specific locations shall be as directed by district energy management technician, 559-457-3044
- B. Outside Air Temperature Sensor: Provide one ACI/34-Outside per NAC. Install on north wall of buildings with NAC. Mount 3 feet below overhang, typical, unless directed otherwise by district. Specific locations shall be as directed by district energy management technician, 559-457-3044.
- C. Photocell: Wattstopper EM-24 A 2. Combine with outside air temperature sensor.
- D. Status Sensor: Current sensing status sensor with sensitivity adjustment, Siebe EI 12-800, Functional Devices RIBXGTA or RIBXKTA. Current sensor must be installed on the "load side" of the magnetic starter.
- E. Duct Smoke Detectors: Ionization air duct smoke detector with auxiliary relays/contacts rated for controls shut-down of mechanical air handling unit, metal sampling tube, remote alarm lamp/indicator. FCI Model #301 DHA (CSFM #3240-0694:168) with #3011-DH (CSFM #72710694:169).
- F. Electric Actuators:
 - 1. General: Fully modulating, UL listed. Visual position indicator, manual override, spring return and weather guard where exposed to weather. Johnson.
 - 2. Valve Actuators: Provide with factory mounting brackets and linkage to the control valve. Capable of shutting off against a 50 psi differential. Provide clutches for all valve actuators.
- G. Damper Actuators: Actuators shall be direct-mounted onto the damper control shaft without linkage. Damper actuators shall be sized to provide a minimum of 5 inch pounds of torque per square foot of damper face area. Johnson

- H. Controls Transformers: 120VAC/24VAC, 50VA with white common wire. UL listed Split Bobbin transformers.
- I. Relays: General purpose relays shall be IDEC RH2B-UL with SH2B-05 base. Motor rated relays (PRD) shall be Functional Devices RIB.
- J. Circuit Breaker: Enclosures receiving 120 volt power shall have a combination circuit breaker/dual receptacle. Functional Devices PSPT2RB4. Enclosures receiving 60 volt (or less) power shall have a circuit breaker, IDEC NRAS 1100.
- K. Enclosures:
 - 1. General: Must be UL#508A approved as a fabricated panel assembly. A hinged, lockable front panel shall be used. Provide hasp where padlocks are required. The front of the panel shall be identified with an engraved plastic label with 1/4 —inch high letterings, with white on black background. Coordinate label names with District. No conduit or other penetration of any kind shall be made on top of any water type enclosure. If any such entry is made, a plug will not be acceptable, replace the enclosure. All panels shall incorporate "Panduit" HI OOX034FIT-B markers on all internal wires. Heat shrink the labels adjacent to the terminal connections.
 - 2. Pull Can for Wires Only (No Relays): Hoffman. For indoor location - NEMA 1 with National cam lock C8051, bright nickel finish, keyed for C346A. For outdoor location - NEMA 3R with Master padlock, keyed for P605.
 - 3. For field control device, unless otherwise noted: Hoffman A 242406LP (minimum size-larger if required) with full size metal back panel. For indoor location – NEMA 1 with National cam lock C8051, bright nickel finish, keyed for C346A. For outdoor location - NEMA 3R with Master padlock, keyed for P605. Panel shall be a UL508A fabricated panel.
 - 4. For Larger Enclosures: Hoffman A 363608LP (minimum size-larger if required) with metal back panel A HHPVV\N. Provide Master padlock, keyed for#P605. NEMA 12 if indoor; NEMA 3R if outdoor. Panel shall be UL508A fabricated panel.
- L. Wiring:
 - 1. Communication cable shall be: W183C-2058Y. Install per manufacturer's recommendations. No splices, Tee's, or cuts of any kind will be allowed. Identify both ends at terminal blocks. All wiring that is routed below grade shall be Part # WI 83C-VNTC. Communication loop and sensors shall be run in separate conduits and junction boxes.
 - 2. Sensor wire shall be: Connectair Part # WI 81 P-2040BL.
 - 3. Analog Output shall be: Part # WI 84C-2059PINK.
 - 4. Thermostat flat wire shall be Connectair Part # W248C-2094.
- M. Conduit: All conduit shall be rigid galvanized or EMT — refer to paragraph 3.1. Conduit shall be minimum 1-inch diameter for communication cable. For underground conduit, provide 100% spare capacity by installing a second conduit (empty) along all conduit routes. All fittings shall be steel - not malleable or aluminum.
- N. Labels: All labels, signs, etc., shall be engraved, laminated plastic. white on black background, 1/8-inch high lettering, minimum, unless otherwise noted.
- O. Wiring Labels: Panduit H100X034F1T-B heat shrink markers.
- P. Wall Plates: Brushed stainless steel. Hubbell.

- Q. Lightning Arrestor and Surge Suppressors: Shall be provided as approved and/or manufactured by the BAS equipment manufacturer.

2.2 VARIABLE SPEED DRIVE

- A. General: The variable frequency drive (VFD) shall be a completely adjustable frequency motor drive system consisting of a pulse width modulated inverter for speed control of NEMA Design B induction motors. Variable frequency drives shall be manufactured by a single source. The VFD manufacturer shall have a minimum of five years' experience in VFD design. Allen-Bradley Powerflex 753, without substitution. Provide factory start-up.
- B. Standards: VFD shall be in accordance with the latest revisions of the following:
1. IEEE Standard 519, Guide for Harmonic Control and Reactive Compensation for Static Power Converters
 2. IJL Standard 508, Electrical Industrial Control Equipment
 3. VFD shall be UL listed and bear the UL label.
- C. Design Requirements: The VFD shall be capable of operating in the following conditions: ambient temperature 0 to 40 degrees C and relative humidity 0 to 95%, noncondensing. The power section shall allow the following faults to occur without damage to the VFD: single-phase fault, three-phase short circuit, or phase to ground short circuit. VFD shall include the following features: overcurrent protection, over speed protection, over temperature protection, electronic thermal motor protection. Enclosures per paragraph 2.1, F. Provide input line reactors, 3% impedance.
- D. Adjustments: VFD adjustments shall be set via menu driven selections accessible from the front panel. The VFD shall operate in the auto or manual mode and shall include the following front panel mounted switches and indicators:
1. 2-line x 14-character alphanumeric display
 2. Local/ remote switch.
 3. Digital indicator of frequency, current, volts, torque, HP, KW, KWhrs and run hrs.
 4. Manual speed control
 5. Run / stop switch.
 6. Power on and run indicator
 7. Fault indication including: current limit, overvoltage, under-voltage, overload or thermal motor protection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: All electrical work shall be in accordance with the California Electrical Code, Fresno Unified School District Standards and the Electrical Specification Sections. Wiring shall be concealed in walls; above the ceilings, or below grade unless otherwise noted. Exposed wiring shall run parallel to room surfaces; location shall be approved by Fresno Unified School District Project Manager. No structural member shall be weakened by cutting, notching, boring or otherwise. Provide a 120-volt circuit for each device requiring external power. Dedicated circuits shall be provided for all UPS serving NACs and field control devices, and elsewhere as required. Identify the power circuit and wiring at both ends. Any devices or wiring exposed to the weather shall be protected in weatherproof

enclosures such as NEMA 3R and weatherproof conduit. Set, test and adjust the system for proper operation. All device locations noted in O&M's, programming, graphics, etc. shall refer to room numbers noted in the District's "Key Plans".

- B. Wiring and Conduit: Wiring in walls or in mechanical rooms, janitor rooms or storage rooms shall be in conduit. All wiring exposed to view shall be run in rigid galvanized steel conduit. All conduits shall include a pull wire (#12 stranded purple). Wiring in accessible attics may be run without conduit — use plenum-rated wiring. This wiring shall be strapped to structure at 48 inches on center and shall not lie on the ceiling. Inside classrooms, wiring may be run in Panduit for remodel projects. Panduit shall be Series LDPH51W10-A. All wiring (field and inside enclosures) shall be labeled at both ends as specified. All wire or cable shields shall be bonded together. Wiring and wire rolls shall be secured to the interior walls of enclosures or equipment. Use industry standard wire ties and support loops. Do not route communication wiring through room sensors, or any other device that is not secured in a locked enclosure.
- C. Existing Controls (remodel projects): Remove all unused control devices and related conduit and wire. Return all unused devices that the District desires to retain. Refer to the Removal and Salvage paragraph in the previous specification section. Where possible, re-use all existing thermostat guards. Existing rigid and EMT conduit may be re-used. Replace all existing flex conduit and fittings.

3.2 SEQUENCE OF OPERATION: See Drawings for Sequence of Operation. Where no sequence is shown, system shall function same as/similar to existing. Coordinate all required control sequence revisions with District and Engineer.

- A. General: Air-side equipment (unit ventilators, fan coils, air handlers, etc.) shall start by normally open relay and signal from BAS. The central plant equipment operates with normally open relays when the BAS is activated. Provide heat/auto/cool selection through the BAS. Auto places heating/cooling selection under control of BAS, based on outside air temperature. Heat/cool changeover setpoint shall be 65 degrees F (adjustable through BAS). Wireless communication is not acceptable. All BAS communication shall be via BACnet. Provide clutches for all control valves. Locations of all control panels and sensors shall be coordinated with, and as directed by, the District.
- B. Set Point Adjustment: Supply temperature set points shall not be set outside the range specified by the equipment manufacturer.

END OF SECTION