COUNTY OF SAN MATEO

STATE OF CALIFORNIA

PROJECT MANUAL

and

CONTRACT DOCUMENTS

for

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROLS SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CALIFORNIA
Project No. PF404

APPROVED: April 18, 2014

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Department of Public Works
San Mateo County
555 County Center, 5TH Floor
Redwood City, California 94063-1665

I N D E X

SAN MATEO COUNTY DOCUMENTS

SPECIFICATIONS

DRAWINGS

PROJECT DIRECTORY

PROJECT:	County Office Building Two Energy Management & Control System Upgrade 555 County Center Redwood City, CA 94063 Project No. PF404
SCOPE OF WORK	Upgrade the existing energy management & control system to improve the functionality and energy efficiency of the existing heating, ventilating, and air conditioning systems in accordance with plans and specifications dated March 27, 2014.
MECHANICAL ENGINEER:	Steve Taylor Taylor Engineering 1080 Marina Village Parkway Suite 501 Alameda, CA 94501 Phone: 510-749-9135
OWNER'S REPRESENTATIVE:	Mark Hahn Construction Project Manager County of San Mateo Department of Public Works 555 County Center, 5th Floor Redwood City, CA 94063 Phone: 650-599-7390

NOTICE TO CONTRACTORS

NOTICE IS HEREBY GIVEN that the Board of Supervisors of the County of San Mateo, State of California, will receive sealed bids for the construction contract titled

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CA
PROJECT NO. PF404

Bids shall be received in accordance with the Contract Documents. The Contract Documents may be examined and/or downloaded in pdf format at the Department of Public Works website home page:

Publicworks.smcgov.org/projects-out-bid

A pre-bid conference and site visit is scheduled for **Tuesday, May 6, 2014 at 9:30 a.m.** The conference will meet at **the offices of the Department of Public Works, 555 County Center, 5th Floor, Redwood City, California.**

Questions regarding this project should be directed to Mark Hahn, Construction Project Manager, Department of Public Works, 555 County Center, 5th Floor, Redwood City, California, 94063-1665, Phone 650-599-7390.

Bids shall be submitted using forms furnished and bound in the Project Manual and in accordance with Instructions to Bidders, and shall be accompanied by a Certified or Cashier's Check or Bid Bond for ten percent (10%) of the bid amount.

Bids shall be sealed and filed with the Clerk of the Board of Supervisors of the County of San Mateo at the Hall of Justice and Records, 400 County Center, (formerly 401 Marshall Street) 1st Floor, Redwood City, California, **on or before the 21st day of May, 2014 at 2:30 p.m.** and will be opened in public in the Chambers of said Board of Supervisors or at another location as designated by Owner shortly thereafter.

The Board of Supervisors of the County of San Mateo, State of California, reserves the right to reject any and all bids, alternate bids, or unit prices and waive any irregularities in any bid received.

No bidder may withdraw his bid for a period of ninety (90) days after the date set for the opening thereof.

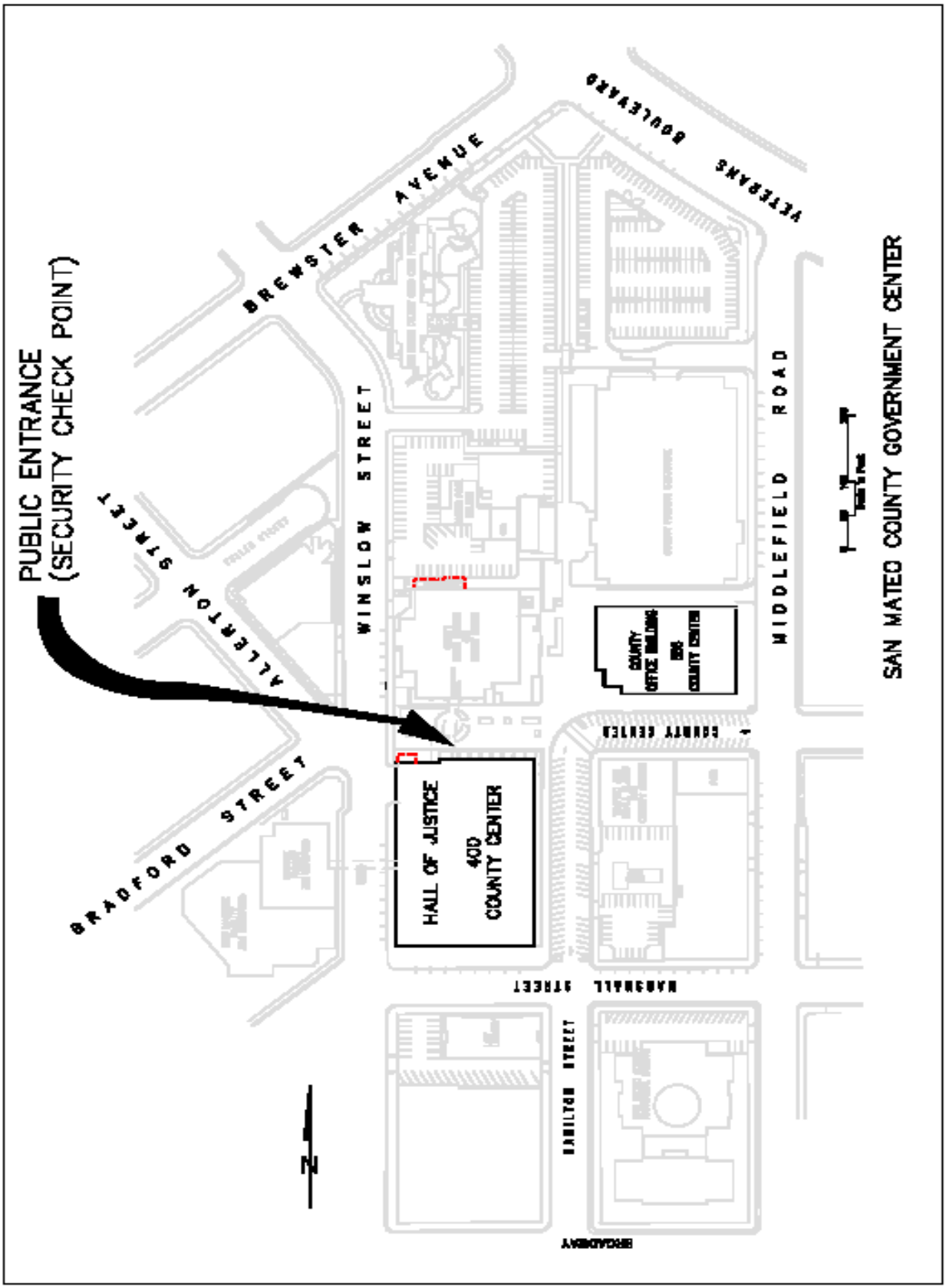
Pursuant to Labor Code Sections 1770, et seq., the Director of the Department of Industrial Relations has determined the general prevailing rate of wages in the County

of San Mateo for each craft, classification, or type of workman needed to execute the contract. The prevailing rates so determined are based on an 8-hour day, 40-hour week, except as otherwise noted. Existing agreements between the Building Trades and the Construction Industry groups relative to overtime, holidays and other special provisions shall be recognized. It shall be mandatory upon the Contractor and upon any sub-contractors under him, to pay not less than the said specific rates to all laborers, workmen or mechanics employed by them in the execution of this contract.

A bond will be required for the faithful performance of the contract in amount of not less than one hundred percent (100%) of the amount of the bid, and a bond will be required to guarantee the payment of wages for services engaged and for materials used in the performance of the contract in an amount of not less than one hundred percent (100%) of the bid.

The work to be done consists, in general, of providing all labor, materials, tools, appurtenances, and equipment required to upgrade the existing energy management & control system to improve the functionality and energy efficiency of the existing heating, ventilating, and air conditioning systems in accordance with plans and specifications dated March 27, 2014 as well as any other items and details not mentioned above but required by the Contract Documents and as directed by the Director of Public Works.

Contract time is specified at one hundred twenty (120) calendar days. Liquidated damages are $500 per calendar day.


PUBLIC ENTRANCE
(SECURITY CHECK POINT)
BREWSTER AVENUE
VETERANS BOULEVARD
ALLERTON STREET
WINSLOW STREET
MIDDLEFIELD ROAD
BRADFORD STREET
HALL OF JUSTICE
400
COUNTY CENTER
COUNTY OFFICE BUILDING
555
COUNTY CENTER
COUNTY CENTER
MARSHALL STREET
HAMILTON STREET
BROADWAY
N
SAN MATEO COUNTY GOVERNMENT CENTER

INSTRUCTIONS TO BIDDERS

1. General

1.1 Bids shall be received in accordance with the Contract Documents. Each bidder shall carefully read the complete Contract Documents including these instructions.

1.2 Before submitting a bid, each Bidder shall visit the Site and evaluate all conditions and limitations involved thereon as no allowance will be made because of the lack of such examination and knowledge.

1.3 Only Licensed Contractors authorized to do business under the laws of the State of California will be eligible to submit a bid. Classification C20.

1.4 Before a contract is awarded, the Board of Supervisors may, in its sole discretion, require from the proposed contractor evidence of his ability to faithfully, capably, and reasonably perform such proposed contract within the Contract Time and for the Contract Amount, and may consider such evidence before making its decision on the award of such proposed contract.

1.5 The Owner reserves the right to reject any and all proposals, to contract work with whomever and in whatever manner, to abandon work entirely, or waiver of any irregularities in receiving bids.

1.6 The contract shall be awarded to the lowest and most responsible bidder as interpreted by the Owner in accordance with the Contract Documents. The Base Bid shall be used to determine the lowest bidder. Alternates may be accepted and awarded to the lowest and most responsible bidder, as determined above, in any combination or order.

1.7 Questions regarding the Contract Documents, such as discrepancies, conflicts, omissions, doubt as to meanings, or regarding scope of Work shall be referred to the Architect. Inquiries must be received by the Architect not later than 96 hours before bid time. Inquiries will be answered in writing to all bidders of record if written clarification is warranted in the opinion of the Architect. The Owner will not be responsible for oral clarifications. Regarding questions on the Contract Documents in the absence of written clarifications, Contractor is instructed to bid the more expensive method or materials.

2. Proposals

2.1 Bids shall be submitted in accordance with the Contract Documents. Bids, which shall be submitted on Proposal Forms incorporated with the Project

Manual, are to be properly and fully filled out including, but not limited to, bid bond, the Equal Employment Opportunity Program questionnaire and report, Certifications, Contractor's Declaration Form, Anti-Trust Law questionnaire, and the designation of all subcontractors who will perform work or labor or render service on behalf of bidder, in an amount in excess of one-half of one percent of the Contractor's total bid.

2.2 No bid will be considered which makes exceptions, changes, or in any manner makes reservations to the terms of the Contract Documents.

2.3 Unit Prices on all classes of work as specified or required shall be submitted. Additions to or deductions from the contract sum shall be based on these unit prices. However, none will be acceptable that are definitely above and beyond a fair and just amount and will be subject to reasonable adjustment before the signing of the Contract or bid disqualification.

2.4 Each bid must give the full business address of the bidder and be signed by the bidder with his usual signature. Bids by partnerships must furnish the full name of all partners and must be signed in the partnership name by one of the members of the partnership or by any authorized representative, followed by the signature and designation of the person signing. Bids by corporations must be signed with the legal name of the corporation, followed by the name of the State of incorporation and by the signature and designation of the president, secretary, or other person authorized to bind it in the matter. Corporations must furnish a Certificate attesting to the existence of the corporation. The name of each person signing shall also be typed or printed below the signature. When requested by the Owner, satisfactory evidence of the authority of the officer signing on behalf of the corporation shall be furnished.

2.5 Bids are to be submitted in separate sealed envelopes. Envelopes shall be marked in lower left corner "Bid for" (provide contract title) and "Bid Opening" (provide bid opening date and time).
Deliver all bids to the office of the Clerk of the Board of Supervisors, Hall of Justice and Records, 400 County Center, First Floor (formerly 401 Marshall Street), Redwood City, San Mateo County, California. Bidders are advised that they will have to pass through a security screening to enter the County building. Please allow adequate time to submit bids. No late bids will be accepted.

2.6 Opening of bids shall be as soon after the hour set for bid opening as possible. Opening and declaration to be in the Chambers of the Board of Supervisors, Hall of Justice and Records, Redwood City, California or at another location as designated by Owner. The bid opening is open to bidders and the public.

2.7 No bid will be considered which is received after the time set for bid opening as determined by Owner.

3. Bonds and Insurance

3.1 Bids shall be accompanied by a certified or cashier's check or bid bond for 10 percent of the amount of the bid.

3.2 Two bonds, as itemized below and in the forms presented in these Contract Documents, shall be furnished by the successful bidder within ten days after notification of award, which documents will be filed with the Department of Public Works, Capital Projects Division, 555 County Center, 5th Floor, Redwood City, California. The bonds shall be in the form of surety bonds issued by corporations duly and legally licensed to transact business in the State of California, satisfactory to the Owner. Premiums for said bonds shall be paid by the Contractor and maintained at Contractor's expense during the period prescribed herein for the completion of the work to be done under the contract.

3.3 Performance Bond in amount of 100 percent of the Contract Amount to insure Owner during construction and for the guarantee period after completion against faulty or improper materials or workmanship and to assure Owner of full and prompt performance of Contract.

3.4 Payment Bond in amount of 100 percent of the Contract Amount in accordance with the laws of the State of California to secure payment of any and all claims for labor and material used or consumed in performance of this Contract.

3.5 Workers' Compensation Insurance, Comprehensive General Liability Insurance, and Motor Vehicle Liability Insurance shall be maintained by the contractor as detailed in the General Conditions.

4. Wage Rates

4.1 The Director of Industrial Relations has determined the general prevailing rate of wages in the County of San Mateo.

4.2 In accordance with the General Conditions, it shall be mandatory upon the Contractor and sub-contractors to pay not less than the said prevailing wage rates to all laborers, workmen, or mechanics employed by them in the execution of this Contract.

5. Non-Discrimination

5.1 All Contractors with contracts over $5,000 must comply with the County Ordinance Code with respect to the provision on employee benefits; as set forth in the ordinance, such Contractors are prohibited from discriminating in the provision of employee benefits with a domestic partner and an employee with a spouse. A copy of the ordinance is included in this project manual.

6. Contractor Employee Jury Service Ordinance

6.1 For contracts over $100,000, Contractor shall comply with the County Ordinance with respect to provision of jury duty pay to employees and have and adhere to a written policy that provides that its employees shall receive from the contractor, on an annual basis, no less than five days of regular pay for actual jury service in San Mateo County. The policy may provide that employees deposit any fees received for such jury service with the contractor or that the contractor deduct from the employees regular pay the fees received for jury service. A copy of the ordinance is included in this project manual.

7. Recycling and Diversion of Debris From Construction and Demolition Ordinance

7.1 All Contractors with demolition contracts exceeding $5,000 in value; or construction contracts exceeding $250,000 in value; or construction contracts consisting of at least 2,000 square feet shall comply with the County Ordinance with respect to construction and demolition debris. A copy of the ordinance is included in this project manual.

GENERAL CONDITIONS

GENERAL CONDITIONS

1 THE CONTRACT

1.1 CONTRACT DESCRIPTION

The Contract Documents form the entire Contract between the Contractor and the Owner. The Contract supersedes prior negotiation and representations, either written or oral.

1.2 CONTRACT DOCUMENTS

A The Contract Documents consist of the Notice to Contractors, Instructions to Bidders, Agreement, General Conditions, Special Provisions, Supplementary Conditions, Specifications, Drawings, Addenda, Revision Orders, Change Orders, Field Orders, other documents listed in the Agreement or included in the Project Manual, and written interpretations and instruction when issued in accordance with the provisions herein.

B The Contract Documents are complementary and what is required by any one shall be as binding as if required by all. The Contract Documents are not necessarily complete in every detail. The Contract is to include all labor, materials, equipment and other items as necessary for the proper execution and completion of the work as specified or reasonably inferable as being necessary to produce the intended results in accordance with high quality industry standards.

C An item designated by reference to the number, symbol, or title of a specific standard such as a commercial standard, a Federal Specification, a Trade Association Standard or other similar standard, shall comply with the requirements in the latest revision thereof and any amendments or supplement thereto in effect on the date of the bid. The standards referred to shall have full force and effect as though printed in the Specifications.

D The County will arrange for the Contractor to have access to one set of reproducible Drawings. The Contractor may at his expense, reproduce the Drawings and Specifications as needed. All Drawings and Specifications and copies thereof are the property of the Owner. They are not to be used on other projects.

E For convenience, the Specifications may be arranged in sections and the Drawings may be arranged by system or otherwise. Such separation shall not be considered as the limit of Work required of any separate trade. The terms and conditions of such limitations are wholly between the Contractor and his Subcontractors.

F In general, the Drawings will indicate dimensions, position, quantity and kind of construction; and the Specifications will indicate quality and method. Work

indicated in one but not the other shall be furnished as though fully set forth in both. Work not specifically detailed, marked or specified, shall be the same as similar work that is marked, specified or detailed.

G The Project Manual is a collection of documents assembled for the convenience of the parties and usually includes, but is not limited to, the Notice to Contractors, Instructions to Bidders, General Conditions, Supplementary General Conditions, Special Provisions, Bid Documents, Agreement, and Specifications.

1.3 ERROR IN THE DOCUMENTS

A Should an error or conflict appear in the Contract Documents, or a conflict with the documents and actual conditions, the Contractor shall notify the Architect at once, and the Architect will issue instructions. If the Contractor proceeds with the work without such instructions, he shall make good any resulting unacceptable work or consequences.

B Whenever the documents could be construed to be ambiguous or conflicting, the Contractor is deemed to have included the cost of the more expensive material, method, or requirement in the Contract Amount.

C Figured dimensions shall govern over scaling and large scale details shall govern over smaller scale details.

1.4 SEPARATE CONTRACTS

A The Owner reserves the right to let other contracts in connection with this Project. Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate his work with theirs.

B If any part of Contractor's Work depends for proper execution or results upon the work of another contractor, the Contractor shall inspect and measure the work of other contractor and promptly report to the Owner all defects or discrepancies that render it unsuitable for such proper execution or results. Contractor's action of proceeding with his work shall constitute his acceptance of the prior work as fit and proper for the reception of his work.

C The Contractor shall make good any damage he may do to another contractor's work to the Owner's satisfaction.

1.5 CONTRACT TERMINATIONS

A Owner's Right to Terminate Contract for Cause

If Contractor should be adjudged a bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on

account of his insolvency, or if he should fail to supply enough properly skilled workmen or materials to maintain the schedule, or if he should fail to diligently and expeditiously prosecute the Work, or if he should fail to commence the Work on the Project site within ten calendar days of the date of the Notice to Proceed, or if he should fail to make prompt payments to Subcontractors or for materials or labor, or persistently disregard laws, ordinances or the instructions of the Owner or Architect, or otherwise breach any provision of the Contract between the Contractor and Owner, the Owner may without prejudice to any right or remedy the Owner may have and after giving the Contractor seven days' written notice, terminate the Contract or terminate the Contractor's right to proceed with the Work and take possession of the premises and of all materials, tools and appliances thereon and finish the Work by whatever method the Owner may deem expedient. In such case, Contractor shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Amount shall exceed the expense of finishing the Work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the Owner.

B Owner's Right to Terminate Contract for Convenience

The Owner reserves the right to terminate this contract at any time. Contractor shall be compensated on the basis of the reasonable value of the portion of Work completed as prorated against the Contract Amount or shown as a separate price and the cost incurred for portions of the Work performed but not completed. The total payments to contractor shall not exceed the Contract Amount.

C Contractor's Right to Terminate Contract

Except as provided by paragraph 1.5 D Emergency Termination, if the Work should be stopped by the Owner, or an order of the court, or other public authority for a period of six months, through no act or fault of the Contractor or of anyone employed by him, then the Contractor may, upon twenty-one (21) days written notice to the Owner, terminate this Contract and recover from the Owner the amount owed under the Contract for the portion of Work, if any, which was completed.

D Emergency Termination

This Contract is subject to termination as provided by Section 4410 and 4411 of the Public Contracts Code of the State of California, being portions of the Emergency Termination of Public Contracts Act of 1949. Said Sections read as follows:

> "Sec. 4410. TERMINATION OF CONTRACT FOR PUBLIC WORK IN EVENT OF NATIONAL EMERGENCY. In the event a national emergency occurs, and public work, being performed by Contract, is stopped, directly

or indirectly, because of the freezing or diversion of materials, equipment, or labor, as the result of an order or of a proclamation of the President of the United States, or of an order of any federal authority, and the circumstances or conditions are such that it is impracticable within a reasonable time to proceed with a substantial portion of the Work, then the public agency and the Contractor may, by written agreement, terminate said Contract."

"Sec. 4411. INCLUSION OF TERMS AND CONDITIONS OF TERMINATION OF CONTRACT IN AGREEMENT: COMPENSATION TO CONTRACTOR. Such an agreement shall include the terms and conditions of the termination of the Contract and provision for the payment of compensation or money, if any, which either party shall pay to the other or any other person, under the facts and circumstances in the case."

"Compensation to the Contractor shall be determined on the basis of the reasonable value of the Work done, including preparatory Work. As an exception to the foregoing, in the case of any fully completed separate item or portion of the work for which there is a separate Contract price, the Contract price shall control. The parties may in any other case adopt the Contract price as the reasonable value of the Work or any portions thereof."

1.6 ALLOWANCES

A The Contractor shall include in the Contract Amount all allowances stated in the Contract Documents. Items or services covered by these allowances shall be supplied as the Owner may direct.

B Allowances for material and equipment shall cover the cost to the Contractor, less any applicable trade discount, delivered at the site, and all applicable taxes. The Contractor's costs for unloading and handling on the site, labor, installation costs, overhead, profit and other expenses required to complete the Work shall be included in the Contract Amount and not in the allowance.

C Whenever the cost of the material, equipment or service is more than or less than the allowance, the Contract Amount shall be adjusted by the procedure in Section 2, Contract Modifications.

1.7 DISPUTES

Should any dispute including breach, arise out of or relate to this Contract the Contractor shall continue to perform the Work in accordance with the Contract Documents and the Owner and Contractor agree to pursue resolution of the disagreement by whatever means available. Neither the dispute resolution process, the resolution, nor lack of resolution shall delay, hinder, or alter the completion of the Work in accordance with the undisputed portion of the Contract

Documents and in accordance with the Owner's direction to Contractor regarding disputed portions of the Contract.

1.8 SEVERABILITY

In the event that any provision or any part of a provision of this Contract shall be finally determined to be superseded, invalid, illegal or otherwise unenforceable pursuant to applicable laws by an authority having jurisdiction, such determination shall not impair or otherwise affect the validity, legality, or enforceability of the remaining provisions or parts of provisions of this Contract, which shall remain in full force and effect as if the unenforceable provision or part were deleted.

1.9 HEADINGS

The headings of any section or provision of this Contract are for convenience only and shall not be deemed to limit, restrict or alter the content, meaning or effect thereof.

2 CONTRACT MODIFICATIONS

2.1 MODIFICATION DOCUMENTS

A The Owner, without invalidating the Contract and without consent of surety, may accomplish changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Amount and the Contract Time being equitably adjusted accordingly. All such changes in the Work shall be accomplished by Revision Order, Change Order, Field Order, Owner's Instructions or Architect's Instruction as may be applicable in accordance with the provisions herein. The Contract Amount and the Contract Time may be changed only by a Revision Order. Changes to the Work shall be performed under the applicable provision of the Contract Documents for similar Work. Contractor agrees to promptly proceed with the Work as so changed. All changes to the Work and all Contractor requests for additional compensation shall be resolved in accordance with this Section 2, Contract Modifications.

B A Change Order is a written order from the Owner or Architect ordering a change in the Work. Upon receipt of a Change Order, the Contractor shall promptly proceed with the Work as changed. Within twenty (20) calendar days after receiving a Change Order and prior to or simultaneously with proceeding with the change in the Work, Contractor shall advise the Architect of Contractor's disagreement, if any, with the terms of the Change Order, and shall state the nature and extent of the disagreement. Proceeding with the Work as changed without submitting a notice of disagreement indicates Contractor's full acceptance of the Change Order including the proposed adjustment, if any, in Contract Amount and Contract Time. A Revision Order is required to adjust the Contract Amount and Contract Time for changes in the Work ordered by Change Order. The Contractor will not delay the Work for any reason including pending Revision

Orders or unresolved price or time adjustment.

C A Revision Order is a written document issued after execution of the Contract acknowledging a change in the Work and modifying the Contract Amount and Contract Time in full compensation for the change and its effects on the schedule and all other impacts on the Work and the Project.

D The signature of the Owner and Contractor on the Revision Order indicates their final and conclusive acceptance of the stated terms and provisions as full compensation for the change to the Work. In the event the Owner and Contractor do not agree upon the adjustment to the Contract Amount and Contract Time the Owner may issue a Revision Order unilaterally. A Revision Order issued unilaterally is signed by the Owner and issued to the Contractor authorizing an adjustment in the Contract Amount and Contract Time as the Owner deems equitable. A Revision Order issued unilaterally may be signed by the Contractor and delivered to the Owner thereby indicating Contractor's acceptance of the Revision Order. The Owner may withdraw a unilaterally issued Revision Order at any time prior to receiving the Contractor's signature on the Revision Order.

E If Contractor is in disagreement with the terms or provisions of a unilaterally issued Revision Order, the Contractor shall give the Owner and Architect written notice of his disagreement, the basis thereof, and supporting documentation within twenty (20) calendar days of receiving the unilateral Revision Order. Such notice of disagreement does not excuse performance by the Contractor of all obligations under the Contract Documents and the Contractor shall proceed with the Work including the Work involved with the disagreement. Payments shall be made to the Contractor on the basis of the unilateral Revision Order. Failure to present such notice of disagreement constitutes a waiver by the Contractor of any entitlement to additional cost or time.

F The Owner and Architect have the authority to issue instructions to the Contractor which may require minor changes in the Work not involving an adjustment in the Contract Amount or an extension of Contract Time. If contractor believes an adjustment of Contract Amount or Time is warranted, Contractor shall not incur additional cost or delay and notify the Owner or Architect in writing within 24 hours of receiving the notice.

G A Field Order is a written document signed by the Owner and issued to the Contractor to perform as so specified. The Contractor shall immediately comply with Field Orders. If the Contractor believes an adjustment of Contract Amount or Time is justified, a request may be submitted in accordance with Section 2.4, Contractor Claims. If the Owner concurs with the Contractor a Revision Order will be issued.

2.2 VERBAL INSTRUCTIONS

Contractors shall not act or rely upon verbal instructions. No work will be

accepted by the Owner that differs from the Contract Documents as modified in writing.

2.3 METHOD OF DETERMINING ADJUSTMENT

A An adjustment to the Contract Amount or Contract Time pursuant to a Change Order, Field Order, Claim, or other provision herein shall be determined in one or more of the following ways at the Owners discretion.

1 By negotiation based upon Contractor's estimate. The estimate shall include quantities of materials and man hours, and a breakdown of cost showing labor, materials, profit, overhead, and all other items of cost. General requirements, project supervision, project management and facilities are not allowed. Estimated unit prices used to calculate cost shall not exceed published unit prices, such as those published by R. S. Means Company, Inc., unless it can be justified that the published unit prices do not apply. Such estimates shall be provided within 20 (20) calendar days after the Change Order is issued. Overhead and profit shall not exceed the percentages specified in the Contract Documents.

2 By unit prices stated in the Contract or subsequently agreed upon.

3 By acceptance of a lump sum proposal.

4 By determination of the Owner and issued unilaterally by Revision Order.

B If the adjustment is not determined by the above methods prior to the Contractor starting work involved with a Change Order, Field Order or Claim, Contractor, shall proceed with the Work and keep daily accurate records of the labor hours, materials, and other items of cost used in the performance of the changed Work. Copies of the records shall be given to the Owner or Architect daily. Contractor shall present at such time and in such form as Owner may prescribe, an itemized accounting together with appropriate supporting data as may be required by Owner to fully substantiate the cost of the changed Work. Owner shall consider such accounting in its determination of equitable adjustment. Overhead and profit shall not exceed the percentages specified in the Contract Documents.

C Extension of Contract Time will be granted only to the extent that the time required to complete the Work as changed or delayed extends the schedule critical path beyond the contract completion date. If changes or delays do not extend the critical path of the schedule beyond the contract completion date, there will be no contractor entitlement to extended or additional home office expenses. Float, as used in this agreement, is the sum of the amount of time available to a task before the task becomes critical and the amount of time between the scheduled completion date and the contract completion date. Float may be used in the order needed by either the Owner or the Contractor.

2.4 CONTRACTOR CLAIMS

A If the Contractor wishes to request an adjustment in the Contract Amount or Contact Time, other than pursuant to a Change Order or Field Order, Contractor shall give the Owner and Architect a written Notice of Claim within seven calendar days after the occurrence or beginning of the event giving rise to such Claim except that notice shall be given immediately if delays or extra costs occur within such seven-day period. The Notice of Claim shall be given by the Contractor before disturbing conditions which are the basis for the Claim, except in an emergency endangering life or property in which case the Contractor should proceed in accordance with Section 6.7, Emergencies. Failure to present such Notice of Claim constitutes a waiver of such Claim. The adjustment to the Contract Amount or Contract Time, if any, shall be determined and issued in accordance with this Section 2, Contract Modifications.

B Notices are valid only if written and shall be a document issued for the sole purpose of notification and titled clearly "Notice of (specify category i.e., delay, claim)." A separate written notice is required for each subject and issue.

C Written notice shall be deemed to have been duly served if delivered in person to the individual to whom it is addressed, or if sent by certified mail to the address specified in the Contract Documents as may be revised in writing.

2.5 DELAYS BEYOND CONTRACTOR'S CONTROL

A. If the Contractor is delayed at any time in the progress of the Work by acts or neglect of the Owner or by any separate contractor employed by Owner, or by labor disputes, fire, unusual delays in transportation, unusually adverse weather conditions, unavoidable casualties or by any other unforeseeable cause of delay beyond the Contractor's control, which the Owner decides justifies the delay, then the Contract Time may be extended for such reasonable time as the Owner in his discretion may decide. Contractor's Claim for extension of time shall be made in writing to the Owner in accordance with Section 2.4, Contractor Claims. Only one Claim is necessary in the case of continuing delay.

B. Unusually adverse weather conditions for the purposes of this Project are agreed to be work days lost from weather or the effects of weather greater than the number of lost days specified in Section 7.5, Schedule.

2.6 HIDDEN CONDITIONS

Should concealed or unknown conditions be encountered in the performance of the Work below the surface of the ground or in an existing structure be at variance with the conditions indicated by the Contract Documents, or differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this Contract, the Contract Amount and Contract Time shall be equitable adjusted as provided herein upon Claim by Owner or

Contractor. Contractor Claims shall be in accordance with Section 2.4, Contractor Claims.

2.7 HAZARDOUS MATERIALS

Asbestos or other hazardous material may be present in County buildings or on County property. Asbestos is typically in the form of pipe lagging, fire proofing, floor tiles, mastic, and plaster. Soil may be contaminated by petroleum products or other substances. In the event any suspected asbestos or other hazardous material is encountered during construction that may be disturbed by the Work, the Contractor shall stop immediately and notify the County. The Contractor and all Subcontractors shall instruct their employees of the type and location of the most likely forms of hazardous material to be encountered and of the procedure to be taken if encountered. Contractor will be responsible for the mitigation and abatement of the hazardous material upon authorization of Owner. All Claims for adjustment in time or money shall be processed in accordance with Section 2.6, Hidden Conditions.

2.8 OVERHEAD AND PROFIT

A Adjustments to the Contract Amount due to changes in the Work or any other reason, shall include overhead and profit as follows:

1 Contractor's overhead and profit on the direct cost of Work performed by his forces shall be a total sum not exceeding fifteen percent (15%) of such costs.

2 Contractor's overhead and profit on the direct cost of Work performed by Subcontractors shall be a total sum not exceeding five percent (5%) of such Work.

3 Subcontractor's overhead and profit on the direct cost of Work performed by Subcontractor shall be a total sum not exceeding fifteen percent (15%) of the cost of the Work. Subcontractor overhead and profit will be allowed for one tier only.

4 Changes to the Work ordered by the Architect or Owner which decrease the Contract Amount shall include overhead and profit in accordance with the above provisions. Value engineering revisions initiated by the Contractor and accepted by Owner which decrease the Contract Amount shall be at cost only.

5 The "direct cost of the work" is considered to be the cost of labor and material incorporated into the construction. Supervision and administration of the work, changes, or claims shall not be included in direct cost.

2.9 MAINTAIN RECORDS

Contractor and Subcontractor shall maintain records, in accordance with generally accepted accounting principles, relating to costs of changes to the Work or Claims for 4 years after the final completion. The Owner will have the right to audit these records at any time up to 4 years after completion of the Project and recover from the Contractor or Subcontractor any amount paid by Revision Order but not substantiated by audit.

2.10 PROPOSAL REQUESTS

Contractor is required to provide preliminary estimates using their best judgment of time and cost impact of potential changes to the Project as requested by the Architect. Estimates shall be provided to the Architect within seven (7) days of receiving the Proposal Request. Contractor will be responsible for any cost increase or schedule impact resulting from Contractor's failure to respond within the allowed time.

3 CONTRACTOR

3.1 DEFINITIONS

A The term Contractor, as used herein, is the person or organization identified as such in the Agreement, and is referred to as if singular and masculine and includes his authorized representatives.

B The term Subcontractor, as used herein, includes only those persons or organizations having a direct Contract with the Contractor to perform a portion of Contractor's Work. Subcontractor includes one who furnishes material worked to a special design according to the plans or Specifications but does not include one who furnishes material not so worked.

3.2 GENERAL

A Contractor agrees to perform all Work required by the Contract Documents.

B All Work shall be done in accordance with the best practices of the various trades involved and highest industry standards.

C The Contractor shall keep on the Project site during the progress of the Work a competent superintendent satisfactory to the Owner. The Superintendent shall not be changed except with the consent of the Owner. The Superintendent shall represent the Contractor and all directions given to him shall be as binding as if given to the Contractor.

D It is the Contractor's responsibility to diligently prosecute the Work, using his best skills and attention, and the most appropriate techniques and equipment that are

required to provide a finished product in compliance with the Contract requirements. He shall insure that no Work is done that does not comply with the Contract Documents.

E The Contractor shall attend a preconstruction meeting, weekly progress meetings and other meetings as necessary to accomplish the Work and administer the provisions of the Contract.

F Contractor shall submit to Owner a daily record of Contractor's activity. Such record shall be delivered to Owner daily for previous day's activity and shall include Project name, date, weather, names of Subcontractors, count of personnel by company, material deliveries, description and location of activity and events. The record of daily activity shall not be used as a Notice to Owner.

3.3 SUBCONTRACTS

A The Contractor shall not be permitted to substitute any person or organization for any Subcontractor, person or organization listed by him in his bid without the prior, written consent of the Owner, as provided for in Chapter 2 of Division 5, Title 1 of the California Public Contracts Code.

B In addition to the information required in Form of Proposal regarding Subcontractors, the Contractor, after execution of the Contract but prior to execution of the subcontract, shall submit the following information on each Subcontractor: name, address, and nature of Subcontractor's work, Subcontract Amount, and all other information the Owner deems relevant. The Contractor shall not Contract with any such proposed person or entity to whom the Owner objects.

C Contractor shall bind every Subcontractor and every Subcontractor agrees to be bound by the terms of the Contract Documents insofar as applicable to their work. The Contractor shall be responsible for the acts and omissions of Subcontractors.

D Contractor agrees to pay to each Subcontractor promptly upon receiving payment from Owner.

E Neither the acceptance of the Subcontractor nor any other act of the Owner, nor anything contained in any contract document is to be construed as creating any contractual relation between the Owner and any Subcontractor.

3.4 PERSONNEL AND LABOR POLICY

A Contractor shall at all times enforce strict discipline and good order among his employees and shall not employ any unfit person or anyone not skilled in the work assigned to him. The Contractor shall be responsible to the Owner for the acts and omissions of his employees and other persons performing work for the Contractor.

B No person shall be excluded from participation in, denied benefits of, or be subject to discrimination under this contract on the basis of their race, color, religion, national origin, age, sex, sexual orientation, pregnancy, childbirth or related conditions, medical condition, mental or physical ability, or veteran's status. Contractor shall ensure full compliance with federal, state and local laws, directives and executive orders regarding non-discrimination for all employees and subcontractors under this Contract.

Violation of the non-discrimination provisions of this Contract shall be considered a breach of this Contract and subject the Contractor to penalties, to be determined by the County Manager, including but not limited to: i) termination of this Contract; ii) disqualification of the Contractor from bidding on or being awarded a County contract for a period of up to 5 years; iii) liquidated damages of $2,500 per violation; iv) imposition of other appropriate contractual and civil remedies and sanctions, as determined by the County Manager.

To effectuate the provisions of this paragraph, the County Manager shall have the authority to: i) examine Contractor's employment records with respect to compliance with this paragraph; ii) set off all or any portion of the amount described in this paragraph against amounts due to Contractor under the Contract or any other Contract between Contractor and County.

Contractor shall report to the County Manager the filing by any person in any court of any complaint of discrimination or the filing by any person of any and all charges with the Equal Employment Opportunity Commission, the Fair Employment Housing Commission or any other entity charged with the investigation of allegations within 30 days of such filing, provided that within such 30 days such entity has not notified Contractor that such charges are dismissed or otherwise unfounded. Such notification shall include the name of the complainant, a copy of such complaint and a description of the circumstance. Contractor shall provide County with a copy of its response to the complaint when filed.

For contracts over $5,000, with respect to the provision of employee benefits, Contractor shall comply with the County Ordinance which prohibits contractors from discriminating in the provision of employee benefits between an employee with a domestic partner and an employee with a spouse.

C Contractor shall ensure equal employment opportunity based on objective standards of recruitment, selection, promotion, classification, compensation, performance evaluations, and management relations, for all employees working on the Project. Contractor’s affirmative action policies shall be made available to Owner upon request.

D It is the policy of the Owner that Contractors on public Projects employ their workers from the local labor market whenever possible. Consistent with that

policy, the Contractor is requested to employ his workers from the local labor market. Local labor market within the meaning of this section is defined as the labor market within the geographical confines of the County of San Mateo, State of California.

E The Contractor shall forfeit, as penalty to the Owner, twenty-five Dollars ($25) for each laborer, workman, or mechanic employed in the execution of the Contract by him, or by any Subcontractor under him, upon any of the Work hereinabove mentioned, for each calendar day during which said laborer, workman, or mechanic is required or permitted to labor more than eight hours in violation of the provisions of Article 3, chapter 1, part 7, division 2 of the Labor Code.

F The Contractor shall forfeit as penalty to the Owner, twenty-five dollars ($25) for each laborer, workman or mechanic employed for each calendar day or portion thereof, if such laborer, workman, or mechanic is paid less than the general prevailing rate of wages hereinafter stipulated for any Work done under the attached Contract, by him, or by any Subcontractor under him, in violation of the provisions of Article 2, chapter 1, part 7, division 2 of the Labor Code.

G Apprenticeship Program: Contractor shall comply with the provision of Section 1777.5, chapter 1, part 7, division 2 of the Labor Code.

H The Contractor's attention is directed to the provisions of the California Labor Code, Division 2, Section 1776, and the regulations implementing it in Title 8, California Administrative Code. The Contractor shall be responsible for compliance by his Subcontractors. A certified copy of all weekly payroll records shall be furnished upon request of the Owner, the Division of Labor Standards Enforcement, or the Division of Apprenticeship Standards of the Department of Industrial Relations.

I Payrolls shall contain the full name, address, and social security number of each employee, his correct classification, rate of pay, daily and weekly number of hours worked, itemized deductions made and actual wages paid. They shall also indicate apprentices and ratio of apprentices to journeymen.

J The penalties specified in subdivision (f) of Labor Code Section 1776 for noncompliance with the provisions of said Section 1776 may be deducted from any moneys due or which may become due to the Contractor.

4 OWNER

4.1 DEFINITION

The Owner is the person or organization identified as such in the Agreement, and is referred to as if singular in number and masculine in gender and includes his authorized representatives. The Owner may be the County of San Mateo, sometimes called "The County", or it may be a non-profit corporation.

4.2 GENERAL

A The Owner may furnish information after the bid date and not included in the Contract Documents in the form of drawings, reports, survey data, utility locations, plans of existing facilities and such other information. This information is not part of the Contract Documents.

B The Owner shall receive copies of all correspondence, notices, approved shop Drawings, test reports and such material pertinent to the Contract. The Owner shall have access to the Work at all times.

4.3 THE DIRECTOR OF PUBLIC WORKS

The Director of Public Works for the County of San Mateo or his duly appointed representative is the duly appointed agent for the Owner and as such is empowered to act for the Owner in all matters as stated in the Contract Documents or as provided by law.

4.4 OWNER'S CONSTRUCTION OBSERVER

A The Owner may engage a Construction Observer. The Owner's Construction Observer shall receive copies of all communications regarding the Project, have full access to the Work, and be kept informed of all actions taken.

B The Owner's Construction Observer shall not interpret the plans, coordinate the Work, order changes in the Work, supervise the workmen, or perform any duty which is the responsibility of the Architect or the Contractor.

5 ARCHITECT

5.1 DEFINITION

For the purpose of this Contract, the Architect is identified as the Owner's representative. The Owner may also be the Architect. The term "Architect" shall include his appointed representatives and consultants. The person is referred to throughout the Contract as if singular in number and masculine in gender. Nothing contained in the Contract Documents shall create any contractual relationship between the Architect and the Contractor.

5.2 GENERAL

A The Architect will provide general administration of the Contract between Owner and Contractor.

B The Architect will have authority to act on behalf of the Owner to the extent provided in the Contract Documents. The Owner's instructions to the Contractor may be issued through the Architect.

C The Architect shall at all times have access to the Work. The Contractor shall provide facilities for such access so the Architect may perform his functions under the Contract Documents. The Architect will make periodic visits to the site to familiarize himself with the progress and quality of the work and to determine if the work is proceeding in accordance with the Contract Documents. Architect will endeavor to guard the Owner against defects and deficiencies in the Work.

D The Architect will be the interpreter of the requirements of the Contract Documents and the judge of the Contractor's performance thereunder. The Architect will, within 14 calendar days, render interpretations or answers to questions submitted by Contractor. All interpretations and decisions of the Architect shall be consistent with the intent of the Contract Documents. In his capacity as interpreter and judge he will exercise his best efforts to insure faithful performance by all parties of the Contract. The Architect's decision in matters relating to esthetic effect will be final.

E The Architect will review submittals, samples, adjustments to the Contract, applications for payment, written guarantees, operation and maintenance manual and other documents required by the Contract.

6 PERFORMANCE OF THE WORK

6.1 DEFINITION

A The term "Work" as used herein is all of the Contractors obligations under the Contract including, but not limited, to providing all labor, material, equipment and services indicated by the Contract Documents, as-built drawings, punchlist, inspections and approvals required or necessary for occupancy, and guarantees.

B The term "Project" is the total construction planned or contemplated by the Owner of which the Work may be the whole or a part. The Owner may perform or contract for other work on the Project site during the progress of the Work.

6.2 GENERAL

A The Contractor shall provide, maintain and remove upon completion of the Work, all tools, machinery, equipment, temporary rigging, scaffolding, hoisting equipment, rubbish chutes, barricades around openings and excavation, ladders between floors, fences around buildings, and all other items as required for safe completion of the Work, whether specifically designated or not and shall conform to all requirements in regard to operation, safety, and fire hazards of State and local authorities and of underwriters.

B Deliver all materials and equipment in the manufacturer's original sealed, labeled containers and protect items against moisture, rust, dust, tampering, or damage.

C Place all materials and equipment orders in time to avoid job delay or hindrance. Schedule deliveries to coincide with the construction schedule so that materials and equipment are promptly installed upon delivery.

D Except as specifically noted otherwise, the installation and/or maintenance directions provided by the manufacturer shall be followed for all materials and equipment.

E All materials and equipment shall be new, unless specifically marked otherwise.

F All materials and equipment not conforming to the Contract Documents shall be rejected and shall be immediately removed from the site of the Work.

G All utilities and services required by the Contractor including electrical power, water, temporary telephones, temporary sanitary facilities, and temporary heat as required for the proper installation of materials and the completion of the Work shall be provided by Contractor.

H Shut down of utilities for any reason or duration shall be subject to approval by the Owner. The Owner requires a minimum of 14 days notice prior to authorizing a utility shut down. When shut-downs of 30 minutes or more are required, the Contractor shall provide alternate service for normal occupancy requirements. Utility shut-downs shall be scheduled during non-business hours.

I Prior to ordering materials, the Contractor shall verify all measurements at the site and shall be held responsible for their accuracy. No extra compensation will be allowed for differences between actual measurements and the dimensions shown on the Drawings.

J Fences, office facilities, enclosures, storage sheds, etc., required by the Contractor in the performance of the Work shall be located where approved by the Owner.

K The Contractor shall confine operations at the site to areas permitted by law, ordinances, permits and the Contract Documents and shall not unreasonably encumber the site with any materials or equipment.

L During the progress of the Work, Contractor shall keep the premises orderly and safe and free from accumulation of waste materials and rubbish.

M At the completion of the Work, Contractor shall remove all waste, surplus materials, and rubbish and shall clean all surfaces, removing all extraneous paint, mortar, dust, and stains, leaving the Work bright, clean and polished.

N The project is not exempt from any Federal, State or local taxes.

O Royalty and License Fees incidental to the use of any patented material, device or

process shall be paid by the Contractor and in the event of a Claim of alleged infringement of patent rights, the Contractor shall save the Owner free and harmless from loss on account thereof; and also defend, at his own expense, all suits that may be brought in such connection.

P Contractor shall continuously maintain adequate protection of all Work and shall protect the Owner's property from damage or loss arising in connection with this Contract.

Q Precaution shall be exercised at all times for the protection of persons (including Contractor's and Owner's employees) and property. The safety provisions of applicable laws, building and construction codes shall be observed. Machinery, equipment and all hazards shall be guarded or eliminated in accordance with the safety provisions of the latest safety orders of the State of California (General Industrial Safety Orders and Construction Safety Orders), and in compliance with the Occupational Safety and Health Administration.

R All materials and workmanship shall be subject to inspection, examination, test and acceptance by the Owner at all times during manufacture and construction and at all places where such manufacture and construction are carried on.

6.3 EXISTING CONDITIONS

A The Contractor by executing the Contract represents that he has visited the site and familiarized himself with the local conditions under which the Work is to be performed and has correlated his site observations with the requirements of the Contract Documents.

B The contractor shall carefully study and compare the Contract Documents and existing conditions and dimensions and the connection of the Work to existing conditions and shall report to the Architect any error, conflict, inconsistency, omission, or any variance with laws, ordinances, codes, rules or regulations bearing on the Work. Contractor shall report such conditions to the Architect in writing at such time as to allow at least twenty (20) calendar days for a response with no delay to the Work. All necessary changes shall be accomplished in accordance with Section 2, Contract Modifications.

6.4 ADJACENT FACILITIES

A The Contractor shall provide adequate protection for all parts of the Project site, and adjacent property, its improvements and its occupants throughout the Work. All damage done to existing property shall be neatly repaired or replaced at the Contractor's expense.

B Work shall be executed in careful, orderly manner, with the least possible disturbance to public and occupants of the area.

C The Owner will continue to use adjacent facilities. Contractor shall take care to disrupt the Owner as little as possible. Contractor shall provide legal and safe access to all facilities at all times. In order to facilitate use of adjacent facilities Owner may order Contractor to alter or temporarily cease operations.

6.5 PERMITS

A It shall be the responsibility of the Contractor to obtain and pay for all permits, licenses, certificates, approvals, utility connections and services necessary for the proper execution and completion of the Work.

B All fees which are for temporary approvals or services, such as those which are necessary for construction procedures, shall be paid by the Contractor.

C In the event the Special Provisions require the Owner to pay any fee, the Contractor shall notify the Owner in writing, twenty (20) calendar days in advance of a required fee payment.

D It is the policy of the County to cooperate with State, County and City officials in regard to the construction of this Project, and it is the responsibility of the Contractor and all his Subcontractors to meet the requirements of government officials having responsibility for inspecting or observing construction by taking out permits for the Work, calling for inspections and adhering to safety practices in accordance with standard practice. In the case of conflict of any of these provisions, the Owner shall be notified. The term Inspector means a Public Building Construction Inspector or an individual performing the inspection as required by building codes or jurisdiction.

6.6 LAWS

A The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the Work. If the Contractor performs any Work contrary to such laws, ordinances, rules and regulations, he shall bear all costs and delays arising therefrom.

B Owner and Contractor have all rights provided by law not specifically waived by this contract.

6.7 EMERGENCIES

A In an emergency affecting the safety of life, the Work, or property, the Contractor, without special instruction or authorization from the Owner, is hereby permitted to act, at his discretion, to prevent such threatened loss or injury; he shall so act without appeal if so instructed or authorized. Any compensation, claimed by the Contractor on account of emergency work, beyond Contractor's contractual obligations, shall be determined by agreement. The Contractor shall immediately notify the Owner in writing.

B In an emergency affecting the safety of life, the Work, or property or if an unsafe condition exists, the Owner may, but is not obligated, take measures to mitigate the condition. Such measures may include expending labor or material, engaging other contractors, entering the Project site utilizing materials, equipment or facilities of Contractor. The Owner's actions may be performed immediately and without notice to Contractor. Contractor shall pay Owner for all costs which are attributable to Contractor.

6.8 SUBMITTALS

A Submittals are shop drawings, product data, maintenance information, samples, manufactures instructions, certifications, and similar documents or items which demonstrate the way the Contractor proposes to conform the Work to the information in the Contract Documents. Contractor shall review the entire Contract Documents for other provisions relating to submittals and individual submittal requirements, if any.

B The Contractor shall review, stamp with his approval and submit to the Architect in orderly sequence so as to cause no delay in his Work or in the work of any other contractor, all submittals required by the Contract. Submittals shall be properly identified with specification section. At the time of submission, the Contractor shall note in writing any deviation in the submittals from the requirements of the Contract Documents. By approving and submitting shop drawings and samples, the Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and that he has checked and coordinated each shop drawing and sample with the requirements of the Work and of the Contract Documents.

C The Architect will review submittals for conformance with the designed concept and with the information given in the Contract Documents. A minimum of 14 calendar days is required for each submittal review. The Architect's review will not relieve the Contractor of responsibility for complying with the Contract Documents. If a submittal is required to be resubmitted, the time and cost of resubmission is the responsibility of the Contractor.

6.9 SUBSTITUTIONS

A The intent of the Specifications is to specify high grade equipment and materials. It is not the intent of the Specifications to exclude or limit the products of any responsible manufacturer, except when the Owner has adopted a specific system or product which will be noted, "No Substitutions Allowed", or similar language. Where equipment, material, or process is specified by trade name or by patentee, manufacturer or dealer, it shall mean the specified item or any other product which is equal in every respect including quality, utility, serviceability, and aesthetic effect. The Architect shall be the sole judge of equality between products, materials or methods.

B Should the Contractor wish to use equipment or materials different from those specified, he shall request approval for the desired substitution. His request shall include all substantiating data required for the Architect to make any evaluation of the request. No substitution shall be made without written approval of the Architect. The Architect's refusal to approve a substitution shall not effect the progress of the work and is not grounds for a Claim against the Owner.

C The Contractor shall pay $200, lump sum, for the Architect's time to review substitution requests. Payment is to be included with the substitution request package.

6.10 CORRECTING WORK

A The Contractor shall promptly correct all Work rejected by the Owner or Architect, whether observed before or after the Notice of Completion and whether or not fabricated, installed or completed. The Contractor shall not receive a time extension for correcting such rejected Work. All such defective or non-conforming Work shall be corrected to comply with the Contract Documents without cost to the Owner. The Contractor shall bear the cost of making good all Work of separate contractors destroyed or damaged by such removal or correction.

B If any Work should be covered before it is inspected, the Contractor at his expense, must uncover the Work for inspection and then replace the cover.

C If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents, or fails to perform any provisions of the Contract Documents, the Owner may, after seven days written notice to the Contractor and without prejudice to any other remedy Owner may have, and without Contract termination or ordering the Contractor to stop Work make good such deficiencies in any manner the Owner deems expedient. In such case an adjustment to the Contract shall be made in accordance with section 2, Contract Modifications, deducting from the payment then or thereafter due the Contractor, the cost of correcting such deficiencies, including the cost of additional services made necessary by such default, neglect or failure.

D If the Owner deems it not expedient to correct Work damaged or not done in accordance with the Contract Documents, a deduction from the Contract price shall be made.

E If the Contractor fails to correct defective Work or fails to supply materials or equipment in accordance with the Contract Documents, the Owner may order the Contractor to stop the Work or any portion thereof until the cause of such order has been eliminated. Contractor shall not receive a time extension or compensation as a result of stopping Work as required by this provision.

6.11 TESTING

A The Owner will provide for testing of materials or workmanship as required by these Specifications. The Contractor shall coordinate and schedule tests directly with the testing firm. The costs of tests on materials at the Project site will be borne by the Owner, except for retesting, as specified below, the material required for testing, and the Contractor's labor required to facilitate the test or delayed by the test, which the Contractor shall furnish. The Contractor will cooperate with the Owner's testing representative in the taking of test Samples. The Contractor shall pay for all tests which are not at the job site.

B Required tests are specified elsewhere in the Specifications.

C Should the results of any required tests fail to meet the requirements of the Contract Documents, Contractor shall either correct the unacceptable condition or furnish new materials, as directed by the Owner. Additional tests shall be made at the Contractor's expense until the materials are found to meet the requirements of the Contract Documents.

D Should the results of any soil compaction tests fail to meet the requirements of the Specifications, Contractor shall recondition and/or recompact the fill, and additional tests shall be made at the Contractor's expense until the compaction is found to meet the requirements of the Specifications.

E Testing or inspection services required outside of regular working hours shall be paid for by the Contractor.

F When existing building systems such as fire alarms, fire sprinkler systems, smoke detectors, halon systems, etc., are modified by the Work, the Contractor shall test the entire system at the completion of the Work and demonstrate to the Owner that the system is functioning correctly and reliably.

6.12 RECORD DOCUMENTS

A The Contractor shall maintain at the site record documents consisting of all Drawings, Specifications, addenda, approved shop drawings and samples, Revision Orders, Change Orders, instructions from the Architect, and other documents relating to the Project. All record documents shall be marked neatly and legibly by the Contractor to record all changes to the Work, field measurements, actual conditions, and adjustments made during construction.

B Upon completion of the Work, Contractor shall transfer all record document information to a clean set of Drawing and Specifications and electronic media compatible with the Owner's software and deliver them to the Architect. CAD documents shall be in sheet format. Contractor shall provide any explanation or clarification of the record documents requested by Owner or Architect.

6.13 OPERATING AND MAINTENANCE MANUALS

Assemble and bind three (3) sets of all guarantees, certificates, warranties, operating instructions, as-built specification, and maintenance manuals into clearly organized files with an index, a list of Subcontractors and suppliers including their names, addresses, and phone numbers and present to Architect at the completion of the Work.

6.14 TRAINING OWNER'S REPRESENTATIVE

Contractor shall provide training to Owner's representative for all operating systems, features, and equipment. Training shall be sufficient to explain and demonstrate the location, function, and operation and shall be a minimum of four hours for each item of Work. Training shall be given by a person familiar with the Project. Operation and maintenance manuals must be available to the Owner prior to training and referenced during the training.

7 TIME

7.1 DEFINITION OF OFFICIAL DATES

A The Contract Time is the period of time indicated in the Contract Documents for achieving Substantial Completion of the Work. Time is of the essence of the Contract. The term day as used in reference to this Contract shall mean calendar day unless specifically designated otherwise.

B The Notice to Proceed shall establish the official date the Work may commence and the start of the Contract Time.

C The date of Substantial Completion of the Work is the date established by the Architect as herein provided. A date of beneficial occupancy or acceptance may be determined but they will not have official status in the Contract.

D The date of Final Completion is the date established by the Architect after Substantial Completion when the Work is complete in every detail. Retention may be withheld until after Final Completion.

7.2 SUBSTANTIAL COMPLETION

A Substantial Completion is the stage in the progress of the Work when the entire Work, or a designated portion thereof acceptable to the Owner, is sufficiently complete in accordance with the Contract Documents to allow the Owner to use and occupy the entire Work or portion as intended. Prior to Substantial Completion the Contractor shall have inspected the Work, completed corrective measures, obtained all approvals necessary for occupancy, placed into operation all equipment and systems, and obtained the Architects concurrence that Substantial Completion has been achieved.

B When the Contractor considers that the Work, or designated portion thereof acceptable to the Owner, is substantially complete, the Contractor shall provide a written notice to the Architect and Owner in which the Contractor certifies that the Work or portion is Substantially Complete, lists all deficiencies, and requests inspection and acceptance. The failure to include any items on such list does not alter the responsibility of the Contractor to complete the Work in accordance with the Contract Documents.

C Upon receiving notice in accordance with paragraph 7.2B the Architect and/or Owner will review the Work or designated portion thereof. If the Architect determines the Work or portion is substantially complete, the Architect will establish a date of Substantial Completion. If the Architect determines the Work or portion is not Substantially Complete the Contractor will be notified. Contractor is required to initiate reinspections by providing notice in accordance with Section 7.2B and reimburse the Owner for the cost of the reinspection.

D The guarantee period shall begin on the date of Substantial Completion. A separate date of Substantial Completion shall be established for designated portions of Work as agreed to by owner.

E Any Work used by Contractor prior to Substantial Completion shall be made new as of the date of Substantial Completion. Such Work may include lights, filters and systems or equipment requiring periodic maintenance.

7.3 LIQUIDATED DAMAGES

A Should the Work not be Substantially Complete, as defined herein, within the Contract Time as may be revised, damages will be sustained by the Owner. It is understood and agreed that it is or may be impracticable or extremely difficult to determine the actual amount of damages the Owner will sustain in the event of and by reason of such delay in completing the Work; and it is therefore agreed that the Contractor will pay the Owner the amount specified in the Special Provisions, as and for the Owner's liquidated damages. This amount covers Owner's damages only and is not in lieu of the indemnification obligations set forth separately at section 9 nor shall these liquidated damages cover damages, including delay damages, claimed by third parties. Third parties shall include other contractors working on the Project. In the event the Contractor fails to make such payment, the Owner may deduct the amount thereof from any money due or that may become due the Contractor under the Contract and should the balance due under the Contract not be sufficient to cover the amount owed, the Owner shall have the right to recover the balance from the Contractor, from other contracts between Contractor and Owner, or from the Contractor’s sureties.

B The Owner may allocate liquidated damages to portions of the Work. In the event the Contractor fails to complete Work remaining after Substantial Completion within the time periods established or fails to adhere to the conditions as agreed

for achieving Final Completion, liquidated damages, and third party claims shall be charged to Contractor.

7.4 USE AND OCCUPANCY PRIOR TO SUBSTANTIAL COMPLETION

A The Contractor agrees to use and occupancy of a portion of the Work by Owner before Substantial Completion.

B Prior to the Owner occupying a portion of the Work, a list of Work to be completed or corrected shall be prepared jointly by the Contractor and Architect.

C Occupancy by the Owner shall not be construed by the Contractor as being an acceptance by Owner of that part of the Work to be occupied.

D The Contractor shall not be held responsible for any damage to the occupied part of the Work resulting from the Owner's occupancy.

E Occupancy by the Owner shall not be deemed to constitute a waiver of any claims which Owner or Contractor may have.

F Use and occupancy of a portion of the Work by the Owner prior to Substantial Completion does not relieve the Contractor of his responsibility to maintain all insurance and bonds required under the Contract until the Work is completed and accepted by Owner.

7.5 SCHEDULE

A Contractor shall, within two weeks of being awarded the Contract, submit to the Owner and Architect a schedule for the Work. The schedule shall be a series of tasks representing the Contractor's plan for performing the Work including all activities both on site and offsite, submittal due dates, submittal review periods, material purchasing, lead or fabrication times, a period for punchlist and corrections, final inspection and approvals, and other events or activities having an effect on the progress or completion of the Work. For each task, the schedule shall show the duration, the starting and finish dates, predecessors, successors, and the average manpower and equipment planned. The schedule shall be submitted in bar chart and pert chart format and with a separate task list showing all data in spreadsheet format. No single task on the schedule may exceed two weeks in duration.

B The schedule shall be revised as required by the progress and conditions of the Work, change orders and all other factors that could influence the date of Substantial Completion.

C Contractor shall post a schedule on the Project site in a location readily accessible to the Owner and Architect. The posted schedule shall be updated at least weekly by the Contractor to show actual progress. At least once a month, Contractor will

provide a written progress report to the Owner in a format approved by Owner.

D Weather shall be allowed for in the Contractor's Schedule. Additional time will be granted for adverse weather to the extent the number of scheduled work days lost due to weather exceed: July 0, August 0, September 1, October 3, November 6, December 9, January 10, February 9, March 9, April 5, May 1, June 0.

8 PAYMENTS

8.1 CONTRACT AMOUNT

The Contract Amount as stated in the Agreement, including adjustments authorized under the terms of the Contract, is the total amount payable by the Owner to the Contractor for the complete Work.

8.2 CONTRACT AMOUNT BREAKDOWN

The Contractor shall, before the first application for payment, submit to the Architect a Contract Amount breakdown for the various parts of the Work divided into material and installation so as to facilitate payment. The payment breakdown shall be in such form as may be agreed upon by the parties and supported by such evidence as to its correctness that may be required by the Architect. The payment breakdown does not establish the value of Work for contract modifications.

8.3 PROGRESS PAYMENTS

A The Owner shall make progress payments to the Contractor for labor and materials incorporated into the Work as called for by the Contract Documents and approved Revision Orders. Not more often than once each month and on a day of each month agreed upon between the Owner and the Contractor, the Contractor shall submit to the Owner through the Architect an application for payment consisting of a Certificate of Payment, a calculation of completed Work based on the approved payment breakdown and, if required by Owner, receipts, releases, or other evidence showing the Contractor's payments for materials, labor, Subcontractors, and any such information as the Owner may require. Payment shall not be owed if the application does not conform to these requirements.

B Payment for materials stored on site which have not been permanently incorporated into the Work is at the discretion of the Owner. Payment for materials stored off-site, whether or not specially fabricated for the Project, can be made only when payment for such materials has been previously approved by the Owner and shown on the approved payment breakdown and such payment shall be conditional upon submission by the Contractor of a Bill of Sale in a form acceptable to the Owner or other such evidence as is required by the Owner to establish the Owner's title to such material. All materials stored off-site shall be stored in a bonded warehouse at no additional expense to the Owner.

C The Contractor shall present the application for payment, as required herein, to the Architect for approval. Architect will review and adjust the Certificate of payment to such amount as he decides is properly due and deliver it to the Owner for payment.

D The Owner will retain 5 percent of the amount of each payment due the Contractor until after the date of Final Completion.

E No Certificate of Payment issued nor payment made to the Contractor nor partial or entire use of occupancy of the Work by the Owner shall be an acceptance of any Work not in accordance with the Contract Documents.

F The Contractor shall not assign any monies due or to become due hereunder without the written consent of the Owner and of all sureties executing bonds on behalf of the Contractor in connection with this Contract.

8.4 OWNER'S FAILURE TO ISSUE PAYMENT

Should the Owner fail to issue payment for approved amounts owned under the Contract within 30 calendar days after the Architect receives the application for payment from Contractor, then the Contractor may, upon fourteen days written notice to the Owner and provided the Owner does not pay the Contractor within said fourteen days, stop Work only until Contractor receives the approved amount owed.

8.5 PAYMENTS WITHHELD

A The Owner may withhold payment, on account of subsequently discovered information, nullify the whole or a part of any progress payment or retention payment to such extent as may be necessary to protect the Owner from loss on account of:

1 Defective Work.

2 Third party claims or reasonable evidence indicating probable filing of third party claims.

3 Failure of the Contractor to make payments to Subcontractors or for material, labor or equipment.

4 The Owner's doubt that the Work can be completed for the unpaid portion of the Contract Amount.

5 Damage to another contractor's work.

6 Damage to Owner's property.

7 Failure to pay fees in accordance with the Contract Documents.

8 Owner's cost of correcting deficiencies in the Work or undertaking any Work.

9 Liquidated damages or anticipated liquidated damages.

10 Any amount owed to Owner or claimed by Owner.

11 Contractor's failure to deliver as-built drawings, guarantees, operating manuals or other documents.

12 Failure by Contractor to fulfill any Contract requirement.

8.6 FINAL PAYMENT AND RETENTION PAYMENTS

A The final payment shall be the one made in response to the 100 percent complete application for payment which will bring the total paid to the Contractor to 95 percent of the Contract Amount. Contractor's acceptance of the final payment shall constitute a waiver of all claims by Contractor except those previously made in writing.

B The Owner is entitled to retain 5 percent of the amount of each payment due Contractor until at least 35 days after the date of recording the Notice of Completion. At that time if any Work is still not complete, the Owner may continue to withhold all retention or, at the Owners option, the Owner may pay any portion of the retention.

C As a prerequisite to the release of retention, Contractor shall sign a Release of Liens in a form prescribed by Owner.

D Contractor shall not be paid interest on retention.

9 INSURANCE

9.1 HOLD HARMLESS

A To the full extent permitted by law, CONTRACTOR shall indemnify and save harmless the COUNTY, its officers, employees and servants from all claims, suits, or actions of every name, kind, and description, brought for or on account of: (A) injuries to or death of any person, including CONTRACTOR, its officers, employees and servants, or (B) damage to any property of any kind whatsoever and to whomsoever belonging, (C) any sanctions, penalties or claims of damages resulting from CONTRACTOR'S failure to comply with applicable laws, or (D) any other loss or cost resulting from the CONTACTOR'S negligent or reckless acts or omissions or willful misconduct in connection with the performance of any work

required of CONTRACTOR or payments made pursuant to this Agreement, provided that this shall not apply to injuries or damage for which the COUNTY has been found in a court of competent jurisdiction to be solely liable by reason of its own negligence or willful misconduct.

B The duty of CONTRATOR to indemnify and save harmless as set forth herein, shall include the duty to defend as set forth in Section 2778 of the California Civil Code.

C. The obligations set forth in this section shall continue beyond the term of this Agreement as to any act or omission which occurred during or under this Agreement.

9.2 INSURANCE

A The Contractor shall not commence Work under this Contract until all required insurance has been obtained and such insurance has been approved by the Owner. The Contractor shall furnish the Owner with Certificates of Insurance evidencing the required coverage, and there shall be a specific contractual liability endorsement extending the Contractor's coverage to include the contractual liability assumed by the Contractor pursuant to this Contract. Certificates of Insurance shall be filed with the Owner within ten (10) days after award of the Contract. These certificates shall specify or be endorsed to provide that thirty (30) days notice must be given, in writing, to the Owner of any pending change in the limits of liability or of any cancellation or modification of the policy.

B The Contractor shall have in effect during the entire life of this Contract Workers Compensation and Employers Liability Insurance providing full statutory coverage; and in case any work is sublet, the Contractor shall require all Subcontractors similarly to provide Workers Compensation and Employers Liability Insurance to full statutory limits. In signing this Contract, the Contractor makes the following certification, required by Section 1861 of the Labor Code:

> I am aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for Workers' Compensation or to undertake self-insurance in accordance with the provisions of the Code, and I will comply with such provisions before commencing the performance of the work of this Contract.

C The Contractor shall take out and maintain during the life of this Contract such Bodily Injury Liability and Property Damage Liability Insurance as shall protect him and any Subcontractor performing Work covered by this Contract, from any and all Claims for damages for bodily injury, including accidental death, as well as any and all Claims for property damage including third party property damage to include coverage on property in the care, custody and control of the Contractor, and also including what are commonly known as the X, C and U exclusions (having to do with blasting, collapse, and underground property damage) which

may arise from the Contractor's operations under this Contract, whether such operations be by himself or by any Subcontractor or by anyone directly or indirectly employed by either of them. Such insurance shall be combined single limit bodily injury and property damage for each occurrence and shall not be less than the amount specified below. Such insurance shall include:

1 Comprehensive General Liability $2,000,000
2 Motor Vehicle Liability Insurance $1,000,000

D The Owner and its officers, agents, employees and servants shall be named as additional insured on any such policies of insurance, which shall also contain a provision that the insurance afforded thereby to the Owner, its officers, agents, employees and servants shall be primary insurance to the full limits of liability of the policy, and that if the Owner or its officers and employees have other insurance against the loss covered by such a policy, such other insurance shall be excess insurance only.

E The Contractor shall purchase and maintain at his expense All Risk Property Insurance, excluding Earthquake and Flood coverage, in an amount covering all work and materials in the Contract, including that of Subcontractors, in an amount equal to the Contract Amount including adjustments. Subcontractors shall be included as insureds and the Owner shall be named as a Loss Payee as its interests may appear. Said insurance shall be maintained in complete coverage throughout the duration of the Contract until the date of Substantial Completion.

9.3 FAILURE TO PROVIDE INSURANCE

If Contractor fails to provide insurance as required herein, the Owner, at its option, may take out and maintain such insurance as the Owner deems in its best interest and charge the cost thereof to the Contractor.

10 GUARANTEES

10.1 REQUIRED GUARANTEES

A In addition to guarantees required elsewhere in the Contract Documents, the Contractor shall guarantee all of the work, and each Subcontractor shall guarantee his own Work, against defective material or faulty workmanship for a minimum of one year after the date of Substantial Completion. All guarantees must be submitted in triplicate to the Architect on the Contractor's own letterhead in the form prescribed by Owner.

B In addition to the requirements of paragraph 10.1A, all standard manufacturer warranties shall be passed to the Owner which may extend the warranty period beyond one year.

C In addition to the guarantees and warranties required by the Contract Documents,

the Owner has all rights and remedies provided by law including those pertaining to latent defects.

10.2 REPAIR OF GUARANTEED WORK

A If repairs are required in connection with guaranteed Work, the Contractor shall promptly upon receipt of notice from the Owner, and without expense to the Owner:

1 Place in satisfactory condition in every detail all of such guaranteed Work;

2 Make good all damage to the building, site, equipment, furniture, or contents which, in the opinion of the Owner, is the result of work not in accordance with the terms of the Contract Documents or disturbed in the process of correcting guaranteed Work.

B If the Contractor disturbs any work guaranteed under another contract in fulfilling the requirements herein he shall restore such disturbed work to a condition satisfactory to the Owner and guarantee such restored work to the same extent as it was guaranteed under such other contract.

C A new full term guarantee period shall apply to repaired work upon completion of repairs.

D If Contractor fails to proceed to comply with the terms of the guarantee or make repairs of defective work within 7 days of Notice from Owner, the Owner may remedy the Contractor's failure by whatever means the Owner deems expedient. The Owner may, at any time, take measures to mitigate damage or reduce undesirable effects of defective work. All costs expended by Owner pursuant to this Section shall be paid by Contractor.

+ + END OF GENERAL CONDITIONS + +

SAN MATEO COUNTY SUPPLEMENTARY GENERAL CONDITIONS
EQUAL EMPLOYMENT OPPORTUNITY (EEO) PROGRAM FOR MINORITY EMPLOYMENT

1 STATEMENT OF INTENT

It is the intent of the Board of Supervisors of the County of San Mateo to prohibit and eliminate employment discrimination and to further the opportunities for minority persons to be gainfully employed in the performance of County building contracts. The Bidder's attention is directed to all the provisions set forth herein. The Board of Supervisors has by Ordinance No. 2174 added Title 2, Chapter 2.50 to Division II of the San Mateo County Ordinance Code prohibiting discrimination in employment and providing for an Equal Employment Opportunity Program by Contractors doing business with the County of San Mateo. The following provisions are a part of the contract documents.

2 LOWEST RESPONSIBLE BIDDER

Award of contract to the low bidder shall not be made until the requirements set forth in these Supplementary General Conditions have been complied with and reviewed by the County Compliance Officer and a satisfactory Equal Employment Opportunity Program as submitted by the low bidder has been accepted.

A Criteria for Determining Lowest Bidder. Criteria to determine the acceptability of bids on construction contracts requiring public bidding and involving an expenditure of $6,500 or more shall include but not be limited to the following:

1 Criteria of Compliance with Federal and State Laws. Each bidder shall submit with his bid a certification that he is in compliance with the Equal Employment Opportunity Requirement of Executive Order 11246, Title VII of the Civil Rights Act of 1973, the California Fair Employment Practices Act and any other Federal or State Laws and regulations relating to Equal Employment Opportunities and the provisions of this article and the Board established guidelines implementing them. See report form entitled "Certification of Compliance with Laws Prohibiting Discrimination" bound herein after Form of Proposal.

2 Certification of Intent to Develop and Implement an Equal Employment Opportunity Program. Each bidder shall submit with his bid a certification that he will develop, implement and maintain, during the course of work concerned, an affirmative action program in employment conducted without regard to race, religion, color, national origin, ancestry, physical or mental disability, or sex of the

applicants. With this certification he shall submit any and all information which may be required by the County in connection with this program. As used in this Article, the term "minority" or "minority group" pertains to Latinos, Asians and Pacific Islanders, African Americans, American Indians, and women (regardless of her race or ethnicity). See report form entitled "Certification of Intent" bound herein after Form of Proposal.

3 Compliance by Subcontractors. The provision of this Section apply to any subcontractor engaged by the successful bidder, and each successful bidder shall notify his subcontractors of their obligations under the provisions of this Section.

3 PENALTIES FOR NON-COMPLIANCE WITH THE PROVISIONS OF THIS SECTION

A Any bidder who fails to submit a proposed Equal Employment Opportunity Program or who is unable to make the certifications required in this Section of the Supplementary General Conditions may be disqualified from consideration for the award of the contract.

B If, after an award is made, the Contractor is found by the County or by a Federal or State agency empowered to make such findings to be in substantial or material violation of the Fair Employment Practices Act of the State of California, the Equal Employment Opportunity Requirement of Executive Order 11246, Title VII of the Civil Rights Act of 1964, Section 503 of the Rehabilitation Act of 1973, or of the provisions of this Section, he may be found to be in material breach of his contract, and the County shall have the power to cancel the contract in whole or in part, or alternatively, to deduct for each working day during which the Contractor is found to have been in such non-compliance, two (2) percent of the total amount payable to the Contractor.

4 WAIVER OF COMPLIANCE

In the event that the requirements of this ordinance are found to work an undue hardship upon a low bidder, said bidder shall submit evidence of such hardship to the Board of Supervisors and shall petition the Board for a waiver of these requirements. This waiver shall only be granted by the Board of Supervisors and shall become an integral part of the contract.

5 DEFINITIONS

A Equal Employment Opportunity Program. Equal Employment Opportunity Program is a set of specific and result oriented procedures to which a

Contractor commits himself in order to achieve equal employment opportunity.

B Compliance Officer. A Compliance Officer is the County official designated by the County Manager to represent him in the administration of these guidelines and in the enforcement of the provisions of Title 2, Chapter 2.50 of the County Ordinance Code.

6 CERTIFICATION OF COMPLIANCE AND INTENT

Every bidder shall submit with his bid a Certificate of Compliance with laws prohibiting discrimination and a Certification of Intent to implement an equal employment opportunity program on a form furnished by the County, as required by Title 2, Chapter 2.50 of the County Ordinance Code.

7 EQUAL EMPLOYMENT OPPORTUNITY PROGRAM

In addition to furnishing the Certification of Compliance, each Contractor will submit his Equal Employment Opportunity Program with his bid.

The EEO shall contain the following information:

A Analysis of current work force:

1 Total number of employees

2 Numerical racial breakdown of employees by job classification

3 Information on apprentices

These figures will provide the base by which the Contractor's EEO will be evaluated. Factors to be considered both in the original statistics and in any plans for future employment will include the percentage of minority population in San Mateo County, the availability of minority construction workers and the present minority representation in the various construction trades.

B The equal employment opportunity actions the Contractor has taken or will take to insure equal employment opportunity. These shall include:

1 Recruiting and hiring minority persons. If non-union personnel are employed this would involve employment advertising through sources which serve areas of minority population. These include local minority newspapers, referral agencies, high schools, vocational schools, and community groups. Specific information on these sources may be obtained from the Compliance Officer. Union employees will be recruited in accordance with applicable

labor agreements. The Contractor will seek to have included or will reaffirm clauses in all labor agreements prohibiting discrimination based on race, religion, color, national origin, age, ancestry, physical or mental handicap, or sex. Assistance for admission into the craft of minorities over the traditional apprenticeship age is also suggested. The Contractor will support Bay Area Construction Opportunity Program or similar groups as recruiting sources and will urge all labor organizations with which he has agreements to use BACOP.

2 Providing adequate opportunity for the upgrading or further training of all employees to insure equal opportunity in advancement and promotion. This might include a counseling service, information and assistance with night classes, or special career-directed program information.

3 Appointing an Equal Employment Opportunity Coordinator - full time or as an additional duty. He will have the responsibility of administering an active program, informing company personnel and union representatives of this company policy and advising all subcontractors of their obligation to this program.

4 Establishing or maintaining an apprenticeship or training program designed to insure hiring of additional minority employees in the journeyman or skilled classes, if possible. The Contractor is urged to support the Joint Apprenticeship Committee on this trade.

5 Selecting minority subcontractor or subcontractors who are known for their ongoing program of apprenticeship for minorities. This includes advising minority contractor associations of bids for subcontractors. Joint ventures with minority subcontractors are encouraged.

C. The EEO should state any previous experience the Contractor has had with similar plans and result of that effort. Any current equal employment opportunity plans should be described in detail and a copy attached, if printed plan is available. The Compliance Office will review the EEO submitted by each bidder in order to determine whether the program submitted complies with Title 2, Chapter 2.50 of the County Ordinance Code and these guidelines.

The EEO as submitted will be kept on file by the Compliance Officer. If the Contractor bids for other county contracts, he may refer to the EEO on file and state any changes, but will not be required to refile his program.

The Compliance Officer may request additional information from the bidder and will be available to answer questions relative to the guidelines and to advise those seeking assistance of resources known to him. He will not be responsible for the service or lack of service rendered by the resources recommended, nor will he develop an EEO for any bidder, or serve as a recruiter for any bidder.

Bidders may revise their EEO after consultation prior to award of contract. Deficiencies will be discussed and appropriate remedies suggested. If bidders withdraw their EEO for revision, their revised program must be submitted by a date established by the Compliance Officer.

The Compliance Officer will determine whether the low bidder's EEO is acceptable and will report to the appropriate county department. The EEO's of each subcontractor of the low bidder will also be evaluated by the Compliance Officer.

8 INCLUSION OF EEO AND CERTIFICATIONS

Upon award of the contract by the Board of Supervisors, the EEO and Certifications for the prime contractor and all subcontractors, which have been approved and accepted by the County, will become an integral part of the contract and subject to the provisions thereof.

9 PERFORMANCE OF CONTRACTOR

A The Contractor will post, in conspicuous places available to employees and applicants for employment, notices to be provided by the County, stating that the Contractor is obliged to comply with the provisions of these guidelines and Title 2, Chapter 2.50 of the County Ordinance Code. These notices will also be sent to all union and employee organizations and other recruiting sources providing employees to the Contractor.

B All announcements of job openings will include the statement: "An Equal Opportunity Employer".

C The Contractor will make written Progress Reports on a form provided by the County to illustrate the effectiveness of his EEO at intervals established by the County.

D The Compliance Officer will monitor the performance of the EEO until completion of the contract and will report the progress of the Contractor in living up to his EEO to the County Manager.

E The Contractor shall permit, during Contractor's normal business hours and at Contractor's place of business, access by the County to his records of employment, employment advertisements, application forms and other

data and records pertaining to Contractor's employment practices, for the purpose of determining whether Contractor is complying with the Non-Discrimination and Equal Employment Opportunity rules of the County.

10 PERFORMANCE OF SUBCONTRACTORS

A All subcontractors listed in a general Contractor's bid are subject to all the provisions of these guidelines and Title 2, Chapter 2.50 of the County Ordinance Code.

B All subcontractors will file their Certifications of Compliance and Intent and their EEO with the Equal Employment Coordinator of the prime Contractor for transmittal to the County, after award of the contract has been made.

EQUAL BENEFITS COMPLIANCE ORDINANCE NO. 4324, CHAPTER 2.84

2.84.010 Definitions

For the purposes of this chapter:
(a) "Contract" means a legal agreement between the County and a Contractor for public works, consulting, or other services, or for purchase of supplies, material or equipment for which the consideration is in excess of $5,000.
(b) "Contractor" means a party who enters into a Contract with the County.
(c) "Contract Awarding Authority" means the Board of Supervisors or the individual authorized by the Board of Supervisors to enter into Contracts on behalf of the County.
(d) "Domestic Partner" means any person who is registered as a domestic partner with the Secretary of State, State of California registry or the registry of the state in which the employee is a resident.
(e) "Employee Benefits" means the provision of any benefit other than pension and retirement benefits provided to spouses of employees or provided to an employee on account of the employee's having a spouse, including but not limited to bereavement leave; disability, life, and other types of insurance; family medical leave; health benefits; membership or membership discounts; moving expenses; vacation; travel benefits; and any other benefits given to employees, provided that it does not include benefits to the extent that the application of the requirements of this chapter to such benefits may be preempted by federal or state law. (Ord. 4324, 08/15/06)

2.84.020 Discrimination in the provision of benefits prohibited

(a) No Contractor on a County Contract shall discriminate in the provision of Employee Benefits between an employee with a domestic partner and an employee with a spouse, subject to the following conditions:
1. In the event that the Contractor's actual cost of providing a particular benefit for the domestic partner of an employee exceeds that of providing it for the spouse of an employee, or the Contractor's actual cost of providing a particular benefit to the spouse of an employee exceeds that of providing it for the domestic partner of an employee, the Contractor shall not be deemed to discriminate in the provision of Employee Benefits if the Contractor conditions providing such benefit upon the employee's agreement to pay the excess costs.
2. The Contractor shall not be deemed to discriminate in the provision of Employee Benefits if, despite taking reasonable measures to do so, the Contractor is unable to extend a particular employee benefit to domestic partners, so long as the Contractor provides the employee with a cash payment equal to the Contractor's cost of providing the benefit to an employee's spouse.
(b) The Board of Supervisors may waive the requirements of this Chapter when it determines that it is in the best interests of the County. The County Manager may waive the requirements of this chapter for Contracts not needing the approval of the Board of Supervisors where waiver would be in the best interests of the County for such reasons as follows:
1. Award of a Contract or amendment is necessary to respond to an emergency;

2. The Contractor is a sole source;
3. No compliant Contractors are capable of providing goods or services that respond to the County's requirements;
4. The requirements are inconsistent with a grant, subvention or agreement with a public agency;
5. The County is purchasing through a cooperative or joint purchasing agreement.
(c) Contractors should submit requests for waivers of the terms of this Chapter to the Contract Awarding Authority for that Contract, or in the case of Contracts approved by the Board, the County Manager.
(d) The Contract Awarding Authority, or in the case of Contracts approved by the Board, the County Manager, may reject an entity's bid or proposals, or terminate a Contract, if the Contract Awarding Authority determines that the entity was set up, or is being used, for the purpose of evading the intent of this Chapter.
(e) No Contract Awarding Authority shall execute a Contract with a Contractor unless such Contractor has agreed that the Contractor will not discriminate in the provision of Employee Benefits as provided for in this Chapter. (Ord. 4324, 08/15/06)

2.84.030 Application of Chapter

The requirements of this Chapter shall only apply to those portions of a Contractor's operations that occur (a) within the County; (b) on real property outside of the County if the property is owned by the County or if the County has a right to occupy the property, and if the Contractor's presence at that location is connected to a Contract with the County; and (c) elsewhere in the United States where work related to a County Contract is being performed. The requirements of this Chapter shall not apply to subcontracts or subcontractors of any contract or Contractor. (Ord. 4324, 08/15/06)

2.84.040 Powers and duties of the County Manager

The County Manager's office shall have the authority to:
(a) Adopt rules and regulations, in accordance with this Chapter and the Ordinance Code of the County of San Mateo, establishing standards and procedures for effectively carrying out this Chapter.
(b) Receive notification from employees of Contractors regarding violations of this Chapter.
(c) Determine and recommend to the Board of Supervisors for final decision the imposition of appropriate sanctions for violation of this Chapter by Contractors including, but not limited to:
1. Disqualification of the Contractor from bidding on or being awarded a County contract for a period of up to 5 years; and;
2. Contractual remedies, including, but not limited to termination of contract;
3. Liquidated damages in the amount of $2,500;
(d) Examine Contractors' benefit programs covered by this chapter;
(e) Impose other appropriate contractual and civil remedies and sanctions for violations of this chapter;
(f) Allow for remedial action after a finding of non-compliance, as specified by rule;

(g) Perform such other duties as may be required or which are necessary to implement the purposes of this Chapter. (Ord. 4324, 08/15/06)

2.84.050 Date of Application

The provisions of this Chapter shall apply to any Contract awarded or amended on or after July 01, 2001, provided that if the Contractor is then signatory to a collective bargaining agreement, this Chapter shall only apply to any Contract with that Contractor which is awarded or amended after the effective date of the next collective bargaining agreement. (Ord. 4324, 08/15/06)

CONTRACTOR EMPLOYEE JURY SERVICE ORDINANCE NO. 4324, CHAPTER 2.85

2.85.010 Definitions

For the purposes of this chapter:
(a) "Contract" means a legal agreement between the county and a contractor for public works, consulting, or other services, or for purchase of supplies, material or equipment.
(b) "Contractor" means a party who enters into a contract with the county for which the contractor receives consideration of $100,000 or more.
(c) "Contract Authority" means the Board of Supervisors or the head of the department or agency presenting the proposed contract to the Board of Supervisors.
(d) "Employee" means any California resident who is a full-time employee of a contractor under the laws of California.
(e) "Full time" means 40 hours or more worked per week, or a lesser number of hours if (1) the lesser number is a recognized industry standard as determined by the County Manager, or (2) the contractor has a long standing practice that defines the lesser number of hours as full time. (Ord. 4324, 08/15/06)

2.85.020 Contractor Jury Service Policy

(a) A contractor shall have and adhere to a written policy that provides that its employees shall receive from the contractor, on an annual basis, no less than five days of regular pay for actual jury service in San Mateo County. The policy may provide that employees deposit any fees received for such jury service with the contractor or that the contractor deduct from the employees' regular pay the fees received for jury service.
(b) At the time of seeking a contract, a contractor shall certify to the county that it has and adheres to a policy consistent with this chapter or will have and adhere to such a policy prior to award of the contract.
(c) The Board of Supervisors may waive the requirements of this chapter when it determines that it is in the best interests of the County for such reasons as follows:
1. Award of a Contract or amendment is necessary to respond to an emergency;
2. The Contractor is a sole source;
3. No compliant Contractors are capable of providing goods or services that respond to the County's requirements;
4. The requirements are inconsistent with a grant, subvention or agreement with a public agency;
5. The County is purchasing through a cooperative or joint purchasing agreement.
(d) Contractors should submit requests for waivers of the terms of this chapter to the Contract Authority or the County Manager.
(e) The County Manager may reject a contractor's bid or proposal, or terminate a contract, if he determines that the contractor is in violation of the requirements of this chapter or was established, or is being used, for the purpose of evading the intent of this chapter.
(f) No contract shall be executed with a contractor unless such contractor is in compliance with this chapter. (Ord. 4324, 08/15/06)

2.85.030 Powers and duties of the County Manager

The County Manager's office shall have the authority to:
(a) Adopt rules and regulations, in accordance with this chapter and the Ordinance Code of the County of San Mateo, establishing standards and procedures for effectively carrying out this chapter;
(b) Receive notification from employees of contractors regarding violations of this chapter;
(c) Determine and recommend to the Board of Supervisors for final decision the imposition of appropriate sanctions for violation of this chapter by contractors including, but not limited to:
1. Disqualification of the contractor from bidding on or being awarded a County contract for a period of up to 5 years, and
2. Contractual remedies, including, but not limited to termination of contract.
(d) Impose other appropriate contractual sanctions for violations of this chapter;
(e) Allow for remedial action after a finding of noncompliance.
(g) Perform such other duties as may be required or which are necessary to implement the purposes of this chapter. (Ord. 4324, 08/15/06)

2.85.040 Date of Application

The provisions of this chapter shall apply to any contract awarded or amended on or after September 01, 2005, provided that if the contractor is then signatory to a collective bargaining agreement, this chapter shall only apply to any contract with that contractor which is awarded or amended after the effective date of the next collective bargaining agreement. (Ord. 4324, 08/15/06)

RECYCLING AND DIVERSION OF DEBRIS FROM CONSTRUCTION AND DEMOLITION ORDINANCE NO. 4099, CHAPTER 4.105

4.105.010 Definitions

For purposes of this chapter, the following definitions apply:
(a) “Construction and demolition debris” means and includes:
1. Discarded materials generally considered to be not water soluble and non-hazardous in nature, including but not limited to steel, copper, aluminum, glass, brick, concrete, asphalt material, pipe, gypsum, wallboard, and lumber from the construction or destruction of a structure as part of a construction or demolition project or from the renovation of a structure and/or landscaping, including rocks, soils, tree remains, trees, and other vegetative matter that normally results from land clearing, landscaping and development operations for a construction project;
2. Remnants of new materials, including but not limited to: cardboard, paper, plastic, wood, and metal scraps from any construction and/or landscape project.
(b) “Contractor” means any person or entity holding, or required to hold, a contractor’s license of any type under the laws of the State of California, or who performs (whether as contractor, subcontractor, owner-builder, or otherwise) any construction, demolition, remodeling, renovation, or landscaping service relating to buildings or accessory structures in the unincorporated area of San Mateo County.
(c) “Covered Project” means and includes any project which consists of one or more of the following:
1. Demolition work only, where the cost of the work exceeds $5,000 as determined by the Building Official;
2. The renovation, remodel or addition to an existing structure, or the construction of a new structure where the cost of the work exceeds $250,000, as determined by the Building Official;
3. Commercial, residential or multi-family residential development, and any new structure that is equal to or greater than 2,000 square feet.
(d) “Designated recyclable and reusable materials” means and includes:
1. Inert solids
2. Wood materials, including any and all dimensional lumber, fencing or construction wood that is not chemically treated, creosoted, CCA pressure treated, contaminated or painted;
3. Vegetative materials, including trees, tree parts, shrubs, stumps, logs, brush or any other type of plants that are cleared from a site for construction or other use;
4. Metals, including all metal scrap such as, but not limited to, pipes, siding, window frames, door frames and fences;
5. Roofing materials including wood shingles and shakes as well as asphalt, stone and slate based roofing material;
6. Salvageable materials and structures, including, but not limited to doors, windows, fixtures, hardwood flooring, sinks, bathtubs and appliances;
7. Any other materials that the Building Official determines can be diverted due to the identification of a recycling facility, reuse facility, or market accessible from the

County.
(e) “Inert solids” includes asphalt, concrete, rock, stone, brick, sand, soil and fines;
(f) “Salvage” means the controlled removal of materials from a covered project, for the purpose of reuse or storage for later reuse;
(g) “Structure” means anything constructed or erected. (Ord. 4099, 02/26/02)

4.105.020 Deconstruction and salvage and recovery

(a) Contractors are encouraged to make every structure planned for demolition available for deconstruction, salvage, and recovery prior to demolition; and to recover the maximum feasible amount of salvageable designated recyclable and reusable mater-ials prior to demolition.
(b) Recovered and salvaged designated recyclable and reusable materials from the deconstruction phase shall be counted towards the diversion requirements of this chapter. (Ord. 4099, 02/26/02)

4.105.030 Diversion requirements

(a) One hundred percent (100%) of inert solids, and at least fifty percent (50%) of the remaining construction and demolition debris tonnage shall be diverted.
(b) For each covered project, the diversion requirements of this chapter shall be met by submitting and following a Waste Management Plan that includes the following:
1. Deconstructing and salvaging all or part of the structure as practicable. AND
2. Directing one hundred percent (100%) of inert solids to reuse or recycling facilities approved by the County. AND
3. Either
a. Taking all mixed construction and demolition debris to the Mixed Construction and Demolition Debris Recycling facilities approved by the County and taking all sorted or crushed construction and demolition debris to approved facilities. OR
b. Source separating non-inert materials, such as cardboard and paper, wood, metals, green waste, new gypsum wallboard, tile, porcelain fixtures, and other easily recycled materials, and directing them to recycling facilities approved by the County and taking the remainder (but no more than 50% by weight or yardage) to a facility for disposal. In this option, calculations must be provided to show that 50% of construction and demolition debris (in addition to 100% of inert solids) has been diverted. (Ord. 4099, 02/26/02)

4.105.040 Information required before issuance of permit.

Every contractor shall submit a properly completed “Waste Management Plan,” on a form prescribed by the County, as an integral part of the building or demolition permit application process for a covered project. The Waste Management Plan shall indicate the intended salvage, reuse, and recycling facilities, chosen from a list of facilities approved by the County, for all construction and/or demolition debris from the project. Approval of alternative facilities or special salvage or

reuse options may be requested of the Building Official. Approval by the Building Official, or designee, of the Waste Management Plan as complying with this chapter shall be a condition precedent to the issuance of any building or demolition permit for a covered project. (Ord. 4099, 02/26/02)

4.105.050 Administrative fee

As a condition precedent to the issuance of any building or demolition permit for a covered project, the applicant shall pay to the County a fee as established by resolution to compensate the County for all expenses incurred in administering this chapter. (Ord. 4099, 02/26/02)

4.105.060 Reporting

(a) No later than thirty (30) days following the completion of a demolition project or construction project, the contractor shall, as a condition of final approval and for issuance of any certificate of occupancy, submit documentation to the County that demonstrates compliance with the requirements of this chapter.
(b) The documentation shall consist of photocopies of receipts and weight tags or other records of measurement or equivalent documentation from recycling companies, deconstruction contractors, and landfill and disposal companies. The contractor's approved "Waste Management Plan" shall be completed by recording and confirming the type of debris diverted and the facilities to which it was taken. The contractor shall sign the completed "Waste Management Plan" form to certify its accuracy as part of the documentation of compliance.
(c) Progress reports during construction may be required.
(d) All documentation submitted pursuant to this section is subject to verification by the County.
(e) It is unlawful for any person to submit documentation to the County under this section which that person knows to contain any false statements, including but not limited to false statements regarding tonnage of materials recycled or diverted, or to submit any false or fraudulent receipt or weight tag or other record of measurement. (Ord. 4099, 02/26/02)

4.105.070 Penalties and enforcement

(a) Each violation of the provisions of this chapter shall constitute a misdemeanor, and shall be punishable by imprisonment in the county jail for up to six (6) months, or by a fine of up to one thousand dollars ($1,000), or both. Each day that a violation continues shall be deemed a new and separate offense.
(b) The Building Official shall have the authority to enforce this chapter as specified in section 9021 of the San Mateo County Building Regulations, including but not limited to the authority to order that work be stopped where any work is being done contrary to the provisions of this chapter. (Ord. 4099, 02/26/02)

SPECIAL PROVISIONS

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CA
PROJECT NO. PF404

These Special Provisions are part of the Contract Documents and will govern over specific inconsistencies with the General Conditions.

1. CONTRACT TIME: The Contract Time is one hundred twenty (120) calendar days.

2. SCHEDULE: Contractor's attention is directed to the Contract Time and the requirement to achieve substantial completion within said time period.

3. LIQUIDATED DAMAGES: Liquidated damages are $500 per calendar day.

4. PERMITS: All work is subject to inspection and acceptance of authority having jurisdiction.

PROPOSAL

To the County of San Mateo
State of California

Bid Opening Date: May 21, 2014

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
PROJECT NO. PF404

1. SCOPE OF BIDS – The undersigned, doing business under the name of

_____,
declares that the only persons or parties interested in this Proposal as Principals are those named herein; that this Proposal is made without collusion with any other person, firm or corporation; that he has carefully examined the location of the proposed Work, the annexed proposed form of Agreement, and the Contract Documents therein referred to; that he proposes, and agrees if this Proposal is accepted, that he will contract with the County of San Mateo, in the form of the copy of the Agreement annexed hereto, and do all the Work and furnish all the materials specified in the Contract Documents for the following amount(s). The base bid, unit price bids, alternate bids, allowances, as applicable, shall include all labor, materials, equipment, supervision, overhead, profit, and incidentals necessary to complete the Work in accordance with the Contract Documents. The Base Bid will be used to determine the low bidder.

2. BASE BID – Base bids shall include all Work shown in the Contract Documents. Show base bid in words and numbers. The base bid is the initial contract amount.

_____ Dollars

($_____)

3. UNIT PRICES – A unit price shall be quoted for each of the following items of work in accordance with the specifications. Unit Prices shall apply to Work added to or deducted from the contract by Change Order. Unit Prices will not apply to work shown on the drawings unless specifically called out to be paid by a unit price. The quantities of unit price work shown are not estimates of work to be performed but are only used to determine the Bid Total.

A) Unit price for each CO2 sensor added to a VAV zone.

Add ($_____) per CO2 sensor

B) Unit price for each supply air temperature sensor added to a VAV zone.

Add ($_____) per supply air temperature sensor

C) Unit price to replace existing VAV box with new Titus, or equal box, including net impact on controls cost, if any. Assume all work done on overtime.

Add ($_____) per VAV box

D) Unit price to relocate existing zone thermostat within 20 feet including patching and painting.

Add ($_____) per thermostat

4. ALLOWANCES: Not used

5. ALTERNATES: Not used

6. CONTRACT – If written notice of the acceptance of this bid is mailed or delivered to the undersigned within ninety (90) calendar days after the date of opening of the bids, or any time thereafter before the bid is withdrawn, the undersigned will, within ten (10) calendar days after the date of such mailing or delivering of such notice, execute and deliver a contract in the Form of Agreement present in these Contract Documents and give Payment and Performance Bonds in the form provided in these Contract Documents. The undersigned designates the address provided in Section 14 of this proposal to be the office to which such notice of acceptance may be mailed or delivered.

7. TIME OF COMPLETION – We propose, if awarded the Contract, to complete this entire work within Contract Time specified in the Special Provisions.

8. BONDS – The undersigned agrees, if awarded the Contract to execute within ten days, two corporate surety bonds as called for in the “Instruction to Bidders”.

9. INSURANCE – Our Public Liability and Property Damage Insurance is placed with:

Our Workers Compensation Insurance is placed with:

Our All Risk Property Insurance is placed with

---

10. ADDENDA – Addenda bound with Contract Documents or issued during the time of bidding, are to be included in the proposal, and in the Contractor's Work. **The undersigned agrees it is the Bidder's sole responsibility to confirm receipt of addendums, *if any,* which will be posted on the Department of Public Works website home page no less than 48 hours prior to the time set for bid opening as called for in the "Instructions to Bidders."**

11. ADDENDA RECEIPT – The receipt of the following addenda is acknowledged:

ADDENDUM NO. _____ DATE_____

ADDENDUM NO. _____ DATE_____

ADDENDUM NO. _____ DATE_____

12. This bid may be withdrawn at any time prior to the scheduled time for the opening of bids or any authorized postponement thereof.

13. CONTRACTOR'S LICENSE – The undersigned agrees, if awarded the contract, to maintain and keep current through the completion of the contract the valid licenses for the work to be performed as required by the California Contractors License Law and all other applicable licensing requirements.

License No. License Class Expiration Date

14. By the signature below, the bidder certifies, under penalty of perjury, the accuracy of the representations made in this Proposal.

Dated _____, 20_____.

Company
Business Type _____Corporation _____Partnership _____Sole Proprietorship

State of Incorporation of Location of Business Registration_____

Signed _____

Title_____

Print Name_____

Address_____

Phone:_____ Fax:_____

Tax I.D. No._____

NOTE: If Bidder is a partnership, give full names of all partners.

15. DESIGNATION OF SUBCONTRACTORS – In compliance with the provisions of Secs. 4100-4108 of the Public Contracts Code of the State of California, and any amendments thereof, each bidder shall set forth below the name and the location of the mill, shop, or office of each subcontractor who will perform work or labor or render service to the Contractor in or about the construction of the Work in an amount in excess of one-half of one percent of the Contractor's bid to Owner.

DESIGNATION OF SUBCONTRACTORS

DIVISION OF WORK	SUBCONTRATOR'S NAME AND ADDRESS

Attach additional pages as necessary. Indicate none or number or pages attached:

_____ pages attached.

NONCOLLUSION DECLARATION
(To Be Executed By Bidder and Submitted With Bid)

Project: ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE

The undersigned declares:

I am the _____ of _____, the party making the foregoing bid. The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on _____date], at _____city], _____state]."

_____ _____

Signature Title

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned,

_____, as Principal and

_____, as Surety, are hereby held and firmly bound unto the County of San Mateo in the State of California, as represented by the County Board of Supervisors, hereinafter called the "Owner" in the sum of

_____ Dollars ($_____)
for payment of which sum, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns.

The condition of the above obligation is such that, whereas the Principal has submitted to the Owner a certain Bid, attached hereto and hereby made a part hereof, to enter into a contract in writing for

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CALIFORNIA
PROJECT NO. PF404

in strict accordance with contract documents.

NOW, THEREFORE,

a. If said Bid shall be rejected, or, in alternate

b. If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Agreement attached hereto and shall execute and deliver Performance and Payment Bonds in the Forms attached hereto (all properly completed in accordance with said Bid), and shall in all other respects perform the agreement created by the Acceptance of said Bid.

Then, this obligation shall be void; otherwise, the same shall remain in force and effect, it being expressly understood and agreed that the liability of the Surety for any and all default of the Principal hereunder shall be the amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligation of said Surety and its bond shall be in no way affected or impaired by any extension of the time within which the Owner may accept such Bid, and said Surety does hereby waive notice of such extension.

IN WITNESS WHEREOF, the above-bounden parties have executed this

instrument under their several seals this _____ day of _____, 20__, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In presence of:

_____
(Individual Principal) (Seal)

_____
(Business Address)

Attest:

_____
(Corporate Principal)

_____
(Business Address

By_____ (Affix Corporate Seal)

Attest:

_____
(Corporate Surety)

_____
(Business Address)

By_____ (Affix Corporate Seal)

The rate or premium on this bond is _____ per thousand.

Total amount of premium charge, $_____
(The above must be filled in by Corporate Surety.)

EQUAL EMPLOYMENT OPPORTUNITY PROGRAM
QUESTIONNAIRE

THIS QUESTIONNAIRE MUST BE COMPLETED IN FULL BY AN OFFICIAL OF THE COMPANY AND SUBMITTED WITH THE BID

Project: ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE

Company Name: _____

Name of Company Official: _____

Phone: _____ Date: _____

1. _____Yes _____No Have you read and are you acquainted with the Equal Employment Opportunity Requirement of Executive Order 11246, Title VII of the Civil Rights Act of 1964, Section 503 of the Rehabilitation Act of 1973, the California Fair Employment Practices Act and Title 2, Chapter 2.50 of the San Mateo County Ordinance Code?

2. _____Yes _____No Is it the policy of your company to recruit, hire, train, upgrade, transfer, compensate, and discharge without regard to race, religion, color, national origin,age, ancestry, physical or mental disability,sexual orientation, or sex?

3. _____Yes _____No Have you appointed an Equal Employment Opportunity Officer? Give his name, position in the company, office address, and phone number.

_____

_____

_____

4. _____Yes _____No Does your employment advertising state that you are an Equal Opportunity Employer?

5. _____Yes _____No Have all recruitment sources been advised that all qualified applicants will be considered for employment without regard to race, religion, color, national origin, age,ancestry, physical or mental disability, sexual orientation, or sex?

6. _____Yes _____No Were any employees hired by means other than the union hiring hall in the past year?

How many? _____

What positions? _____

_____

7. If non-union personnel are employed by the company, or if a position cannot be filled by the union hall, specify the advertisement and recruitment sources that are used. (For example, State HRD, newspapers, high schools, vocational schools, referral agencies/organizations, community groups).

_____

_____

8. How many apprentices do you employ? _____

How many of these are minorities? _____

9. _____Yes _____No Do you have a program for upgrading and counseling present employees?

Describe: _____

_____

_____

_____

_____

10. _____Yes _____No Do you have a collective bargaining agreement with a labor union or other organization?

Please list these groups: _____

_____

_____

11. What percentage of your work force is covered by union agreement?_____

12. _____Yes _____No Have you advised the labor union and/or worker organization of your company's responsibility under the Equal Employment Opportunity Program?

13. _____Yes _____No Does your company's collective bargaining agreement include a provision for non-discrimination in employment?

14. _____Yes _____No Have you notified all subcontractors submitting bids to you that they will be subject to the same minority employment requirements should you be the successful bidder?

15. Describe any previous experience with Equal Employment Opportunity Programs:

_____

_____

_____

_____

_____

16. State what Equal Employment Opportunity Program you plan to take in connection with this project:

_____

_____

_____

_____

_____

If your company has a written Equal Employment Opportunity Program now in effect, please attach a copy of it.

CERTIFICATION OF COMPLIANCE

WITH LAWS PROHIBITING DISCRIMINATION

We are in compliance with the Equal Employment Opportunity Requirement of Executive Order 11246, Title VII of the Civil Rights Act of 1964, the California Fair Employment Practices Act, Section 503 of the Rehabilitation Act of 1973, and any other federal or state laws relating to equal employment opportunity and the provisions of Title 2, Chapter 2.50 of the San Mateo County Ordinance Code and the Board established guidelines implementing them.

We will not discriminate against any employee or applicant for employment based on race, religion, color, national origin, age, ancestry, physical or mental disability, sexual orientation, or sex. This pertains to the areas of recruitment, hiring, training, upgrading, transfer, compensation, and termination.

CERTIFICATION OF INTENT

We will develop and implement, during the course of the work concerned, an Equal Employment Opportunity Program of hiring and employment conducted without regard to race, religion, color, national origin, age, ancestry, physical or mental disability, sexual orientation, or sex of the applicants. With this certification we shall submit any and all information which may be required by the County in connection with this program.

Signature and Title of Authorized Representative

_____

Date _____

EQUAL EMPLOYMENT OPPORTUNITY PROGRAM
CONTRACTOR REPORT FORM

THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED WITH THE BID

Project: ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE

Company Name: _____ Date: _____

RACIAL/ETHNIC MAKEUP OF THE COMPANY

Be sure to include the total of all employees in each classification in the first column, not just minorities. Report the number of employees enrolled in formal on-the-job (apprenticeship) training programs in parenthesis () for each classification.

Minority Employees										
Job Classification	Total All Employees	Ethnicity								
		American-Indian or Native Alaskan	Asian	Native Hawaiian or Pacific Islander	Black American or African American	Caucasian	Filipino	Hispanic or Latino (1)	Other (2)	Unidentified (3)
Total(s)										

Notes: (1) "Hispanic" includes all persons of Mexican, South and Central American, Puerto Rican, Cuban or Spanish ancestry.
(2) "Other" includes all others whose origin consists of two or more races other than Hispanic or Latino.
(3) Use this category for employees who have chosen not to identify any race or ethnicity, including "Other".

CONTRACTOR'S DECLARATION FORM

THIS FORM MUST BE COMPLETED IN FULL AND SUBMITTED WITH THE BID

Project: ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE

I CONTRACTOR INFORMATION

Contractor Name: _____ Phone: _____

Contact Person: _____ Fax: _____

II EQUAL BENEFITS (check one or more boxes)

Contractors with contracts in excess of $5,000 must treat spouses and domestic partners equally as to employee benefits.

☐ Contractor complies with the County's Equal Benefits Ordinance by:
- ☐ offering equal benefits to employees with spouses and employees with domestic partners.
- ☐ offering a cash equivalent payment to eligible employees in lieu of equal benefits.

☐ Contractor does not comply with the County's Equal Benefits Ordinance.

☐ Contractor is exempt from this requirement because:
- ☐ Contractor has no employees, does not provide benefits to employees' spouses, or the contract is for $5,000 or less.
- ☐ Contractor is a party to a collective bargaining agreement that began on _____ (date) and expires on _____ (date), and intends to offer equal benefits when said agreement expires.

III NON-DISCRIMINATION (check appropriate box)

☐ Finding(s) of discrimination have been issued against the Contractor within the past year by the Equal Employment Opportunity Commission, Fair Employment and Housing Commission, or other investigative entity. Please see attached sheet of paper explaining the outcome(s) or remedy for the discrimination.

☐ No finding of discrimination has been issued in the past year against the Contractor by the Equal Employment Opportunity Commission, Fair Employment and Housing Commission, or any other entity.

IV EMPLOYEE JURY SERVICE (check one or more boxes)

Contractors with original or amended contracts in excess of $100,000 must have and adhere to a written policy that provides its employees living in San Mateo County up to five days regular pay for actual jury service in the County.

☐ Contractor complies with the County's Employee Jury Service Ordinance.

☐ Contractor does not comply with the County's Employee Jury Service Ordinance.

☐ Contractor is exempt from this requirement because:
- ☐ the contract is for $100,000 or less.
- ☐ Contractor is a party to a collective bargaining agreement that began on _____ (date) and expires on _____ (date), and intends to comply when said agreement expires.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, and that I am authorized to bind this entity contractually.

_____ _____

Signature Name

_____ _____

Date Title

ANTI-TRUST LAWS QUESTIONNAIRE

THIS QUESTIONNAIRE MUST BE COMPLETED IN FULL AND SUBMITTED WITH THE BID

Project: ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE

Company Name: _____

In accordance with instructions from the State of California Attorney General's Office, with regard to California and Federal Anti-Trust Laws, answers to the following must be included with the bid.

1. _____Yes _____No Were bid depository of registry services used in obtaining subcontractor bid figures in order to compute your bid?

2. If the answer to No. 1 is "Yes" please list the subcontractors using a bid depository or registry service.

_____

_____

_____

_____

_____

3. _____Yes _____No Did you have any source of subcontractor's bids other than bid depositories?

4. _____Yes _____No Has any person or group threatened you with subcontractor boycotts, union boycotts, or other sanctions to attempt to convince you to use the services or abide by the rules of one or more bid depositories?

Date: _____ Name: _____

Nature of the threats: _____

Additional comments: _____

AGREEMENT

THIS AGREEMENT, entered into this _____ day of _____, 20__, by and between the COUNTY OF SAN MATEO, a Political Subdivision of the State of California, hereinafter called the "County", and _____, hereinafter called the "Contractor".

WITNESSETH that the Contractor and the County, in consideration of the mutual covenants, considerations and agreements herein contained, agree as follows:

STATEMENT OF WORK – The Contractor shall furnish all labor and materials and perform all work for:

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROLS SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CALIFORNIA
PROJECT NO. PF404

in strict accordance with the Contract Documents.

TIME FOR COMPLETION – The work shall be commenced on a date to be specified in the Notice to Proceed issued by the County and shall be completed within one hundred twenty (120) calendar days.

COMPENSATION TO BE PAID TO CONTRACTOR – The County will pay and the Contractor will accept in full consideration for the performance of the contract, subject to additions and deductions and procedures for payment as provided therein, the sum of _____ ($_____) which is the Contractor's Bid. The Contract as defined in paragraph 1.1 of the General Conditions constitutes the sole agreement of the parties hereto relating to said work and correctly states the rights, duties, and obligations of each party as of the document's date. Any prior agreement, promises, negotiations, or representations between the parties not expressly stated in this document are not binding. All subsequent modifications shall be in writing.

IN WITNESS WHEREOF, the parties hereto on the day and year first above written have executed this agreement in three counterparts, each of which shall, without proof or accounting for the other counterparts, be deemed an original thereof.

COUNTY OF SAN MATEO

A Political Sub-Division of the State of California

By _____
President, Board of Supervisors

Attest:

_____
John L. Maltbie, County Manager
Clerk of the Board of Supervisors

Contractor

By _____

PAYMENT BOND

KNOW ALL PERSONS BY THESE PRESENTS:

That WHEREAS, the County of San Mateo, hereinafter designated as the "County," has awarded to (CONTRACTOR"S NAME), hereinafter designated as the "Principal," a contract dated (CONTRACT AWARD DATE), hereinafter designated as the "Contract," which Contract is by this reference made a part hereof, for the work described as

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CALIFORNIA
PROJECT NO. PF404

And WHEREAS, pursuant to law, the Principal is required, before entering upon the performance of the work, to file a good and sufficient bond with the body by whom the Contract is awarded to secure the claims to which reference is made in Sections 9550 to 9566 and 9100 to 9364 both inclusive, of the Civil Code of California.

NOW THEREFORE, THESE PRESENTS WITNESSETH:

That the said Principal and the undersigned, _____, as corporate Surety, are held and firmly bound unto all laborers, material men and other persons referred to in said statutes in the sum of

_____Dollars ($_____)
lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, or assigns, jointly and severally, by these presents.

The condition of this obligation is that if the above bonded Principal, contractor, person, company or corporation, or his or its sub-contractor, fails to pay any claimant name in Section 9100 of the Civil Code of the State of California, or amounts due under the Unemployment Insurance Code, with respect to work or labor performed by any such claimant, that the Surety on this bond will pay the same, in an amount not exceeding the aggregate sum specified in this bond, and also, in case suit is brought upon this bond, a reasonable attorney's fee, which shall be awarded by the court to the prevailing party in said suit, and attorney's fees to be taxed as costs in said suit.

It is hereby expressly stipulated and agreed that this bond shall inure to the benefit of any and all persons, companies and corporations entitled to file claims under Section 9100 to 9364 of the Civil Code, so as to give a right of action to them or their assigns in any suit brought upon this bond.

This bond is executed and filed to comply with the provisions of the act of Legislature of the State of California as designated in the Civil Code, Sections 9550-9566 inclusive, and all amendments thereto.

Should the condition of this bond be fully performed, then this obligation shall become null and void, otherwise it shall be and remain in full force and effect.

And the said Surety, for value received, hereby stipulates and agrees that no charge will be made which increases the total Contract price more than twenty percent (20%) in excess of the original Contract price without notice to the Surety, then, this obligation to be void, otherwise to remain in full force and virtue.

Correspondence relating to this bond shall be sent to the Surety at the address set forth below.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and Surety this _____ day of _____, 20___.

_____	_____
Principal	Surety
_____	_____
Signature	Signature
_____	_____
Printed Name	Printed Name

Address for Notices

_____

_____

_____

_____

NOTE: Notary acknowledgement for Surety and Surety's Power of Attorney must be attached.

PERFORMANCE BOND

KNOW ALL PERSONS BY THESE PRESENTS:

That WHEREAS, the County of San Mateo, hereinafter designated as the "County," has awarded to (CONTRACTOR'S NAME), hereinafter designated as "Principal," a contract dated (CONTRACT AWARD DATE), hereinafter designated as the "Contract," which Contract is by this reference made a part hereof, for the work described as

COUNTY OFFICE BUILDING TWO
ENERGY MANAGEMENT & CONTROL SYSTEM UPGRADE
555 COUNTY CENTER
REDWOOD CITY, CALIFORNIA
PROJECT NO. PF404

And WHEREAS, Principal is required to furnish a bond in connection with the Contract, guaranteeing the faithful performance thereof;

NOW THEREFORE, THESE PRESENTS WITNESSETH:

That the said Principal and the undersigned, _____, as corporate Surety, are held and firmly bound unto the County in the sum of

_____ Dollars ($_____)
lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

The condition of this obligation is such, that if the Principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of said Contract during the original term of said Contract and any extensions thereof that may be granted by the County, with or without notice to the Surety, and during the life of any guarantee required under the Contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to Surety being hereby waived, on Principal's part to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify, defend, protect, and hold harmless the County as stipulated in the Contract, then this obligation shall become and be null and void; otherwise it shall be and remain in full force and effect.

No extension of time, change, alteration, modification, or addition to the Contract, or of the work required thereunder, shall release or exonerate Surety on this bond or in any way affect the obligation of this bond; and Surety does hereby waive notice of any such extension of time, change, alteration, modification, or addition.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and Surety this _____ day of _____, 20_____.

_____	_____
Principal	Surety
_____	_____
Signature	Signature
_____	_____
Printed Name	Printed Name

NOTE: Notary acknowledgement for Surety and Surety's Power of Attorney must be attached.

(Contractor's or Subcontractor's own letterhead)

GUARANTEE FOR (PROJECT NAME, PROJECT NUMBER).

(PROJECT ADDRESS,)

We (Contractor's name) hereby guarantee (Trade or Work Scope)

beginning _____ for _____ year(s) in accordance with the Contract Documents.

We agree to repair or replace to the satisfaction of the Owner any and all such work that may prove defective in workmanship or materials within that period, ordinary wear and tear and unusual abuse or neglect excepted, together with all other work which may be damaged or displaced in so doing.

In the event of our failure to comply with the above-mentioned conditions within seven calendar days after being notified in writing, we collectively and separately do hereby authorize the Owner to proceed to have the defects repaired and made good at our expense, and will pay the costs and charges therefore immediately upon demand.

I hereby certify that I am authorized to sign this document.

Date_____ _____
(Signature of Subcontractor)

_____
Print Name and Title

Date_____ _____
(Signature of Contractor)

_____
Print Name and Title

(Contractor must co-sign with Subcontractor)

RecycleWorks

COUNTY OF SAN MATEO
WASTE MANAGEMENT PLAN

Case/Group Number(s):

BLD _____ — _____

Project Address:

Street _____

City _____

SUBMIT TO:

County of San Mateo
Public Works Department – RecycleWorks
555 County Center, 5th Floor
Redwood City, CA 94063
Mon. – Fri. 8:00-12:00, 1:00-4:00

INFORMATION AND SUPPORT: www.RecycleWorks.org/con_dem
1-888-442-2666

WMP REQUIRED BECAUSE PROJECT IS A

- ❑ Demolition ≥ $5000
- ❑ Construction project ≥ $250,000
- ❑ Construction ≥ 2000 sq. ft.
- ❑ Remodel

SECTION ONE: PERMIT APPLICATION

This Waste Management Plan (WMP) must be completed, submitted for review, and approved to obtain a building permit. Separate WMPs must be completed for demolition and construction at the same site unless the building department requires only one permit.

STEP 1: PROJECT INFORMATION – FILL OUT THE FOLLOWING INFORMATION

Applicant's Name: _____ Owner's Name: _____

Contact Phone Number: _____ Fax Number: _____

Check one: ❑ Owner ❑ Architect ❑ Builder ❑ Owner/Builder ❑ Other _____

Contractor: _____ Contact Phone Number: _____

Project Type(s): ❑ New ❑ Remodel ❑ Addition ❑ Demolition

Project Square Footage: _____

Does this project fall under the Green Building Ordinance requirements? ❑ Yes ❑ No

Project Description: _____

Estimated Completion Date: _____

STEP 2: WASTE MANAGEMENT REQUIREMENTS

REQUIREMENTS: You are required to recycle or re-use 100% of inert solids (asphalt, brick, concrete, dirt, fines, rock, sand, and stone) and 50% of all other construction and demolition debris.

I understand that I am required by San Mateo County Ordinance No. 04099 to salvage, reuse, or recycle **100% of inert solids** (asphalt, brick, concrete, dirt, fines, rock, sand, and stone) and a **minimum of 50%** of all other construction and demolition debris (C&D). _____(Initial)

I understand that failure to meet the requirements of Ordinance No. 04099 shall constitute a misdemeanor, and shall be punishable by imprisonment in the county jail for up to 6 months, or by a fine of up to $1,000, or both. In addition a stop order on the job or a delay of final approval may occur. _____ (Initial)

At the completion of this project, or more frequently if required, all weight tags or other equivalent documentation from salvage, recycling and waste facilities will be provided to the County of San Mateo and I understand that I may not be issued my final inspection unless all receipts and documentation are submitted to the County of San Mateo Public Works Department. _____ (Initial)

Please only include construction and demolition waste weight tags; no household waste.

STEP 3: RECYCLING CONSTRUCTION AND DEMOLITION DEBRIS – ANSWER THE QUESTIONS AND FILL OUT THE TABLE BELOW.

SALVAGE AND REUSE:

What materials will be salvaged? _____

Salvage Company (if applicable): _____

What materials will be reused on site? _____

How will this be documented? _____

MATERIAL TRANSPORTATION:

Will you be using a hauling company, debris box company or hauling the material yourself? (Check one.)

❑ Hauler ❑ Debris Box ❑ Self-haul

If using a hauling or debris box company, which company? _____
Have they been notified that the diversion of 50% mixed debris is required? ❑ Yes ❑ No

WASTE MANAGEMENT PLAN:

Check the materials you anticipate generating and fill in the facilities that you plan to use.

SECTION ONE			
Category	Material	√	Reuse, Recycling or Disposal Facility
MIXED C&D	Mixed debris *		
INERTS	Asphalt		
	Bricks		
	Concrete		
	Dirt		
	Other inert solids		
SOURCE SEPARATED	Cardboard		
	Metals		
	Wood		
	Roofing		
	Carpet		
	Drywall		
	Green Waste		
	Other		
DISPOSAL	Waste		

**One compliance option is to take all loads of mixed debris to a facility that will sort your loads of mixed debris. The sorting facilities listed in our Construction Site Recycling Guide will satisfy the County's requirement.*

The undersigned hereby agrees to comply with the Waste Management Plan as submitted and is the owner or authorized agent to sign for the owner of this project.

Applicant Signature _____ **Date** _____

County Approval: ❑ Approved ❑ Approved with comments ❑ Denied

_____

_____

All original receipts, weight tags and documentation for salvage, recycling, and disposal must be submitted:
❑ On completion of project ❑ Other _____

DPW Approval: _____ Date _____

Building Official Approval: _____ Date_____

COUNTY OF SAN MATEO
WASTE MANAGEMENT PLAN

Address_____
Case/Group Number(s):
BLD _____—_____

SECTION TWO: FINAL REPORT APPROVAL

Please complete this section, have it approved by the Public Works Department, and then submit to the Development Review Center for final approval no later than 30 days after completion of the demolition or construction project.

This section must be completed and signed, and all original receipts or other supporting documentation must be attached in order to receive final project approval.

CATEGORY	DATE	MATERIAL/ITEMS	FACILITY	WEIGHT (TONS)	VOLUME (CU. YD.)
MIXED C&D WASTE					
SALVAGE					
INERTS Asphalt, bricks, concrete, dirt, rock, sand, soil, stone					
SOURCE SEPARATED Cardboard, wood, metal, sheetrock, wire, carpet, yard trimmings, (reusable items)					
DISPOSAL					

❑ All original receipts or equivalent documentation for salvage, recycling, and disposal are hereby attached.
❑ This project has recycled all of the inert solids and at least 50% of all other debris generated.

Applicant Signature _____ **Date** _____

County Approval: ❑ Approved ❑ Approved with comments ❑ Denied

_____

_____

DPW Approval: _____ Date _____

Building Official Approval: _____ Date _____

SAN MATEO COUNTY OFFICE BUILDING II EMCS UPGRADE

SECTION 250000

ENERGY MANAGEMENT AND CONTROL SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This project consists of replacing the existing pneumatic and direct digital control systems at the San Mateo County Office Building II in Redwood City with a new Energy Management and Control System (EMCS).

B. The purpose of the replacement is to replace obsolete control systems and to improve the functionality and energy efficiency of the HVAC systems.

C. Work Excluded

1. Cost of repairing existing equipment that is specified to be reused, if required.

2. Lighting controls

1.2 CONTRACTOR PROPOSALS

A. Contractor shall visit site prior to bid. Ascertain and check all conditions and take all measurements that may affect the work. No allowance shall subsequently be made for any additional expenses or claims due to the failure or neglect under this section to make such examination, including examination of restricted working conditions or such other difficulties that can be visually observed during site visit.

B. The system requirements described in this specification are generally performance based. Where requirements are prescriptive, the intent is to provide minimum quality, not to give unfair advantage to any given manufacturer or product. If a contractor finds that a certain requirement is unduly difficult or expensive to meet, contact the Engineer prior to bid due date and an addendum modifying the requirement will be considered.

C. Where requirements are unclear, the contractor shall clarify the requirements with the Engineer before the bid due date. Where requirements continue to be unclear, the contractor's proposal must accurately describe what is included and excluded.

D. By submitting a proposal, contractor guarantees that their proposal is in full compliance with these specifications and is complete and turnkey, except where specific exceptions are provided herein or clearly noted in the contractor's proposal.

E. Include any charges, including overtime wages, required to perform work within scheduling criteria and use-of-premises restrictions specified in paragraph 1.41.

F. Bid proposals shall include:

1. Completed bid forms

2. Any clarifications and exceptions to these specifications. Do not exclude work that is required – this is a turn-key project with no other contractors involved.

1.3 UNIT PRICING

A. Unit Prices. Unit prices shall include all equipment, material, labor, design engineering, start-up and testing costs necessary to provide a complete operational system. Prices may be used to add or deduct items from scope during the period of the contract and assume that options are accepted prior to installation.

1. Zone upgrades

a. Each CO2 sensor added to VAV zone

b. Each supply air temperature sensor added to a VAV zone

2. Replace (E) VAV box with new Titus or equal box, including net impact on controls cost if any. Assume all work done on overtime.

3. Relocate (E) thermostat within 20 feet including patching and painting.

1.4 SCHEDULE OF WORK

1. After issuance of Notice to Proceed the work should be completed in 120 calendar days.

1.5 USE OF PREMISES

A. EMCS Contractor shall become fully informed of, and shall fully comply with, Owner's site security requirements and provisions.

B. EMCS Contractor shall limit the storage of materials and equipment on-site to specific areas approved by Owner. The Owner may also limit the type of material stored. At no time during the work under the contract shall the EMCS Contractor place, or cause to be placed, any material or equipment at any location that would impede or impair access to or from the present facilities.

C. EMCS Contractor shall send proper notices, make all necessary arrangements, and perform all services required in the care and maintenance of building utilities to the extent that these utilities may be affected and/or interrupted by the EMCS installation work. Building utilities include telephone / telecommunications, electrical service, natural gas, central heating and cooling, water, and other utilities necessary for building operation and occupant comfort.

D. All work that has the potential for interrupting building usage, utilities, and/or maintenance services shall be scheduled to occur during evenings and/or weekends and coordinated with Owner. This includes all VAV box upgrade work, all work in public areas, offices, etc. Work in mechanical rooms, roof, garage, and other areas not generally inhabited by building occupants may be conducted during normal work hours except any cutting and drilling work from which dissipated noise and vibration may impact the normal work of building occupants

E. The building will remain operational during construction. Changes to systems that affect these areas must be minimal in impact and time out-of-service. The functions of the existing EMCS must be migrated in a manner that keeps all systems operational throughout the

duration of this work. All down-times must be scheduled in advance with approval of Owner.

1. Air handling systems serving tenant spaces shall be operational during normal business hours, except they may be shut off for occasional periods not exceeding 15 minutes and shall be operational for at least 45 minutes between outages.

2. Auxiliary condenser water plant shall be operational 24/7 unless first coordinated with building engineering staff to arrange for temporary shut-down or temporary cooling.

3. Hot water plant shall be operational during normal business hours, except it may be shut off for occasional periods not exceeding 60 minutes and shall be operational for at least 60 minutes between outages, and may be off whenever outdoor air temperature is greater than 65ºF.

1.6 REUSE OF EXISTING SYSTEMS AND EQUIPMENT

A. Unless otherwise directed, the Controls Contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators that are designated to be reused. Should the Contractor find existing equipment that requires maintenance, the Owner shall be notified immediately.

B. Patch and paint at demo'd wall sensors visible to occupants.

C. Wiring

1. All existing control conduit may be reused.

2. All existing wiring to digital inputs and outputs may be reused.

3. All wiring to analog inputs and outputs may be reused.

4. All network wiring shall be new.

5. Where wiring is allowed to be reused, its integrity and suitability to the new application is the responsibility of the Contractor. Wiring shall be properly identified and tested. The cost to replace/repair defective wiring is outside the scope of this proposal.

6. Unused or redundant wiring and conduit shall be removed.

D. Dampers

1. Reuse existing dampers.

2. Replace damper actuators with new Belimo actuators

E. Valves

1. Valve bodies and actuators at VAV boxed shall be replaced. New valves are primarily 2-way rather than 3-way.

F. Temperature Sensors

1. Existing temperature sensors shall be replaced, except as specifically indicated in the Control Points section.

2. Existing wells in piping for temperature sensors may be reused.

3. Unused wells in piping may be abandoned in place.

G. Other Sensors

1. Reuse existing sensors unless specifically called out to be new in Control Points lists.

2. Existing static pressure tips may be used provided their location is found and noted on shop drawings.

H. Local Control Panels and cabinets

1. The Contractor may reuse any existing local control panels to locate new equipment.

2. All unused existing equipment within these panels must be removed and shall not be reused.

3. All unused panels shall be removed.

I. Starters and variable speed drives

1. Reuse existing starters and variable speed drives; repair of same is not part of this project.

J. Safeties and Fire Alarm Controls

1. All life safety systems are existing and to be reused.

2. Existing safeties in control circuits (duct smoke detectors, life safety system interlocks) are not to be bypassed and are to remain functional at all times during and after construction.

K. Instrumentation. Existing pressure gauges and thermometers on pumps, boilers, etc. are to remain as-is; repair or calibration of same are not part of this project.

1.7 REFERENCE STANDARDS

A. Nothing in Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, and regulations. When Contract Documents differ from requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement.

B. The latest published or effective editions, including approved addenda or amendments, of the following codes and standard shall apply to the EMCS design and installation as applicable.

C. State, Local, and City Codes

1. CBC − California Building Code

2. CMC − California Mechanical Code

3. CEC – California Electrical Code

4. Local City and County Codes

D. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ANSI/ASHRAE 135 – BACnet - A Data Communication Protocol for Building Automation and Control Networks.

2. ANSI/ASHRAE Standard 15 – Safety Standard for Refrigeration Systems.

E. Electronics Industries Alliance

1. EIA-232 – Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

2. EIA-458 – Standard Optical Fiber Material Classes and Preferred Sizes.

3. EIA-485 – Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.

4. EIA-472 – General and Sectional Specifications for Fiber Optic Cable.

5. EIA-475 – Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications.

6. EIA-573 – Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications.

7. EIA-590 – Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications.

F. Underwriters Laboratories

1. UL 916 – Energy Management Systems.

G. National Electrical Manufacturers Association

1. NEMA 250 – Enclosure for Electrical Equipment.

H. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems.

2. IEEE 802.3 – CSMA/CD (Ethernet – Based) LAN.

3. IEEE 802.4 – Token Bus Working Group (ARCNET – Based) LAN.

1.8 DEFINITIONS

A. Acronyms

AAC	Advanced Application Controller
AH	Air Handler
AHU	Air Handling Unit
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
ASC	Application Specific Controllers
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
A-to-D	Analog-to-Digital
BACnet	Data Communications Protocol for Building Automation and Control Systems
BC	Building Controller
BIBB	BACnet Interoperability Building Blocks
BTL	BACnet Testing Laboratory
CAD	Computer Aided Drafting
CHW	Chilled Water
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
COV	Change of Value
CSS	Control Systems Server
CU	Controller or Control Unit
CV	Constant Volume
CW	Condenser Water
CWR	Condenser Water Return
CWS	Condenser Water Supply
DBMS	Database Management System
DDC	Direct Digital Control
DHW	Domestic Hot Water
DI	Digital Input
DO	Digital Output
D-to-A	Digital-to-Analog
EMCS	Energy Management and Control System
EMT	Electrical Metallic Tubing
EP	Electro-Pneumatic
ETL	Edison Testing Laboratories
FAS	Fire Alarm System
GUI	Graphical User Interface
HHD	Hand Held Device
HOA	Hand-Off-Automatic
HVAC	Heating, Ventilating and Air-Conditioning
HTTP	Hyper-Text Transfer Protocol
I/O	Input/output
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LAN	Local Area Network

LANID	LAN Interface Device
MAC	Medium Access Control
MHz	Megahertz
MS/TP	Master-Slave/Token-Passing
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
ODBC	Open Database Connectivity
OI	Operator Interface
OWS	Operator Workstation
P	Proportional
PC	Personal Computer
PI	Proportional-Integral
PICS	Protocol Implementation Conformance Statement
PID	Proportional-Integral-Derivative
POT	Portable Operators Terminal
PTP	Point-to-Point
RAM	Random Access Memory
SOO	Sequence of Operation
SQL	Standardized Query Language
SSL	Secure Socket Layers
TAB	Test, Adjust, and Balance
TDR	Time Delay Relay
UL	Underwriters' Laboratories, Inc.
XML	Extensible Markup Language

B. Terms

Term	Definition
Accessible	Locations that can be reached with no more than a ladder to assist access and without having to remove permanent partitions or materials. Examples include inside mechanical rooms, mechanical equipment enclosures, instrument panels, and above suspended ceilings with removable tiles.
BACnet Interoperability Building Blocks	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Change of Value	An event that occurs when a digital point changes value or an analog value changes by a predefined amount.
Client	A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
Concealed	Embedded in masonry or other construction, installed in furred spaces, within double partitions, above hung ceilings, in trenches, in crawl spaces, or in enclosures.

Term	Definition
Continuous Monitoring	A sampling and recording of a variable based on time or change of state (such as trending an analog value, monitoring a binary change of state).
Contract Documents	Specifications, drawings, and other materials provided with request for bids.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to BCs, AACs, and ASCs.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Energy Management and Control System	The entire integrated management and control system.
Equal	Approximately equal in material types, weight, size, design, quality, and efficiency of specified product.
Exposed	Not installed underground or concealed.
Furnish	To purchase, procure, acquire and deliver complete with related accessories.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Hand Held Device	Manufacturer's microprocessor based portable device for direct connection to a field Controller.
Inaccessible	Locations that do not meet the definition of accessible. Examples include inside furred walls, pipe chases and shafts, or above ceilings without removable tiles.
Indicated, shown or noted	As indicated, shown or noted on drawings or specifications.
Install	To erect, mount and connect complete with related accessories.
Instrumentation	Gauges, thermometers and other devices mounted in ductwork or piping that are not a part of the EMCS.
IT LAN	Reference to the facility's Information Technology network, used for normal business-related e-mail and Internet communication.
LAN Interface Device	Device or function used to facilitate communication and sharing of data throughout the EMCS.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Motor Controllers	Starters, variable speed drives, and other devices controlling the operation of motors.

Term	Definition
Native BACnet Device	A device that uses BACnet for communication. A device may also provide gateway functionality and still be described as a Native BACnet device.
Native BACnet System	A network composed only of Native BACnet Devices without gateways.
Open Database Connectivity	An open standard application-programming interface for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system is handling the data.
Open Connectivity	OPC is an interoperability standard developed for industrial applications. OPC compliant systems make it possible to access or exchange data from any application, regardless of which database management system is handling the data.
Operator Interface	A device used by the operator to manage the EMCS including OWSs, POTs, and HHDs.
Operator Workstation	The user's interface with the EMCS system. As the EMCS network devices are stand-alone, the OWS is not required for communications to occur.
Owner	The Owner or their designated representatives.
Piping	Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and related items.
Points	All physical I/O points, virtual points, and all application program parameters.
Point-to-Point	Serial communication as defined in the BACnet standard.
Portable Operators Terminal	Laptop PC used both for direct connection to a controller and for remote dial up connection.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Provide	Furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
Reviewed, approved, or directed	Reviewed, approved, or directed by or to Owner's Representative.
Router	A device that connects two or more networks at the network layer.
Secondary Controlling LAN	LAN connecting AACs and ASCs.
Server	A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.

Term	Definition
Standardized Query Language	SQL - A standardized means for requesting information from a database.
Supervisory LAN	Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs, CSS, and THS. See System Architecture below.
Supply	Purchase, procure, acquire and deliver complete with related accessories.
Wiring	Raceway, fittings, wire, boxes and related items.
Work	Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

1.9 QUALITY ASSURANCE

A. Materials and Equipment

1. Manufacturer's Qualifications: See 2.1 for approved manufacturers.

2. Product Line Demonstrated History: The direct digital control equipment product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of one year since date of final completion in at least 10 installations of comparative size and complexity.

3. All products used in this Project installation shall be new, currently under manufacture, and shall have been available from the manufacturer for a minimum of 6 months prior to date of proposal and previously installed and proven effective in installations of similar nature, not including test sites. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing. Spare parts shall be available for at least five years after completion of this contract.

4. All BACnet devices must either be certified as complaint with the BACnet standard through a listing by the BACnet Testing Laboratory (BTL) or the vendor must supply proof of having submitted the device for testing by BTL.

5. The EMCS and components shall be listed by Underwriters Laboratories UL 916 as an Energy Management System.

6. Manufacturer shall be ISO 9001 registered.

B. Installer

1. EMCS Contractor's Project Manager Qualifications: Individual shall specialize in and be experienced with direct digital control system installation for not less than 3 years. Project Manager shall have experience with the installation of the proposed direct digital control equipment product line for not less than 2 projects of similar size and complexity. Project Manager must have proof of having successfully completed the most advanced training offered by the manufacturer of the proposed product line.

2. EMCS Contractor's Programmer Qualifications: Individual(s) shall specialize in and be experienced with direct digital control system programming for not less than 3 years and

with the proposed direct digital control equipment product line for not less than 1.5 years. Programmers must show proof of having successfully completed the most advanced programming training offered by the vendor of the programming application on the proposed product line.

3. EMCS Contractor's Service Qualifications: The installer must be experienced in control system operation, maintenance and service. EMCS Contractor must document a minimum 5-year history of servicing installations of similar size and complexity. Installer must also document at least a 1-year history of servicing the proposed product line.

4. Installer's Response Time and Proximity

    a. Installer must maintain a fully capable service facility within 50 miles of the subject Project. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.

    b. Installer must demonstrate the ability to meet the emergency response times listed in Paragraph 1.15B.1.

5. Electrical installation shall be by manufacturer-trained electricians.

    a. Exception: Roughing in wiring and conduit and mounting panels may be subcontracted to any licensed Union electrician.

1.10 SUBMITTALS

A. No work may begin on any segment of this Project until the related submittals have been reviewed for conformity with the design intent and the Contractor has responded to all comments to the satisfaction of the Owner's Representative.

B. Submit drawings and product data as hereinafter specified.

C. Submittal Schedule: Submittal schedule shall be as follows unless otherwise directed by the Owner's Representative:

1. Allow 10 working days for approval, unless Owner's Representative agrees to accelerated schedule.

2. Submittal Package 1 (Hardware and Shop Drawings) shall be submitted in accordance with schedule established by the Owner in bid documents.

3. Submittal Package 2 (Programming and Graphics) and shall be submitted no less than 30 days before software is to be installed in field devices.

4. Submittal Package 3 (Functional Testing) shall be submitted no less than 30 days prior to conducting tests.

5. Submittal Package 4 (Training Materials) shall be submitted no less than 14 days prior to conducting first training class.

6. Submittal Package 5 (Post-Construction Trend Logs) shall be submitted after demonstration tests are accepted and systems are in full automatic operation. The list of points to be trended shall be submitted for approval 14 days prior to the start of the trend collection period.

D. Submission and Resubmission Procedure

1. Each submittal shall have a unique serial number that includes the associated specification section followed by a number for each sub-part of the submittal for that specification section, such as SUBMITTAL 250000-01.

2. Each resubmittal shall have a the original unique serial number plus unique revision number such as SUBMITTAL 250000-01 REVISION 1.

3. Submit one copy of submittal in electronic format specified under each submittal package below. Submissions made in the wrong format will be returned without action.

4. Owner's Representative will return a memo or mark-up of submittal with comments and corrections noted where required.

5. Make corrections

   a. Revise initial submittal to resolve review comments and corrections.

   b. Indicate any changes that have been made other than those requested.

   c. Clearly identify resubmittal by original submittal number and revision number.

6. Resubmit revised submittals until no exceptions are taken.

7. Once submittals are accepted with no exceptions taken, make photocopies for coordination with other trades. Photocopies will serve as submittal for record and coordination.

E. Submittals Packages

1. Submittal Package 1 (Hardware and Shop Drawings)

   a. Hardware

      1) Organize by specification section and device tags as tagged in these specifications.

      2) Do not submit products that are not used even if included in specifications.

      3) Include a summary table of contents listing for every submitted device:

         a) Tab of submittal file/binder where submittal is located

         b) Device tag as tagged in these specifications (such as TS-1A, FM-1)

c) Specification section number (down to the lowest applicable heading number)

d) Whether device is per specifications and a listed product or a substitution

e) Manufacturer

f) Model number

g) Device accuracy (where applicable)

h) Accuracy as installed including wiring and A/D conversion effects (where applicable)

4) Submittal shall include manufacturer's description and technical data, such as performance data and accuracy, product specification sheets, and installation instructions for all control devices and software.

5) When manufacturer's cut-sheets apply to a product series rather than a specific product, the data specifically applicable to the Project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements.

6) Format: Word-searchable format per Paragraph 1.11C.2.

b. Shop Drawings

1) System architecture one-line diagram indicating schematic location of all control units, workstations, LAN interface devices, gateways, etc. Indicate address and type for each control unit. Indicate media, protocol, baud rate, and type of each LAN.

2) Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. The schematics provided on Drawings shall be the basis of the schematics with respect to layout and location of control points.

3) All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

4) All (E) fire alarm points and functionality shall be shown on Drawings.

5) Label each input and output with the appropriate range.

6) Device table (Bill of Materials). With each schematic, provide a table of all materials and equipment including.

a) Device tag as indicated in the schematic and actual field labeling (use tag as indicated in these specifications where applicable and practical)

b) Device tag as indicated in these specifications where applicable and if it differs from schematic device tag

c) Description

d) Proposed manufacturer and model number

e) Range

f) Quantity

7) With each schematic or on separate valve sheet, provide valve and actuator information including size, C_v, design flow, target pressure drop, actual design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.

8) Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

9) Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

10) Floor plans

a) Provide floor plans indicating the approximate location of the VAV zone terminal unit, dampers, and temperature sensor.

11) Format

a) Sheets shall be consecutively numbered.

b) Each sheet shall have a title indicating the type of information included and the mechanical/electrical system controlled.

c) Table of Contents listing sheet titles and sheet numbers.

d) Legend and list of abbreviations.

e) Schematics and floor plans

1. AutoCAD or Visio compatible format.

2. 17 inch x 11 inch.

c. Do not include sequence of controls on shop drawings or equipment submittals; they are included in Submittal Package 2.

d. Submit along with shop drawings but under separate cover memory allocation projections and calculated and guaranteed system response times of the most heavily loaded LAN in the system.

2. Submittal Package 2 (Programming and Graphics)

a. A detailed description of point naming convention conforming to Paragraph 3.12B to be used for all software and hardware points, integrated with existing database convention.

b. A list of all hardware and software points identifying their full text names, device addresses and descriptions.

c. Control Logic Documentation

1) Submit control logic program listings (graphical programming) consistent with specified English-language Sequences of Operation for all control units.

2) Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.

3) Include specified English-language Sequences of Operation of each control sequence updated to reflect any suggested changes made by the Contractor to clarify or improve the sequences. Changes shall be clearly marked. SOO shall be fully consistent with the graphical programming. (An electronic version of the sequences of controls in Paragraph 3.12 will be provided to the Contractor upon request.)

4) Include control settings, setpoints, throttling ranges, reset schedules, adjustable parameters and limits.

5) Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation.

d. Graphic screens of all required graphics, provided in final colors.

e. Format

1) Points list: Word-searchable format per Paragraph 1.11C.2.

2) Programming: Native electronic file if interpreter is available (such as ALC Eikon or Alerton Visio); otherwise provide pdf files of screen shots.

3) Programming and operating manual: Word-searchable format per Paragraph 1.11C.2.

4) Graphics: Graphical electronic format (pdf, png, etc.).

3. Submittal Package 3 (Functional Testing)

a. Provide pre-functional test forms as required by Paragraph 3.15C.1.a.

b. Provide functional test forms as required by Paragraph 3.15C.2.

c. Format: Word-searchable format per Paragraph 1.11C.2.

4. Submittal Package 4 (Training Materials)

a. Provide training materials as required by Paragraph 3.16.

b. Format: Word-searchable format per Paragraph 1.11C.2.

5. Submittal Package 5 (Trend Logs)

a. Provide a list of points being trended along with trend interval or change-of-value per Paragraph 3.15G.2.d.

b. Provide trend logs as required by Paragraph 3.15G.

c. Format: See Paragraph 2.11D.11.

1.11 COMPLETION REQUIREMENTS

A. Procedure

1. Until the documents required in this Section are submitted and approved, the system will not be considered accepted and final payment to Contractor will not be made.

2. Before requesting acceptance of Work, submit one set of completion documents for review and approval of Owner.

3. After review, furnish quantity of sets indicated below to Owner.

B. Completion Documents

1. Operation and Maintenance (O & M) Manuals. Provide in both paper and electronic format per Paragraph 1.11C.

a. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual.

b. As-built versions of the submittal product data. Submittal data shall be located in tabs along with associated maintenance information.

c. Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.

d. Complete original issue documentation, installation, and maintenance information for all third-party hardware and software provided, including computer equipment and sensors.

e. A list of recommended spare parts with part numbers and suppliers.

f. Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.

g. Programming Manuals with a description of the programming language, control block descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the programming editor.

h. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

i. A listing and documentation of all custom software for the Project created using the programming language, including the set points, tuning parameters, and point and object database.

j. English language control sequences updated to reflect final programming installed in the EMCS at the time of system acceptance.

k. A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface.

2. Complete original issue CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

3. Complete CD copy of EMCS database, user screens, setpoints and all configuration settings necessary to allow re-installation of system after crash or replacement of server, and resume operations with the EMCS in the same configuration as during owner sign-off.

4. Project Record Drawings.

   a. As-built versions of the submittal drawings in reproducible paper and electronic format per Paragraph 1.11C.

   b. As-built network architecture drawings showing all BACnet nodes including a description field with specific controller and device identification, description and location information.

5. Commissioning Reports. Completed versions of all Pre-functional, Functional, and Demonstration Commissioning Test reports, calibration logs, etc., per Paragraph 3.15C.

6. Copy of inspection certificates provided by the local code authorities.

7. Written guarantee and warranty documents for all equipment and systems, including the start and end date for each.

8. Training materials as required by 3.16E.

9. Contact information. Names, addresses, and 24-hour telephone numbers of contractors installing equipment, and the control systems and service representatives of each.

C. Format of Completion Documents

1. Provide the type and quantity of media listed in table below.

2. Project database, programming source files, and all other files required to modify, maintain, or enhance the installed system shall be provided in their source format and compiled format (where applicable).

3. Where electronic copies are specified, comply with the following:

a. Provide in word-searchable electronic format; acceptable formats are MS Word, Adobe Acrobat (pdf), and HTML; submit other formats for review and approval prior to submission; scanned paper documents not acceptable.

b. For submittals, provide separate file for each type of equipment.

c. Record drawings shall be in original format per Paragraph 1.10E.1.b.11)e).

d. Control sequences shall be in MS Word.

4. Optical media shall be readable on Operator Workstations.

	Document	Paper (binder or bound)	Electronic	
			Read only optical disk	Loaded onto CSS
1.	O&M Manual	5	1	1
2.	Original issue software	–	1 per workstation	1
3.	Project database including all source files	–	1 per workstation	1
4.	Project Record Drawings	5	1	1
5.	Control sequences	1	1	1
6.	Commissioning Reports	1	1	1
7.	Inspection Certificates	1	–	–
8.	Warranty documents	1	–	–
9.	Training materials	1 per trainee	1	1
10.	Contact information	1	–	1

D. Permanent On-site Documentation

1. In panels, provide point list of all points in panel in sufficiently permanent manner that list cannot be easily removed (and lost).

1.12 EMCS DESIGN

A. System Architecture

1. General

a. The system provided shall incorporate hardware resources sufficient to meet the functional requirements specified in this Section. Include all items not specifically itemized in this Section that are necessary to implement, maintain, and operate the system in compliance with the functional intent of this Section.

b. The system shall be configured as a distributed processing network(s) capable of expansion as specified herein.

c. The system will consist of EMCS Operator Workstation/server located in the building engineer's office in basement. They will connect via a high-speed network to BCs and other control devices located throughout the building. JACE panels shall not serve as the control system server.

d. All control products provided for this Project shall comprise an interoperable Native BACnet System. All control products provided for this Project shall conform to ANSI/ASHRAE Standard 135.

2. EMCS Network Architecture

a. Supervisory LAN: The LAN shall be an Ethernet-based, 100 or 1000 Mbps network connecting the server and OWS(s) and to certain gateways as specified herein. LAN shall be IEEE 802.3 Ethernet over Fiber with switches and routers that support 100 Mbps throughput. Power-line carrier communication are not acceptable for communications. This network shall be BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet. LAN shall be dedicated to the control system; the owner's intranet may not be used. Extend Supervisory LAN up to BCs in RTUs and provide port for operators to connect a laptop into the system in one of the RTUs.

b. Primary Controller LAN (Primary LAN): High-speed, peer-to-peer communicating LAN used to connect BCs, AACs, and certain gateways where specified herein. The Primary LAN communicates exclusively control information. Acceptable technologies include and are limited to:

1) Ethernet (IEEE802.3)

2) ARCNET (IEEE802.4)

c. Secondary Controller LAN (Secondary LAN): Network used to connect ASCs and certain gateways where specified herein. These may be Master Slave/ Token Passing (MS/TP) in addition to those allowed for Primary Controller LANs. Network speed versus the number of controllers on the LAN shall be dictated by the response time and trending requirements.

3. Operator Interfaces and Servers

a. Control Systems Server (CSS). This shall be a server upon which the systems configuration and programming databases are maintained and serves as web server for operator interface. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to or from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. It shall also store trend data uploaded from controllers.

b. The Operator Workstations and Portable Operator Terminals shall provide for overall system supervision, graphical user interface, management report generation, and alarm annunciation. Existing owner PCs and the CSS will serve as OWSs.

c. Remote monitoring and control shall be through use of a web browser via the internet through the DSL connection.

4. Controllers. The BCs, AACs, and ASCs shall monitor, control, and provide the field interface for all points specified.

5. Gateways

a. Gateways shall be provided only as required for connection to

1) Variable Speed Drive Controls

b. Where gateways are used, critical points shall be hard-wired from the EMCS to the controlled device, rather than using the gateway, to avoid problems with gateway failures, currently a common problem. Critical points are those that are essential for proper operation and are listed in points list as separate points. Where listed, these points shall be hard-wired even when available through gateway.

B. System Performance

1. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. This includes when system is collecting trend data for commissioning and for long term monitoring. (See Paragraph 3.15G.) In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein, assuming no other simultaneous operator activity. Reconfigure LAN as necessary to accomplish these performance requirements. This does not apply to gateways and their interaction with non-EMCS-vendor equipment.

a. Object Command: The maximum time between an operator command via the operator interface to change an analog or binary point and the subsequent change in the controller shall be less than 5 seconds.

b. Object Scan: All changes of state and change of analog values will be transmitted over the network such that any data used or displayed at a controller or workstation will have been current within the previous 10 seconds.

c. Graphics Scan: The maximum time between an operator's selection of a graphic and it completely painting the screen and updating at least 10 points shall be less than 10 seconds.

d. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation or broadcast to pager (where so programmed) shall not exceed 10 seconds for a Level 1 alarm, 20 seconds for alarm levels 2 and 3, and 30 seconds for alarm levels 4 and 5. All workstations on the onsite network must receive alarms within 5 seconds of each other.

e. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

f. Control Loop Performance: Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

2. Sensor selection, wiring method, use of transmitters, A-to-D conversion bits, etc. shall be selected and adjusted to provide end-to-end (fluid to display) accuracy at or better than those listed in the following table.

Measured Variable	**Reported Accuracy**
Space drybulb temperature	±1°F
Ducted Air drybulb temperature	±0.5°F
Mixed Air drybulb temperature	±1°F
Outside Air drybulb temperature	±0.5°F
Chilled Water Temperature at central plant mains only	±0.2°F
Chilled and Condenser Water Temperature − general	±0.5°F
Hot Water Temperature	±1°F
Water and Gas Flow	±1% of full scale
Airflow (terminal)	±10% of reading
Airflow (measuring stations)	±5% of full scale
Air Pressure (ducts)	±0.05 inches
Air Pressure (space)	±0.01 inches
Water Pressure	±2% of full scale
Electrical power	1% of reading
Carbon Dioxide (CO_2)	±75 ppm

1.13 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:

1. Project graphic images

2. Record drawings

3. Project database

4. Project-specific application programming code

5. All documentation

1.14 WARRANTY

A. At the successful completion of the final testing, commissioning, and demonstration phase in accordance with the terms of this specification, if equipment and systems are operating satisfactorily to the Owner and if all completion requirements per Paragraph 1.11B have been fulfilled, the Owner shall certify in writing that the control system has been accepted. The date of acceptance shall be the start of the warranty period.

B. Guarantee all materials, equipment, apparatus and workmanship (including programming) to be free of defective materials and faulty workmanship for the following periods from date of acceptance:

1. BCs, AACs, and ASCs: two years

2. Valve and damper actuators: five years

3. All else: one year

C. Provide new materials, equipment, apparatus and labor to replace that determined by Owner to be defective or faulty.

D. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

E. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies shall be provided at no cost to the Owner during the warranty period.

F. Sequence of operation programming bugs (both due to programming misinterpretations and sequence errors) shall be corrected and any reasonable control sequence changes required to provide proper system operation shall be provided at no additional cost to the Owner during this period.

1.15 WARRANTY MAINTENANCE

A. The Owner reserves the right to make changes to the EMCS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the EMCS.

B. At no cost to the Owner, provide maintenance services for software and hardware components during the warranty period as specified below:

1. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by the Owner to the Contractor.

a. Response by telephone or via internet connection to the EMCS to any request for service shall be provided within two hours of the Owner's initial request for service.

b. In the event that the malfunction, failure, or defect is not corrected, at least one technician, trained in the system to be serviced, shall be dispatched to the Owner's site within eight hours of the Owner's initial request for such services.

2. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following notification by the Owner to the Contractor.

a. Response by telephone to any request for service shall be provided within eight working hours (contractor specified 40 hr. per week normal working period) of the Owner's initial request for service.

b. In the event that the malfunction, failure, or defect is not, at least one technician, trained in the system to be serviced, shall be dispatched to the Owner's site within three working days of the Owner's initial request for such services, as specified.

3. Owner's Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended continuously (24/7). Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.

4. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.

5. Documentation: Record drawings and software documentation shall be updated as required to reflect any and all changes made to the system or programming during the warranty period.

PART 2 PRODUCTS

2.1 PRIMARY EMCS MANUFACTURER

A. The Energy Management and Control System (EMCS) as provided in this Division shall be based on the Tridium Niagara AX Framework. Systems not developed on the Niagara AX Framework platform are unacceptable.

B. Or preapproved equal

2.2 GENERAL

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way.

B. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

2.3 CONTROLLERS

A. General

1. Point information from any controller (including BCs, AACs, and ASCs) and from any gateway shall be capable of being used in a control sequence in any other panel. The use of OWS or CSS to serve as a communications server between control panels and gateways is not acceptable.

2. For all controllers, operating configuration and software shall be retained in the event of a power outage without requiring a download from upper level controllers by one or a combination of the following:

    a. Volatile RAM shall have a replaceable battery backup using a lithium battery with a rated service life of 10,000 hours continuous and a rated shelf life of at least 7 years.

    b. Volatile RAM shall have a automatically rechargeable battery backup using a lithium battery with a rated service life of 50 hours continuous and a rated shelf life of at least 10 years.

    c. EEPROM, EPROM, or NVROM non-volatile memory.

3. Controllers shall allow independent operation regardless of the status of the other controllers or OWS or CSS. BCs, AACs, and ASCs shall perform all specified control sequences independent of operator interface devices and servers, i.e. all programming shall reside in BCs, AACs, and ASCs.

4. Each controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall.

    a. Assume a predetermined failure mode.

    b. Generate an alarm notification to the master controller, Operator Workstation, or both.

5. All input points and output points shall be protected such that shorting of the point to itself — to another point, or to ground — will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

6. Controller hardware shall be suitable for the anticipated ambient conditions.

    a. Controllers used outdoors or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°F to 150°F.

    b. Controllers used in conditioned space shall be mounted in dust--resistant enclosures and shall be rated for operation at 32°F to 120°F.

7. Programmability: All controllers, including BCs, AACs, and ASCs, shall be fully user programmable. Configurable pre-programmed logic shall not be acceptable in any controller. (This is required due to non-standard control sequences at AHUs and VAV terminal units.)

B. Stand-Alone Functionality

1. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in Part 3. This item refers to acceptable paradigms for associating the points with the processor.

2. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system or equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category will dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller with respect to standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

3. The following configurations are considered acceptable with reference to a controller's standalone functionality:

   a. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).

   b. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.

   c. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.

4. The following configurations are considered unacceptable with reference to a controller's standalone functionality:

   a. Multiple controllers enclosed in the same control panel to accomplish the point requirement.

C. Building Controller (BC)

1. General Requirements

   a. BCs shall be peer-to-peer devices connected to the Primary Controller LAN.

   b. Each BC shall be capable of standalone direct digital operation utilizing its own microprocessor, internal RAM, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure. Refer to standalone functionality specified above.

   c. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device.

d. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. Each controller shall permit multi-user operation from multiple workstations and portable operator terminals connected either locally or over the Primary Controller LAN.

e. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.

f. The BC may provide for point mix flexibility and expandability. This requirement may be met via either a family of expander boards, modular input/output configuration, or a combination thereof. Refer to standalone functionality specified above.

g. All BC point data, algorithms and application software shall be configurable, and all control strategies performed by the BC shall be both operator definable and modifiable, from Operator Interfaces. The point database and all application programs shall be stored in non-volatile or battery backed volatile memory within the BC and shall be able to upload to or download from the OWS or CSS.

h. BC shall provide buffer for holding alarms, messages, trends etc.

i. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.

j. Each BC shall contain software to perform full DDC/PID control loops.

k. Memory

1) Memory for data trending shall reside in BCs; the Operator Workstation shall not need to be connected for data trending to occur. Memory shall be large enough to record 256 records of each hardware point on the panel and an equal number of software points, each record to include both data value and time of occurrence. See Paragraph 3.15G for trending software requirements.

2) Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of approximately 25% of available memory free for future programming changes.

3) Provide an additional BC if needed to comply with this Paragraph.

l. For systems requiring end-of-line resistors those resistors shall be located in the BC.

m. Input-Output Processing

1) Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 0.5 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and a supervised manual hand off or auto (HOA) switch to allow for override. HOA override switches shall be monitored via additional input

channels to provide dynamic indication of the switch status at any Operator Interface. Each DO shall be discrete outputs from the BC's board. Multiplexing to a separate manufacturer's board is unacceptable. Provide suppression to limit transients to acceptable levels.

2) Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10 Vdc, and 0-20 mA. Provide signal conditioning and zero and span calibration for each input. Each input shall be a discrete input to the BC's board. Multiplexing to a separate manufacturers board is unacceptable. A/D converters shall have a minimum resolution of 12 bits.

3) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors is unacceptable.

4) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

5) Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog is not acceptable. D/A converters shall have a minimum resolution of 8 bits.

6) Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.

n. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers, or workstations.

o. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.

p. All output points shall have a selectable failure setpoint or mode. The BC shall be capable of maintaining this failure setpoint or mode in the event of a system malfunction, which causes loss of BC control or loss of output signal as long as power is available at the BC. The failure setpoint or mode shall be selectable on a per point basis.

q. Slope intercepts and gain adjustments shall be available on a per-point basis.

r. BC Power Loss

1) Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.

2) Upon a loss of power, all software, database parameters, and data (except trend data) shall be protected from memory loss per Paragraph 2.3A.2.

3) Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.

4) Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report, or CSS shall automatically determine, the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the Owner shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the OWS via the local area network, or via the local RS-232C port to the POT.

s. BC Failure

1) Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value.

2) BC Hardware Failure: BC shall cease operation and terminate communication with other devices. All outputs shall go to their specified fail position.

t. Each BC shall be equipped with firmware resident or software self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).

u. BCs may include LAN communications interface functions for controlling secondary LANs. Refer to Paragraph 2.3C for requirements if this function is packaged with the BC.

v. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure, as specified herein.

2. BACnet Building Controller Requirements

a. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.

b. Each BC shall be connected to the BACnet Primary Controller LAN communicating to or from other BCs.

D. Advanced Application Specific Controller (AAC) and Application Specific Controller (ASC)

1. General Requirements

a. AACs and ASCs shall be connected to the Primary or Secondary Controller LAN.

b. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment. Each unit shall have its own internal RAM, non-volatile memory and will continue to operate all local control functions in the event of a loss of communications on the Secondary LAN. Refer to standalone requirements by application specified in Part 3 of this Section. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.

c. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.

d. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.

e. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, voltage transient and lightning protection devices to perform all specified application sequences.

f. All point data; algorithms and application software within an AAC /ASC shall be modifiable from Operator Interfaces.

g. Memory

1) Memory for data trending is not required for AACs and ASCs. If not provided in controller, memory for trend data shall reside in BCs connected to the same Network.

2) Provide sufficient internal memory for the specified sequences of operation. For AACs, there shall be a minimum of approximately 25% of available memory free for future programming changes. Provide additional AACs or a BC if needed to comply with this requirement.

h. AAC Input-Output Processing. Same as BCs (Paragraph 2.3C.1.m) except A/D converters may be 10 bit.

i. ASC Input-Output Processing

1) Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 0.5 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output. Each DO shall be discrete outputs from the ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.

2) Analog Inputs (AI): AI shall be 0-5 Vdc or direct thermistor connection. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the ASC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 10 bits.

3) Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the ASC and shall be isolated from the main board. Software multiplexing of an AI and resistors may only be done in non-critical applications and only with prior approval of the Owner.

4) Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.

5) Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection. Pulse Width Modulated (PWM) analog is not acceptable. D/A converters shall have a minimum resolution of 8 bits.

2. BACnet AAC(s) and ASC(s) Requirements

a. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.

b. AAC(s) and ASC(s) shall communicate over the BACnet Primary Controller LAN or the Secondary LAN.

2.4 COMMUNICATION DEVICES

A. Controller Local Area Network Interface Devices (LANID)

1. The Controller LANID shall be a microprocessor-based communications device which acts as a gateway/router between the Primary LAN, Secondary LAN, an operator interface, or printer. These may be provided within a BC or as a separate device.

2. The LANID shall perform information translation between the Primary LAN and the Secondary LAN, supervise communications on a polling secondary LAN, and shall be applicable to systems in which the same functionality is not provided in the BC. In systems where the LANID is a separate device, it shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Paragraph 2.3C. Each LANID shall be mounted in a lockable enclosure.

3. Upon loss of power to a LANID, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

4. The LANID shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

B. Supervisory LAN Routers

1. The Supervisory Router shall be a microprocessor-based communications device that acts as a router between the Supervisory LAN CSSs or OWS and the Primary LAN.

2. The Supervisory Router shall not perform information translation. Both Primary LAN and the Supervisory LAN shall use BACnet.

3. The Supervisory Router shall contain its own microprocessor, RAM, communication ports, and power supply. Each Supervisory Router shall be mounted in a lockable enclosure.

4. The Supervisory Router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the CSS, OWSs, and POTs.

   a. Configure systems.

   b. Monitor and supervise control of all points.

   c. Change control setpoints.

   d. Override input values.

   e. Override output values.

   f. Enter programmed start/stop time schedules.

   g. View and acknowledge alarms and messages.

   h. Receive, store and display trend logs and management reports.

   i. Upload/Download programs, databases, etc. as specified.

5. Upon loss of power to the Supervisory Router, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

6. The Supervisory Router shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

C. BACnet Gateways & Routers

1. Gateways shall be provided to link non-BACnet control products to the BACnet inter-network. All of the functionality described in this Paragraph is to be provided by using the BACnet capabilities. Each Gateway shall have the ability to expand the number of BACnet objects of each type supported by 20% to accommodate future system changes.

2. Each Gateway shall provide values for all points on the non-BACnet side of the Gateway to BACnet devices as if the values were originating from BACnet objects. The Gateway shall also provide a way for BACnet devices to modify (write) all points specified by the Points List using standard BACnet services.

3. Each Gateway shall provide a way to collect and archive or trend (time, value) data pairs.

4. Each Gateway and any devices that the Gateway represents which have time-of-day information shall respond to workstation requests to synchronize the date and time. Each Gateway and any devices that the Gateway represents shall support dynamic device binding and dynamic object binding.

5. All points in the system shall be made network visible through the use of standard BACnet objects or through proprietary BACnet extensions that the workstation also supports. All points shall be writable using standard BACnet services.

6. All devices have a Device Object instance number that is unique throughout the entire inter-network. All BACnet devices shall be configured with a Device Object instance number that is based on the format specified. This includes all physical devices as well as any logical BACnet devices that are physically represented by Gateways.

7. Upon loss of power to a Gateway, the battery shall provide for minimum 1000-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.

8. UL 916 CE FCC part 15 Subpart B – Class A with surge and transient protection circuitry for power and communications.

D. Variable Speed Drive Gateway

1. Variable speed drives have BACnet or Modbus RTU RS-485 interface

2. Provide gateway(s) as required, quantity and location determined by Contractor.

2.5 EMCS INTERFACE HARDWARE

A. Control System Server (CSS)

1. Hardware:

a. Intel Core 2 Duo 3 GHz (minimum) Processor

b. 2 GB DDR2 RAM (minimum)

c. 1 TB SATA 7200 RPM hard disk (minimum)

d. 16X SATA (minimum) Read/Write DVD drive

e. 24 inch color , 1920 x 1200 pixel flat panel display.

f. 256 MB VGA/DVI graphics adapter

g. 2-button with scroll optical USB mouse

h. One Ethernet 100 GB internal network card (for connection to Supervisory LAN)

i. One Ethernet 1000 GB internal network card (for connection to DSL modem)

j. 2-button with scroll optical USB mouse

k. Enhanced USB 101-key keyboard

l. Internal speakers

m. High efficiency power supply; EnergyStar configured

n. One spare serial port and one spare USB port in addition to those needed for specified peripherals

o. 24x7 dedicated technical support service that delivers reduced hold time, direct access to advanced level technicians, and reduced time to resolution, minimum 3 years

p. Tower cabinet

2. Software by PC Supplier (factory installed):

a. Operating system: Microsoft Windows 7 Professional

b. Browser: Microsoft Internet Explorer

c. DVD burner software: Standard software provided by computer supplier

d. All software shall be at least the latest version available as of the date of purchase.

B. Operator Workstation (OWS)

1. CSS shall double as OWS.

C. Portable Operators Terminal (POT)

1. None required.

D. Uninterruptible Power Supply (UPS)

1. None required; reuse existing.

E. Printers

1. Color Ink Jet printer

a. Print Quality (Color): 1440 x 720 dpi resolution

b. Speed: 5 pages per minute (color)

c. Cartridge / Printhead Duty Cycle: 300 pages

d. Paper Size: 11x17, 8.5x11

2.6 AIR TUBING

A. Seamless copper tubing, Type L-ACR, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder.

B. Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

2.7 ELECTRIC WIRING AND DEVICES

A. Communication Wiring

1. Provide all communication wiring between Building Controllers, Routers, Gateways, AACs, ASCs and local and remote peripherals (such as operator workstations and printers).

2. Ethernet LAN: Use Fiber or Category 5 or 6 of standard TIA/EIA 68 (10baseT). Network shall be run with no splices and separate from any wiring over 30 volts.

3. ARCnet and MS/TP LAN: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30 volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

B. Analog Signal Wiring

1. Input and output signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, current or voltage analog outputs, etc. shall be twisted pair, 100% shielded if recommended or required by controller manufacturer, with PVC cover. Gauge shall be as recommended by controller manufacturer.

2.8 CONTROL CABINETS

A. All control cabinets shall be fully enclosed with hinged door, key-lock latch. A single key shall be common to all field panels and sub-panels within each building. Provide 3 keys.

B. Construction

1. Indoor: NEMA 12

2. Outdoor: NEMA 4

C. Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs or tie-wrapped. Terminals for field connections shall be UL Listed for service, individually identified per control-interlock drawings, with adequate clearance for field wiring. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover. Control terminations for field connection shall be individually identified per control Shop Drawings.

D. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.

E. Provide with

1. Framed, plastic-encased point list for all points in cabinet.

2. Nameplates for all devices on face.

2.9 SENSORS AND MISCELLANEOUS FIELD DEVICES

A. The listing of several sensors or devices in this section does not imply that any may be used. Refer to points list in Paragraph 2.12 Points List for device specification. Only where two or more devices are specifically listed in points list (such as "FM-1 or FM-4") may the Contractor choose among listed products.

B. Control Valves

1. Manufacturers

a. Belimo

b. No equal

2. Characterized Ball Type

a. Valves shall be specifically designed for modulating duty in control application with guaranteed average leak-free life span over 200,000 full stroke cycles.

b. Industrial quality with nickel plated forged brass body and female NPT threads.

c. Blowout proof stem design, glass-reinforced Teflon thrust seal washer and stuffing box ring with minimum 600 psi rating (2-way valves) or 400 psi rating (3-way valves). The stem packing shall consist of 2 lubricated O-rings designed for on-off, floating, or modulating service and requiring no maintenance.

d. Valves suitable for water or low-pressure steam shall incorporate an anti-condensation cap thermal break in stem design.

e. Ball: stainless steel.

f. Stem: stainless steel.

g. Characterizing disk held securely by a keyed ring providing equal percentage characteristic.

3. Minimum valve assembly pressure ratings

a. Hot water: 125 psi at 200ºF

4. Valve Selection

a. Valve Characteristic

1) 2-way valves: equal percentage or modified equal percentage.

2) 3-way valves controlling heating coils: equal percentage or modified equal percentage.

3) Two-position valves: not applicable.

b. Valve Sizing

1) Modulating Water: Size valve to achieve the following full-open pressure drop

a) Minimum pressure drop: equal to half the pressure drop of coil or exchanger.

b) Maximum pressure drop

1. Hot water at coils: 2 psi

c) 3-way valves shall be selected for near minimum pressure drop. 2-way valves shall be selected near maximum pressure drop.

d) Flow coefficient (C_v) shall not be less than 1.0 (to avoid clogging) unless protected by strainer.

2) Two-position valves: Line size unless otherwise indicated on Drawings.

C. Control Dampers

1. None required.

D. Actuators

1. Manufacturers

a. Belimo

b. No equal

2. Warranty: Valve and damper actuators shall carry a manufacturer's 5-year warranty.

3. Electric Actuators

a. Entire actuator shall be UL or CSA approved by a National Recognized Testing Laboratory.

b. Enclosure shall meet NEMA 4X weatherproof requirements for outdoor applications.

c. Dampers. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The clamp shall be steel of a V-bolt design with associated V-shaped, toothed cradle attaching to the shaft for maximum strength and eliminating slippage via cold weld attachment. Single bolt or set screw type fasteners are not acceptable. Aluminum clamps are unacceptable.

d. Valves. Actuators shall be specifically designed for integral mounting to valves without external couplings.

e. Actuator shall have microprocessor based motor controller providing electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible.

f. Actuators shall provide protection against actuator burnout using an internal current limiting circuit or digital motor rotation sensing circuit. Circuit shall insure that actuators cannot burn out due to stalled damper or mechanical and electrical paralleling. End switches to deactivate the actuator at the end of rotation or use of magnetic clutches are not acceptable.

g. Modulating Actuators

1) General: Actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. Actuators shall have positive positioning circuit so that controlled device is at same position for a given signal regardless of operating differential pressure.

2) Optional for VAV box dampers only: Actuators may be floating type if damper/valve position is estimated by timing pulse-open and pulse-closed commands with auto-zeroing whenever zone is in Unoccupied mode and damper is driven full closed.

h. Where indicated on Drawings or Points List, actuators shall include

1) 2 to 10 VDC position feedback signal

2) Limit (end) position switches

i. All 24 VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC. Actuators operating on 120 VAC power shall not require more than 10 VA. Actuators operating on 230 VAC power shall not require more than 11 VA.

j. All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

k. Actuators shall be provided with a conduit fitting an a minimum three-foot electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

l. Where fail-open or fail-closed position is required, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe are not acceptable. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.

m. Actuators shall be capable of being mechanically and electrically paralleled to increase torque where required.

n. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 inch-pound torque capacity shall have a manual crank for this purpose.

o. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed.

p. Actuators shall clearly indicate position of damper/valve.

4. Normal Position. Except as specified otherwise herein, the requirement for spring return actuators and the normal positions of control devices shall be as indicated in table below. For actuators indicated as Spring Return Required in the table, normal position refers to the position with zero control signal and with no power to the actuator. For actuators not indicated as Spring Return Required in the table, non-spring style actuators are acceptable and normal position refers to the position with zero control signal.

Device	**Normal Position**	**Spring Return Required**
Outside air damper	CLOSED	Yes
Return air damper	OPEN	Yes
Exhaust/relief air damper	CLOSED	Yes
Hot water reheat coil valves	CLOSED	
VAV box dampers	OPEN	

5. Valve Actuator Selection

a. Modulating actuators for valves shall have minimum rangeability of 50 to 1.

b. Water

1) 2-way and two-position valves

a) Tight closing against 125% of system pump shut-off head.

b) Modulating duty against 90% of system pump shut-off head.

2) 3-way shall have close-off against twice the full open differential pressure for which they are sized.

6. Damper Actuator Selection

a. Actuators shall be direct coupled. For multiple sections, provide one actuator for each section; linking or jack-shafting damper sections shall not be allowed.

b. Provide sufficient torque as velocity, static, or side seals require per damper manufacturer's recommendations and the following:

1) Torque shall be a minimum 5 inch-pound per square foot for opposed blade dampers and 7 inch-pound per square foot for parallel blade dampers.

2) The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating.

E. General Field Devices

1. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers and as required for proper operation in the system.

2. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

3. Field devices specified herein are generally two-wire type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with two-wire type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, provide four-wire type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

4. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

5. Accuracy: As used in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis. Sensor accuracy shall be at or better than both that specifically listed for a device and as required by Paragraph 1.12B.2.

F. Temperature Sensors (TS)

1. General

a. Unless otherwise noted, sensors may be platinum RTD, thermistor, or other device that is commonly used for temperature sensing and that meets accuracy, stability, and resolution requirements.

b. When matched with A/D converter of BC, AAC, or ASC, sensor range shall provide a resolution of no worse than 0.3ºF (0.16 °C) (unless noted otherwise herein).

c. Sensors shall drift no more than 0.3ºF and shall not require calibration over a five-year period.

d. Manufacturers

1) Mamac

2) Kele Associates

3) Building Automation Products Inc.

4) Automated Logic Corp.

5) Or equal

2. Duct temperature sensors: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Sensor probe shall be 304 stainless steel.

a. TS-1A: Single point (use where not specifically called out to be averaging in points list).

b. TS-1B: Averaging. Sensor length shall be at least 1 linear foot for each 2 square feet of face area up to 25 feet maximum.

3. Water Temperature Sensors

a. TS-2A: Immersion sensors. All piping immersion sensors shall be in brass or stainless steel wells that allow removal from operating system, with lagging extension equal to insulation thickness where installed in insulated piping. Wells shall be rated for maximum system operating pressure, temperature and fluid velocity. The well shall penetrate the pipe by the lesser of half the pipe diameter or four inches. The use of direct immersion or strap-on type sensors is not acceptable.

b. TS-2B: Same as TS-2A except provide matched or high precision temperature sensors for differential temperature measurement, such as chilled water supply and return temperature. See Paragraph 1.12B.2.

4. Room Sensors: Shall be an element contained within a ventilated cover, suitable for wall mounting, with insulated base.

a. TS-3A

1) Thermistor in enclosure with blank cover

2) For temperature sensors connected to terminal box controllers (such as at VAV boxes) that require calibration: Include a USB port or some other means for connection of POT for terminal box calibration.

b. TS-3B: Same as TS-3A except

1) Setpoints shall be adjustable at wall mounted sensor with setpoint knobs (with software limits and setpoint adjustment capability through the OWS).

2) Override button capable of being programmed to start system during unscheduled hours.

c. TS-3C: Same as TS-3B except integral LCD display of space temperature and active setpoint.

5. TS-4: Outdoor Air Sensor

a. Outdoor air sensors shall have a sun shield, utility box, and watertight gasket to prevent water seepage.

G. Differential Pressure Transmitters (DP)

1. DPT-1: Not Used

2. DPT-2: Refrigerant

a. Compatible with R-22

b. Pressure Range: 0 – 400 psig

c. Output: 4 – 20mA or 0-10 Vdc

d. Process Connection Material: Stainless Steel 1.4571 (316Ti)

e. Seal Material: None (welded version)

f. Diaphragm Material: Stainless Steel 1.4542 (17-4PH)

g. Accuracy: 0.5% FSO

h. Thermal Errors (TZS & TSS): ±0.03% FSO / °C

i. Calibration: 5 point NIST Traceable

j. Media Temperature: -40 to +125°C

k. Operating Temperature: -40 to +85°C

l. Housing Material: Stainless Steel 1.4301 (304)

m. Manufacturers

1) Kele

2) SensorsONE

3) Or equal

3. DPT-3: Air, Duct Pressure:

a. General: Loop powered two-wire differential capacitance cell-type transmitter.

b. Output: two wire 4-20 mA output with zero adjustment.

c. Overall Accuracy: ±1% scale.

d. Minimum Range: 0.5 inches water column.

e. Maximum Range: 10 inches water column.

f. Housing: Polymer housing suitable for surface mounting.

g. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301, Davis Instruments, or equal, with connecting tubing.

h. Range: Select as specified in points list or, if not listed for specified setpoint to be between 25% and 75% full-scale.

i. DPT-3A: Include LCD display of reading.

j. Manufacturers.

1) Setra

2) Modus

3) Invensys

4) Dwyer

5) Or equal

4. DPT-4: Not used

5. DPT-5: VAV Velocity Pressure

a. General: Loop powered two-wire differential capacitance cell type transmitter.

b. Output: Two-wire, 4-20 mA output with zero adjustment.

c. Flow transducer (including impact of A-to-D conversion) shall be capable of stably controlling to a setpoint of 0.004 inches differential pressure or lower, shall be capable of sensing 0.002 inches differential pressure or lower, and shall have a ±0.001 inches or lower resolution across the entire scale.

d. Minimum Range: 0 in. water column.

e. Maximum Range: 1.5 inch water column.

f. Housing: Polymer housing suitable for surface mounting.

g. Manufacturer

1) Automated Logic

2) Or equal

H. Current Switches (CS-1)

1. Clamp-on or solid-core

2. Range: as required by application

3. Trip Point: Adjustable

4. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage

5. Lower Frequency Limit: 6 Hz

6. Trip Indication: LED

7. Approvals: UL, CSA

8. May be combined with relay for start/stop

9. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing with override switch. Kele RIBX, Veris H500, or equal

10. Manufacturers

    a. Veris Industries H-608/708/808/908; Inc.

    b. RE Technologies SCS1150A-LED

    c. Or equal

I. FM-1: Magnetic Insertion Type Flow Meters

1. Magnetic Faraday point velocity measuring device.

2. Insertion type complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.

3. 4-20 mA transmitter proportional to flow or velocity.

4. Accuracy: ± 1% of reading from 0.25 to 20 fps

5. Flow range: 0.25 to 20 fps

6. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% and traceable to the U.S. National Institute of Standards and Technology (NIST).

7. Manufacturers:

    a. Onicon F-3500

    b. FloCat YD20-A

    c. Marsh McBirney MultiMag 284

    d. SeaMetrics 100/200 Series

    e. Or equal

J. CO_2 Sensors/Transmitters (CO2)

1. Wall mounted.

2. Non-dispersive infrared sensor with dual beam or dual wavelength technology where a reference channel is used to maintain sensor calibration. Single beam sensors not acceptable.

3. Detachable base with all field wiring terminations on base.

4. Accuracy: ±60 ppm or 5% of reading from 0 to 1500 ppm at temperatures from 60°F to 90ºF.

5. Factory calibrated and set to 0-2000 ppm range (equals 4-20 mA or 0-10 V).

6. Include elevation adjustment.

7. The sensor shall not require recalibration for a minimum of 5 years, guaranteed. If sensor is found to be out of calibration, supplier shall recalibrate at no additional cost to the Owner within 5 years of purchase date.

8. LCD display.

9. Manufacturers

    a. AirTest EE80-2CT

    b. Vaisala GMW21

    c. Telaire 8102

    d. Or equal

K. Power Meter (PM-1)

1. Power measurement device shall include current and potential (voltage) transformers on each leg and shall be certified under UL-3111.

2. Accuracy. Comply with ANSI 12.16 – 1% / IEC-62053-21 or ANSI 12.20 – 0.5% / IEC-62053-22

3. The transducer range shall be selected such that the maximum value shall be 150% of the nominal value being monitored.

4. Power output signal shall be any of the following: pulse output, 4-20mA, or 0-10Vdc output

5. Manufacturers:

    a. E-mon D-mon series 2000 with P2 pulse accessory or D/A converter accessory

    b. Or equal

L. Electric Control Components

1. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

    a. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

        1) AC coil pull-in voltage range of +10%, -15% or nominal voltage.

        2) Coil sealed volt-amperes (VA) not greater than 4 VA.

3) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.

4) Pilot light indication of power-to-coil and coil retainer clips.

b. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load.

c. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

2. Control Transformers and Power Supplies

a. Control transformers shall be UL Listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Mount in minimum NEMA-1 enclosure.

b. Transformer shall be proper size for application. Limit connected loads to 80% of rated capacity.

c. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

d. Unit shall operate between 0°C and 50°C [32°F and 120°F]. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.

e. Line voltage units shall be UL Recognized and CSA Approved.

2.10 CALIBRATION & TESTING INSTRUMENTATION

A. Provide instrumentation required to verify readings, calibrate sensors, and test the system and equipment performance.

B. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

C. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (for example if field device is ±0.5% accurate, test equipment shall be ±0.25% accurate over same range).

2.11 SOFTWARE

A. General

1. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. Servers shall be accessed using a web browser over

the control system Supervisory LAN and remotely over the Internet (through DSL connection).

2. The intent of the thin-client architecture is to provide operators complete access to the EMCS via a web browser GUI. No special software other than a web browser (including ActiveX components or fat java clients) shall be required to be installed on OIs used to access the EMCS graphics, point displays, trends, and trend configuration. Additional software other than a browser may be used to configure or modify the EMCS and programming.

3. Furnish and install all software and programming necessary to provide a complete and functioning system as specified. Include all software and programming not specifically itemized in these specifications that is necessary to implement, maintain, operate, and diagnose the system in compliance with these specifications.

4. Software Components: All software components of the BAS system software shall be installed and completed in accordance with the specification. BAS system components shall include:

    1) Server Software, Database and Web Browser Graphical User Interface

    2) System Configuration Utilities for future modifications to the system

    3) Programming language

    4) Direct digital control software

    5) Application Software

5. Database Open Connectivity: The BAS server database shall be Java DataBase Connectivity (JDBC) compatible, allowing real time access of data via XML/SOAP. Review this with your shortlist of vendors

B. Licensing

1. Include licensing and hardware keys for all software packages at all workstations (OWSs and POTs) and servers.

2. Within the limitations of the server, provide licenses for any number of users shall have web access to the CSS at any given time.

3. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

4. All operator software, including that for programming and configuration, shall be available on all workstations. Hardware and software keys to provide all rights shall be installed on all workstations.

5. Any “orgID” and “projectID” component rights and licenses shall be assigned to the Owner. The Owner shall be allowed to unlock any Tridium-based product to access by competing vendors and manufacturers.

C. Controller Software

1. BC Software Residency: Each BC shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

   a. Real-Time Operating System software

   b. Real-Time Clock/Calendar and network time synchronization

   c. BC diagnostic software

   d. LAN Communication software/firmware

   e. Direct Digital Control software

   f. Alarm Processing and Buffering software

   g. Data Trending, Reporting, and Buffering software

   h. I/O (physical and virtual) database

   i. Remote Communication software

2. AAC/ASC Software Residency: Each AAC/ASC shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Paragraph 2.4A) with the restrictions and exceptions per application provided in Paragraph 2.3D:

   a. Real-Time Operating System software

   b. AAC/ASC diagnostic software

   c. LAN Communication software

   d. Control software applicable to the unit it serves

   e. I/O (physical and virtual) database to support one mode of operation

3. Standalone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Paragraph 2.3 for other aspects of standalone functionality.

4. Operating System: Controllers shall include a real-time operating system resident in ROM or EEPROM. This software shall execute independently from any other device in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Paragraph 2.3 for other aspects of the controller's operating system.

5. Network Communications: Each controller shall include software or firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

    a. Building Controller/Primary LAN shall be a high-speed network designed and optimized for control system communication. If a Primary LAN communications trunk is severed, BCs shall reconfigure into two separate LANs and continue operations without interruption or Operator intervention.

    b. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.

    c. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

6. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions.

7. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as specified below.

8. Application Programs: CUs shall support and execute application programs specified herein.

9. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS using BACnet services connected locally, to the Primary LAN, to the Local Supervisory LAN but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

10. Power Loss and Restart: System software shall provide for orderly shutdown upon loss of power. Volatile memory shall be retained. Outputs shall go to programmed fail position, which as a default shall be set to their position in unoccupied mode. Equipment restart shall be automatic upon power restoration and shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

11. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network or all devices simultaneously. Automatic time synchronization shall be provided using BACnet services.

12. Anti-dithering: In order to improve the life expectancy of modulating electronic actuators, software shall limit the number of re-positions. This can be accomplished by providing anti-dithering software, a small deadband for fully proportioning actuators, and

by ensuring that floating actuators do not receive control pulses of excessively short duration.

D. Graphical User Interface Software

1. A web browser installed on each OWS, POT, and server (see Paragraph 2.1B) shall serve as the graphical user interface to the EMCS. Communication between the web server GUI and EMCS server shall be encrypted using 128-bit encryption technology within Secure Socket Layers. Communication protocol shall be Hyper-Text Transfer Protocol.

2. The GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to have a look-and-feel like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish all features specified in this section.

3. The GUI shall (as a minimum) provide a Navigation Pane for navigation, and an Action Pane for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.

4. Login: Upon launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility. See Security Access below.

5. Navigation Pane

   a. The Navigation Pane shall comprise a Navigation Tree which defines a geographic hierarchy of the EMCS system. Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program) or by selecting dynamic links to other system graphics. Both the navigation tree and action pane defined below shall be displayed simultaneously enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views:

      1) Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and BACnet objects.

      2) Network View shall display the hierarchy of the actual BACnet IP Intranet network. This can include: Systems, Site, Networks, Routers, Half-Routers, Devices, Equipment and all the BACnet Objects in a device.

      3) Groups View shall display Scheduled Groups and custom reports.

      4) Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

   b. Alternative interface structures will also be accepted if they provide similar ease of navigation through the system hierarchy.

6. Action Pane: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding buttons:

    a. Graphics: Using animated png or other graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh at least 6 times per minute.

    b. Properties: Shall include graphic controls and text for the following: Locking or overriding BACnet objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an accept/cancel button.

    c. Schedules: Shall be used to create, modify, edit and view schedules based on the systems geographical hierarchy and in compliance with Paragraph 2.11D.8.

    d. Events: Shall be used to view alarm event information geographically (using the navigation tree), acknowledge events, sort events by category, actions and verify reporting actions.

    e. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling.

    f. Logic - Live Graphic Programs: Shall be used to display a real-time graphic of the control algorithm for the mechanical/electrical system selected in the navigation tree.

7. Graphics

    a. The GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated graphics and active setpoint graphic controls shall be used to enhance usability.

    b. Graphics tools used to create Web Browser graphics shall be non-proprietary and provided and installed on each OWS.

    c. Graphical display shall be 1280 x 1024 pixels or denser, 256 color minimum.

    d. Links

        1) Graphics shall include hyperlinks which when selected (clicked on with mouse button) launch applications, initiate other graphics, etc.

        2) Screen Penetration: Links shall be provided to allow user to navigate graphics logically without having to navigate back to the home graphic. See additional discussion in Paragraph 3.12E.

        3) Information Links

            a) On each MEP system and subsystem graphic, provide links to display in a new window the information listed below.

1. English-language control sequence associated with the system. See Paragraph 1.11B.

2. O&M and submittal information for the devices on the graphic. See Paragraph 1.11B.

b) The display shall identify the target of the link by file name/address.

c) Information shall be displayed in electronic format that is text searchable.

d) Window shall include software tools so that text, model numbers, or point names may be found. Source documents shall be read-only (not be editable) with this software.

e. Point Override Feature

1) Every real output or virtual point displayed on a graphic shall be capable of being overridden by the user (subject to security level access) by mouse point-and-click from the graphic without having to open another program or view.

2) When the point is selected to be commanded

a) Dialog box opens to allow user to override the point (Operator Mode) or release the point (Automatic Mode). Operator Mode will override automatic control of the point from normal control programs.

b) Dialog box shall have buttons (for digital points) or a text box or slide bar (for analog points) to allow user to set the point's value when in operator mode. These are grayed out when in automatic mode.

c) When dialog box is closed, mode and value are sent to controller.

d) Graphic is updated upon next upload scan of the actual point value.

3) A list of points that are currently in an operator mode shall be available through menu selection.

f. Point override status (if a digital point is overridden by the supervised manual override per Paragraph 2.3C or if a point is in operator mode per Paragraph 2.11D.7.e) shall be clearly displayed on graphics for each point, such as by changing color or flag.

g. The color of symbols representing equipment shall be able to change color or become animated based on status of binary point to graphically represent on/off status.

h. On floor plan displays of spaces, temperature shall be graphically displayed by coloring the zone area in accordance with or similar to the following:

1) Red: space temperature above cooling setpoint by 2ºF (adjustable) or more. This condition can be programmed to generate an alarm.

2) Yellow: space temperature between cooling setpoint and 2ºF (adjustable) above setpoint.

3) Green: space temperature between cooling and heating setpoints and space is in occupied mode.

4) Gray: space temperature between cooling and heating setpoints and space is in unoccupied mode.

5) Light blue: space temperature between heating setpoint and 2ºF (adjustable) below setpoint.

6) Dark blue: space temperature below heating setpoint by 2ºF (adjustable) or more. This condition can be programmed to generate an alarm.

8. Graphics Development Package

a. Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

b. Provide capability to store graphic symbols in a symbol directory and incorporate these symbols into graphics.

c. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (such as fans, cooling coils, filters, dampers), mechanical system components (such as, pumps, chillers, cooling towers, boilers), complete mechanical subsystems (such as VAV reheat zone) and electrical symbols.

d. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:

1) Define symbols

2) Position items on graphic screens

3) Attach physical or virtual points to a graphic

4) Define background screens

5) Define connecting lines and curves

6) Locate, orient and size descriptive text

7) Define and display colors for all elements

8) Establish correlation between symbols or text and associated system points or other displays.

9) Create hot spots or link triggers to other graphic displays or other functions in the software.

e. A single graphic file shall be used for common control applications (such as VAV boxes) so that any updates to the graphic may be done once and automatically applied to all applications. Displayed points shall be automatically populated based on wild card entry of point name in graphic definition.

9. Time and Schedules

a. Provide a time master that is installed and configured to synchronize the clocks of all BACnet devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time. All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

b. System shall automatically change time/date for Daylight Savings Time and leap years.

c. An operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor Zone Group. For example, Independence Day Holiday for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the Independence Day Holiday.

d. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

e. Schedules shall comply with the BACnet standard, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on

1) Types of schedule shall be Normal, Holiday or Override

2) A specific date

3) A range of dates

4) Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)

5) Wildcard (example, allow combinations like second Tuesday of every month)

f. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of systems to be scheduled; for example, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.

g. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an individual Tenant Group – who may occupy different areas within a building or buildings. Schedules applied to the Tenant Group

shall automatically be downloaded to control modules affecting spaces occupied by the Tenant Group.

h. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (example: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).

i. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

j. Schedule Distribution: For reliability and performance, instead of maintaining a single schedule in a field device that writes over the network to notify other devices when a scheduled event occurs, field devices will only keep their part of the schedule locally. The EMCS server software shall determine which nodes a hierarchical schedule applies to and will create/modify the necessary schedule objects in each field device as necessary.

10. Events and Alarms

a. Events and alarms associated with a specific system, area, or equipment selected in the Navigation Tree shall be displayed in the Action Pane by selecting an Events View.

b. Events View: Each event shall display an Event Category (using a different icon for each event category), date/time of occurrence, current status, and event report. An operator shall be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.

c. Event Categories (Alarm Levels): The operator shall be able to create, edit or delete event categories (alarm level). An icon shall be associated with each Event category, enabling the operator to easily sort through multiple events displayed. Alarm levels shall be initially configured by the Contractor as follows:

1) Level 1: Critical/life safety

2) Level 2: Significant equipment failure

3) Level 3: Non-critical equipment failure/operation

4) Level 4: Energy conservation monitor

5) Level 5: Maintenance indication, notification

d. BACnet Event Templates: BACnet Event template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of event, acknowledgement requirements, high/low limit and out of range information.

e. Event Areas (Actions): Each Event Categories (Alarm Level) shall be configured to specific Event Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance events on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Event Areas in the Graphic Pane.

f. Alarm Configuration. Alarms shall require configuration related to criticality (Critical/Not Critical), operator acknowledgement (Requires Acknowledgement/Does Not Require Acknowledgement), and conditions required for an alarm to clear automatically (Requires Acknowledgement of a Return to Normal/ Does Not Require Acknowledgement of a Return to Normal).

g. Event Reporting Actions: Event Reporting Actions specified shall be automatically launched (under certain conditions) after an event is received by the EMCS server software. Operators shall be able to define these Reporting Actions using the Navigation Tree and Graphic Pane through the GUI. Reporting Actions shall be as follows:

   1) GUI dialog box: Provide visual and optional audible alarm indication. The alarm dialog box shall always become the top dialog box upon receipt of an alarm irrespective of the foreground application.

   2) Print: Alarm/Event information shall be printed to the any network accessible printer.

   3) Email: Alarm/Event information shall be via email to a POP3 address on the internet.

   4) Page: Alarm/Event information shall be sent to alphanumeric pager using email to internet alphanumeric paging services.

   5) File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).

   6) Write Property: The write property reporting action updates a property value in a hardware module.

   7) Run External Program: The Run External Program reporting action launches specified program in response to an event.

h. Event Time/Date Stamp: All events shall be generated at the EMCS control module level and comprise the Time/Date Stamp using the standalone control module time and date.

i. Event Configuration: Operators shall be able to define the type of events generated per BACnet object. A network view of the Navigation Tree shall expose all BACnet objects and their respective Event Configuration. Configuration shall include

assignment of event, alarm, type of acknowledgement and notification for return to normal or fault status.

j. Event Summary Counter: The view of events in the Graphic Pane shall provide a numeric counter, indicating how many events are active (in alarm), require acknowledgement, and total number of events in the EMCS Server database.

k. Event Auto-Deletion: Events that are acknowledged and closed, shall be auto-deleted from the database and archived to a text file after an operator defined period. The file shall be stored in file on the CSS with no limit to quantity or age of alarms, other than limitations of hard disk. The file can be archived to tape and deleted by operator to clear disk space.

l. Data Format. The system shall allow for external systems to access the event instance data. Event data shall be stored and queried in the database in a relational manner. At a minimum, the fields to be stored in the database are

1) Event Source

2) Event Generation Time

3) Acknowledge Required Flag

4) Delivery Priority

5) BACnet Event Type

6) Event Message Text

7) BACnet Event Parameter

8) Classification of Event

9) Event Acknowledgement Time

10) Return to Normal Time

11) Operator Comments

12) Who Acknowledged the Event

m. Event Simulator: The GUI user shall provide an Event Simulator to test assigned Reporting Actions. The operator shall have the option of using current time or scheduling a specific time to generate the Event. Utilizing the Navigation Tree and drop-down menus in the Graphic Pane, the operator shall be able to select the Event Type, Status, Notification, Priority, Message, and whether acknowledgement is required.

11. Trends

a. Trending and trend analysis capabilities are considered critical to system performance. The system shall be designed to upload and record large amounts of

point data without causing network bottlenecks or affecting proper system operation. Data shall be stored on the CSS. The system as a whole shall be designed to comply with the trending capability test defined in Paragraph 3.15G.

b. Every point, both real and virtual, shall be available for data trending.

c. Trending software shall be capable of recording point values and time on a user specified regular time step and on a change-of-value (COV) basis (data is recorded when point changes by a specified amount for analog points or by changes of state for binary points), at the user's option. Sampling intervals shall be as small as one second. Each trended point shall have the ability to be trended at a different sampling interval.

d. Trend data shall be sampled and stored in control panel memory (see Paragraph 2.3). If historical trending is enabled for the BACnet object, trend data shall be uploaded from control panels to the CSS on a user-defined interval, manual command, or automatically when the trend buffer becomes full. There shall be no limit to the amount of trend data stored at the CSS other than hard disk limitations.

e. Trends shall conform to the BACnet Trend Log Object specification. Trends shall both be displayed and user configurable through the GUI. Trend logs may comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

f. Viewing Trends

1) Trend data shall be displayed graphically by the GUI. This shall be a capability internal to the workstation software and not a capability resulting from download of trend data on a third-party spreadsheet program unless such transfer is automatic and transparent to the operation and the third-party software is included with the workstation software package.

2) The software shall be capable of dynamically graphing the trend logged object data by creating two-axis (x, y) graphs that simultaneously display values relative to time for at least eight objects in different colors, even if objects have been trended at different time intervals. Where trended values are COV, software shall automatically fill the trend samples between COV entries. A graph legend shall identify each variable plotted.

3) Multiple scales shall be possible, one for each object, with range set automatically by the software but capable of being manually adjusted by the operator.

4) Trend format, displayed points, etc. shall be capable of being saved as a template for future trend displays.

5) Trends shall be able to dynamically update at operator-defined intervals, including on a 1 second interval for loop tuning.

6) It shall be possible to zoom-in on a particular section of a trend for more detailed examination and pan through historical data by simply scrolling the mouse.

7) It shall be possible to pick (or float mouse over) any sample on a trend and have the numerical value displayed.

8) The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard Windows keystrokes.

g. Trend Data Storage

1) The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the EMCS using SQL queries.

2) Data shall be stored in an SQL compliant database format and shall be available through the internet (with appropriate security clearance) without having to disable EMCS access to the database.

3) The database shall not be inherently limited in size, e.g. due to software limitations or lack of a correct license. Database size shall be limited only by the size of the provided storage media (hard drive size).

h. Data export. Trends shall be exportable using the following method:

1) SQL Query

a) Provide the exact syntax to allow extraction of data from the database in 4-column format as shown in the table below.

TrendName	DateTime	TimeZone	DataValue
COB2.RTU1.SAT.Temp.F	2009-06-16 13:01:02	-0800	43.5
COB2.RTU1.SAT.Temp.F	2009-06-16 13:06:06	-0800	45.2
COB2.RTU1.SAT.Temp.F	2009-06-16 13:11:01	-0800	44.3

a) Provide a windows-compatible ODBC driver for the database along with the installation of the database itself.

12. Security Access

a. Security access from the GUI to EMCS servers shall require a Login Name and Password.

b. Access to different areas of the EMCS shall be defined in terms of roles and geographic area of responsibility.

c. Roles shall reflect the actual roles of different types of operators. Roles shall be defined in terms of View, Edit and Function Privileges.

1) View Privileges: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.

2) Edit Privileges: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.

3) Function Privileges: Alarm/Event Acknowledgement, Control Module Configuration, Memory Download and Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.

d. Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

e. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected for an adjustable period of time. This auto logoff time shall be set individually per operator.

f. Provide an audit trail of actions taken by any user, including the user name and time. Store in secure file in database format on the CSS. Provide software to view and print audit trail.

13. Report Software

a. Provide software to create standard and custom reports of point status, alarms, etc. Report format, displayed points, time period (daily, weekly, monthly, or annual), etc. shall be capable of being saved as a template for future reports. Reports shall be time and date stamped and shall contain a report title editable by the user.

b. Reports shall be capable of being sent to a printer or export to Word or ASCII format to a file, and shall be capable of being generated automatically based on date and time of day.

c. Standard reports. Prepare the following standard reports for each building and the Owner as a whole, accessible automatically without requiring definition by user.

1) Tenant or department after-hour usage. System must be capable of monitoring tenant override requests and generating a monthly report showing the daily total time in hours that each tenant has requested after-hours HVAC services.

2) Monthly and annual energy usage and cost. See Utility cost calculation in Paragraph 3.12.

3) Alarm events and status.

4) Points in Hand (Operator Override) via Workstation command (including name of operator who made the command) or via supervised HOA switch at output, including date and time.

E. Control Programming Software

1. Points

a. Provide templates customized for point type, to support input of individual point information using standard BACnet Objects, including long-name field.

b. All real and virtual points shall be accessible to any control panel for use in any control sequences regardless of physical location.

2. Programming Language

a. All controllers must be fully user-programmable using a single programming language for all control devices. Use of canned (preprogrammed, burned-in) software is not acceptable.

b. The control programming language must allow virtually any control sequences to be written. Software shall be capable of the sequences specified in Paragraph 3.12 without exception.

c. All custom programs shall be modifiable from Operator Workstations without having to burn chips or locally access the controller. Software shall allow the user to modify and input control sequence software and to download to panels via the control network.

d. The programming language shall support floating point arithmetic using the following operators and functions: +, -, /, x, square root, and x-to-the-y-power, natural log, log, trigonometric functions (sine, cosine, tangent), absolute value, minimum/maximum value from a list of values, and psychrometric parameters (wetbulb, dewpoint, and enthalpy) from temperature and relative humidity.

e. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval timing functions can stopped and started within a program.

f. The system must be capable of supporting software (virtual) points to be used in control sequences and monitored just as if they were real digital or analog points.

g. Control programming shall employ the BACnet protocols for Standard Command Priorities.

h. A PID (proportional-integral-derivative) algorithm with adjustable gains and anti-windup shall be included as an integral part (subroutine) of the programming language, not requiring special programming or hardware.

i. The programming language shall be graphical. BASIC-like or other line- or block-type programming languages are not acceptable. With the graphical programming language, a sequence of operations shall be created by drag-and-drop assembling on screen of graphic blocks that represent each of the commands or functions necessary to complete a control sequence. Blocks represent common logical control devices such as relays, switches, high signal selectors, PID loops, optimum start, etc. Blocks are then interconnected on screen using graphic “wires,” each forming a logical connection. Once assembled, each logical grouping of graphic blocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

j. The graphic programming software shall support a live mode, where all input/output data, calculated data, and setpoints shall be displayed in a real-time mode. For each piece of HVAC equipment, the entire graphic program shall be displayed through the GUI. The operator must have the ability to scroll through the entire live graphic program as necessary.

3. Debugging Software

a. Provide a search capability that will search all control sequences for a given point name to determine all sequences that use or control the point.

b. The control programs shall be capable of being tested on-line or off-line (prior to installation in field panels). The program and results of programming tests shall be displayed graphically using graphical programming language with parameter values displayed in appropriate locations. Simulation capabilities shall include step-by-step, accelerated time, and operator defined simulation criteria like outside weather, demand, and communication status.

F. Miscellaneous Software

1. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide relevant data for the application or object that help is being called from.

2. Provide software for viewing (but not editing) electronic versions of as-built shop drawings of

a. Mechanical, electrical, and plumbing systems in AutoCAD Release 2006+ format

b. EMCS drawings in format selected by Contractor (see limitations in Paragraph 1.10)

G. Energy Dashboard

1. Include “dashboard” interface.

a. Provide an energy dashboard with rich & custom graphics that overlay on Niagara AX front end to display utility consumption and charges, energy usage for lighting, HVAC, and plug loads. Display historic and real-time data in various units and equivalent greenhouse emissions.

b. Acceptable “dashboards” manufacturers:

1) Periscope - http://activelogix.com/about_periscope.asp

2) DG Logik - http://www.dglogik.com/dglux/editions/prophet

3) or approved equal

2.12 CONTROL POINTS

A. Table Column Definitions

1. Point description

2. Type (number in point schedule after each type refers to tag on schematics)

    a. AO: analog output

    b. AI: analog input

    c. DO: digital or binary output

    d. DI: digital or binary input

3. Device description

    a. See Paragraph 2.5 for device definition.

4. New Device

    a. Where listed, a new device (sensor, actuator, etc.) is required as indicated.

5. New Point

    a. Where listed, a new control point and communication wiring are required as indicated. Where indicated otherwise, the point is part of the existing DDC system; existing point conduit and wiring may be reused in accordance with Paragraph 1.6B.

6. Trend Logging

    a. Commissioning: Where listed, point is to be trended at the basis listed for commissioning and performance verification purposes.

    b. Continuous: Where listed, point is to be trended at the basis listed continuously, initiated after system acceptance, for the purpose of future diagnostics.

    c. Trend Basis

        1) Where range of engineering units is listed, trend on a change of value (COV) basis (in other words record time stamp and value when point value changes by engineering unit listed).

        2) Where time interval is listed, trend on a time basis (in other words record time stamp and value at interval listed). All points relating to a specific piece of equipment shall be trended at the same initiation time of day so data can be compared in text format.

7. Calibration

    a. F = factory calibration only is required (no field calibration)

    b. HH = field calibrate with handheld device. See Paragraph 3.15D.5.a.2)

B. Fire alarm points are not listed in the points lists but all existing functionality shall be retained.

C. Points mapped through gateways and network interfaces

1. Variable speed drives (typical of VFD driven fans and pumps): The following points shall be mapped over from the VFD network card as a minimum for each fan that has a variable speed drive. (Note VFD start/stop and speed are hardware points as indicated in points list below and shall not be mapped through the gateway.) This applies to all new and recently replaced VFDs.

Description	Type	Device	Trend Logging		Calibration
			Commissioning	Continuous	
Fault reset	DO	Through network	COV	COV	–
On/off status	DI	Through network	COV	COV	–
Fault (Critical Alarm)	DI	Through network	COV	COV	–
Minor Alarm	DI	Through network	COV	COV	–
Fault Text	DI	Through network (convert code to plain English text)	COV	COV	–
Alarm Text	DI	Through network (convert code to plain English text)	COV	COV	–
Keypad in hand/auto	DI	Through network	COV	COV	–
Minimum frequency setpoint	AO	Through network	±5%	±5%	–
Maximum frequency setpoint	AO	Through network	±5%	±5%	–
Acceleration rate	AO	Through network	±5%	±5%	–
Deceleration rate	AO	Through network	±5%	±5%	–
Actual frequency	AI	Through network	1 min	15 min	–
AC output voltage	AI	Through network	±10%	±10%	F
Current	AI	Through network	15 min	60 min	F
VFD temperature	AI	Through network	60 min	60 min	F
Power, kW	AI	Through network	1 min	15 min	F
Energy, MWh	AI	Through network	15 min	60 min	–
DC Bus Voltage	AI	Through network	±10%	±10%	F

D. Hardwired Points

1. VAV Air Handler. Typical for RTU-1 and RTU-2. See CS-1 detail 3.

a. Demolish existing Delta controller and replace functionality as described herein.

b. Provide and install LCD display and keyboard for each RTU inside existing cabinet. Automatic Logic BACview^6 or equal.

c. Control Points:

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
Start/Stop	DO	Connect to VFD Run on SF and RF			COV	COV	–
Cooling Stage 1	DO	Connect to (N) relay; delete sequencer			COV	COV	–
Cooling Stage 2	DO	Ditto			COV	COV	–
Cooling Stage 3	DO	Ditto			COV	COV	–
Cooling Stage 4	DO	Ditto			COV	COV	–
Cooling Stage 5	DO	Ditto			COV	COV	–
Cooling Stage 6	DO	Ditto			COV	COV	–
Cooling Stage 7	DO	Ditto			COV	COV	–
Cooling Stage 8	DO	Ditto			COV	COV	–
Evaporative Condenser Pump	DO	Connect to relay		X	COV	COV	–
Evaporative Condenser Fan 1	DO	Connect to (N) relay; delete sequencer		X	COV	COV	–
Evaporative Condenser Fan 2	DO	Ditto		X	COV	COV	–
Outdoor Air Damper	AO	Modulating actuator	X (alt.)		1 min	15 min	–
Return Air Damper	AO	Modulating actuator	X (alt.)	X	1 min	15 min	–
Relief Air Damper	AO	Modulating actuator	X (alt.)	X	1 min	15 min	–
Return Fan Speed	AO	Connect to VFD speed both fans		X	1 min	15 min	–
Supply Fan Speed	AO	Connect to VFD speed both fans			1 min	15 min	–
Supply Fan Status	DI	Connect to (E) DPS and freeze-stat			COV	COV	–
Compressor Lockout Status	DI	Connect to (E) relays from each compressor in parallel			COV	COV	–
Shutdown	DI	Connect to (E) relay			COV	COV	–
Duct Static Pressure High Limit	DI	Connect to (E) switch			COV	COV	–
Outdoor Air Temperature	AI	TS-1A	X		1 min	15 min	F
Mixed Air Temperature	AI	TS-1B across filter bank	X		1 min	15 min	F
Return Air Temperature	AI	TS-1A	X		1 min	15 min	F
Supply Air Temperature	AI	TS-1A	X		1 min	15 min	F
Evaporative Condenser Sump Temperature	AI	TS-2A	X		1 min	15 min	F
Duct Static Pressure	AI	DPT-3, 0 to 2.5 inches. Connect to (E) static pressure tip	X		1 min	15 min	F

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
EC Sump Conductivity	AI	Connect to contact on (E) WTS		X	1 min	15 min	–
Refrigerant discharge pressure – circuit 1	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant discharge pressure – circuit 2	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant discharge pressure – circuit 3	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant discharge pressure – circuit 4	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant suction pressure – circuit 1	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant suction pressure – circuit 2	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant suction pressure – circuit 3	AI	DPT-2	X	X	1 min	15 min	F
Refrigerant suction pressure – circuit 4	AI	DPT-2	X	X	1 min	15 min	F

2. Auxiliary AC Units and Hydronic Heat Pumps. See CS-2 detail 2.

   a. Applies to these systems:

Type	Tag	Service
HP	B-1	Electrical Room
HP	B-2	Main Telephone Room
HP	1-1	Server Room
HP	2-1	Server Room
HP	3-1	Server Room
HP	4-1	Server Room
HP	5-1	Server Room
RTU	3	Elevator Room
RTU	4	Elevator Room
AC	?1	Radio Room
AC	?2	Radio Room
AC	?3	Radio Room
AC	?4	Radio Room
AC	?5	Radio Room

   b. Control Points:

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
Cooling on/off	DO	Connect to contact on unit control panel		Note 1	COV	COV	–

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Supply Fan Start/Stop	DO	ditto		Note 1	COV	COV	–
Supply fan status	DI	CS-1	X	Note 1	COV	COV	See 3.11F
Zone Temperature	AI	TS-3A	X	Note 1	1 min	15 min	F
Note 1: New point for Radio Room AC units only.							

3. Mini-Split DX Units. Typical of 5 units. See CS-2 detail 3.

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Zone Temperature	AI	TS-3A thermistor	X	X	1 min	15 min	F

4. Condenser Water System. See CS-1 detail 1.

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
CT-1 High Speed Start	DO	Connect to contact in starter			COV	COV	–
CT-1 Low Speed Start	DO	Connect to contact in starter			COV	COV	–
Spray Pump	DO	Connect to motor starter		X	COV	COV	–
P-3 Start	DO	Connect to motor starter			COV	COV	–
P-4 Start	DO	Connect to motor starter			COV	COV	–
CT-1 Status	DI	CS-1	X		COV	COV	See 3.11F
Spray Pump Status	DI	CS-1	X	X	COV	COV	See 3.11F
P-3 Status	DI	CS-1	X		COV	COV	See 3.11F
P-4 Status	DI	CS-1	X		COV	COV	See 3.11F
Water treatment system alarm	DI	Connect to contact on controller		X	COV	COV	–
CWS temperature	AI	TS-2B	X		5 min	15 min	F
CWR temperature	AI	TS-2B	X		5 min	15 min	F

5. Hot Water System. See CS-1 detail 2.

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Boiler B-1 enable	DO	Connect to boiler enable contact			COV	COV	–
Boiler B-2 enable	DO	Connect to boiler enable contact			COV	COV	–
Start HWP-1	DO	Connect to motor starter			COV	COV	–
Start HWP-2	DO	Connect to motor starter			COV	COV	–
Boiler B-1 alarm	DI	Connect to boiler alarm contact. If no existing contact, add relay downstream of safeties and wire relay's NC contact as alarm.			COV	COV	–
Boiler B-2 alarm	DI	Ditto			COV	COV	–
Boiler B-1 firing status	DI	Connect to boiler alarm contact. If no existing contact, add relay in parallel with firing circuit and wire relay's NO contact as status.			COV	COV	–
Boiler B-2 firing status	DI	Ditto			COV	COV	–
HWP-1 status	DI	CS-1	X		COV	COV	See 3.11F
HWP-2 status	DI	CS-1	X		COV	COV	See 3.11F
HW flow meter	AI	FM-1	X		1 min.	5 min.	F
HWS temperature	AI	TS-2B	X		1 min.	±2°F	F
HWR temperature	AI	TS-2B	X		1 min.	±2°F	F

6. Domestic Water System. See CS-2 detail 1.

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
DHWS temperature	AI	TS-2A in a new well	X	X	1 min.	±2°F	F

7. VAV Box with Reheat. See CS-2 detail 4.

   a. Replace reheat control valves and actuators at each zone. Existing valves are all 3-way. Replace with 2-way valves on all coils except provide 3-way valves at:

      1) Basement: V-2-B-1, V-2-B-2

2) 1st Floor: V-1-1-2, V-2-1-19

b. Replace the entire VAV box with Titus or equal box of the same inlet size (listed in table below). Reconnect ductwork and piping to existing:

1) V2-1-15

2) V2-1-19

c. Applies to these zones:

				Base: no DCV		DCV		
RTU	**Box Tag**	**Duct inlet size**	**Cool Max cfm**	**Heat max cfm**	**Min cfm**	**Heat max cfm**	**Min cfm**	**CO_2**
2	V-2-B-1	14	1700	510	0			
1	V-1-1-1	8	750	225	70			
1	V-1-1-2	10	900	270	125			
1	V-1-1-3	12	1200	360	155			
1	V-1-1-4	12	1200	360	130			
1	V-1-1-5	12	1200	360	110			
1	V-1-1-6	12	1200	360	145			
1	V-1-1-7	12	1200	360	95			
1	V-1-1-8	12	1200	360	125			
2	V-2-1-11	10	1000	300	110			
2	V-2-1-12	8	700	210	55			
2	V-2-1-13	10	1050	315	100			
2	V-2-1-14	10	1050	315	125			
2	V-2-1-15	10	950	285	125			
2	V-2-1-16	12	1200	360	100			
2	V-2-1-17	7	500	150	25			
2	V-2-1-18	10	800	240	95			
2	V-2-1-19	12	1200	360	355	360	120	Y
2	V-2-1-20	10	900	270	140			
2	V-2-1-27	10	900	270	155			
1	V-1-2-1	14	2400	720	255			
1	V-1-2-2	10	850	255	95			
1	V-1-2-3	6	350	105	25			
1	V-1-2-4	12	1400	420	95			
1	V-1-2-5	10	1000	300	65			
1	V-1-2-6	12	1300	390	100			
1	V-1-2-7	8	650	195	30			
1	V-1-2-8	10	1000	300	55			
2	V-2-2-12	12	1300	390	135			
2	V-2-2-13	12	1200	360	85			
2	V-2-2-14	7	400	120	30			
2	V-2-2-15	12	1200	360	150			
2	V-2-2-16	12	1500	450	195			
2	V-2-2-17	8	850	250	120			
2	V-2-2-18	12	1150	345	150			
2	V-2-2-19	7	500	150	30			

2	V-2-2-20	10	900	270	90			
2	V-2-2-21	10	900	270	80			
2	V-2-2-22	8	650	195	65			
1	V-1-3-1	10	950	285	95			
1	V-1-3-2	12	1200	360	165			
1	V-1-3-3	8	625	190	80			
1	V-1-3-4	12	1125	340	235	340	45	Y
1	V-1-3-5	10	1050	315	105			
1	V-1-3-6	12	1300	390	155			
1	V-1-3-7	12	1300	390	145			
1	V-1-3-8	12	1300	390	130			
1	V-1-3-9	12	1500	450	90			
1	V-1-3-10	12	1300	390	305	390	120	Y
2	V-2-3-14	12	1325	400	155			
2	V-2-3-15	10	800	240	55			
2	V-2-3-16	12	1175	355	130			
2	V-2-3-17	12	1100	330	150			
2	V-2-3-18	12	1100	330	145			
2	V-2-3-19	12	1100	330	145			
2	V-2-3-20	12	1100	330	140			
2	V-2-3-21	10	800	240	60			
2	V-2-3-22	12	1200	360	90			
1	V-1-4-1	10	850	255	95			
1	V-1-4-2	12	1300	465	465	465	95	Y
1	V-1-4-3	7	450	135	95			
1	V-1-4-4	10	1050	315	245	315	50	Y
1	V-1-4-5	10	900	270	45			
1	V-1-4-6	12	1350	450	450	450	180	Y
1	V-1-4-7	12	1350	405	160			
1	V-1-4-8	12	1350	405	170			
1	V-1-4-9	8	800	240	50			
2	V-2-4-14	12	1200	360	105			
2	V-2-4-15	8	800	240	70			
2	V-2-4-16	12	1200	360	115			
2	V-2-4-17	12	1200	360	275			
2	V-2-4-18	10	1000	300	210			
2	V-2-4-19	10	800	240	155			
2	V-2-4-20	8	650	195	35			
2	V-2-4-21	10	975	295	60			
1	V-1-5-1	10	950	285	95			
1	V-1-5-2	7	550	165	30			
1	V-1-5-3	8	600	180	90			
1	V-1-5-4	14	1600	480	185			
1	V-1-5-5	12	1300	390	160			
1	V-1-5-6	7	400	130	130	120	25	Y
1	V-1-5-7	12	1200	360	240	360	50	Y
1	V-1-5-8	10	775	235	40			
1	V-1-5-9	8	750	225	100			
1	V-1-5-10	10	1050	315	75			

1	V-1-5-11	12	1100	360	85			
1	V-1-5-12	10	1000	300	80			
1	V-1-5-13	7	450	135	25			
2	V-2-5-19	10	1075	325	105			
2	V-2-5-20	10	800	240	85			
2	V-2-5-21	10	800	240	70			
2	V-2-5-22	8	750	225	55			
2	V-2-5-23	7	500	150	45			
2	V-2-5-24	14	1550	465	205			
2	V-2-5-25	14	1550	465	215			

d. Control Points:

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
VAV Box Damper Position	AO	Modulating actuator	X	X	1 min	15 min	–
HW valve signal	AO	(N) modulating actuator and valve	X	X	1 min.	15 min	
Supply Airflow	AI	DPT-5	X		1 min	15 min	HH - see §3.14 A.4
Supply air temperature	AI	TS-1A mounted at coil discharge	X	X	1 min	15 min	F
Zone Temperature	AI	TS-3C	X		1 min	15 min	F
Zone Temperature Setpoint Adjustment	AI			X	15 min	60 min	F
Local Override	DI			X	COV	COV	–
CO_2 Concentration	AI	CO_2	X	X	1 min	15 min	F

8. VAV Box Cooling Only. See CS-2 detail 5.

a. Add a new zone on 4th floor as follows:

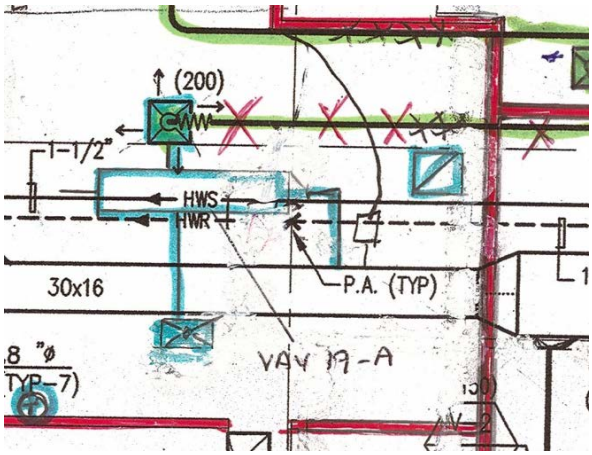
1) Install new cooling-only Titus or equal VAV box as scheduled below connected to duct main with conical tap sized per box inlet; sheet metal duct only (no flex)

2) Install a sheet metal discharge plenum, 5 feet long with 1” acoustic liner

3) Reconnect existing 200 cfm diffuser from V-2-4-18 ducted this new zone discharge plenum with volume damper and helical wire type flexible duct

4) Add one more 2x2 diffuser with 8” neck, style to match existing diffuser, ducted to discharge plenum with volume damper and helical wire type flexible duct

5) Add 2x2 return air grille, ,style to match existing



b. Applies to these zones:

AHU	Box Tag	Duct inlet size	Cool Max cfm	Min cfm
2	V-2-B-2	8	675	203
1	V-1-1-9	7	500	0
1	V-1-1-10	10	900	0
2	V-2-1-21	10	825	0
2	V-2-1-22	8	750	155
2	V-2-1-23	10	950	115
2	V-2-1-24	7	500	0
2	V-2-1-25	8	700	160
2	V-2-1-26	10	800	240
2	V-2-1-28	7	500	15
1	V-1-2-9	14	1600	0
1	V-1-2-10	7	400	120
1	V-1-2-11	12	1500	0
2	V-2-2-23	12	1275	155
2	V-2-2-24	6	300	90
2	V-2-2-25	12	1200	0
2	V-2-2-26	7	500	0
2	V-2-2-27	8	650	110
2	V-2-2-28	12	1300	0
1	V-1-3-11	7	500	75
1	V-1-3-12	12	1250	0
1	V-1-3-13	7	450	135
2	V-2-3-23	8	750	0
2	V-2-3-24	7	500	0
2	V-2-3-25	10	1000	0
2	V-2-3-26	12	1450	0
2	V-2-3-27	8	750	150
1	V-1-4-10	8	700	210
1	V-1-4-11	10	825	0
1	V-1-4-12	12	1300	0
1	V-1-4-13	10	900	145

2	V-2-4-19A	7	400	85
2	V-2-4-22	8	750	225
2	V-2-4-23	12	1150	80
2	V-2-4-24	10	900	0
2	V-2-4-25	8	600	0
2	V-2-4-26	10	875	0
1	V-1-5-14	8	600	0
1	V-1-5-15	10	1000	120
1	V-1-5-16	12	1100	0
1	V-1-5-17	12	1100	195
1	V-1-5-18	7	450	100
2	V-2-5-26	8	700	0
2	V-2-5-27	7	500	0
2	V-2-5-28	12	1500	0
2	V-2-5-29	12	1150	105
2	V-2-5-30	12	1200	0

c. Control Points:

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
VAV Box Damper Position	AO	Modulating actuator			1 min	15 min	–
Supply Airflow	AI	DPT-5			1 min	15 min	HH - see §3.14A.4
Zone Temperature	AI	TS-3C	X		1 min	15 min	F
Zone Temperature Setpoint Adjustment	AI			X	15 min	60 min	F
Local Override	DI			X	COV	COV	–

9. Toilet Exhaust Fan, EF-1, EF-2

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Fan Start/Stop	DO	Connect to starter			COV	COV	–
Fan Status	DI	CS-1			COV	COV	See 3.11F

10. Miscellaneous Points. See CS-2 detail 7.

Description	Type	Device	New Device	New Point	Trend Logging		Calibration
					Commissioning	Continuous	
Sump pump 1 status	DI	Connect to controller			COV	COV	–
Sump pump 2 status	DI	Connect to controller			COV	COV	–

Description	Type	Device	New Device	New Point	Trend Logging		Cali-bra-tion
					Comm-issioning	Contin-uous	
Sump pump 3 status	DI	Connect to controller			COV	COV	–
Sump pump 4 status	DI	Connect to controller			COV	COV	–
Sump pump 5 status	DI	Connect to controller			COV	COV	–
Sump pump 6 status	DI	Connect to controller			COV	COV	–
Sump pump 1 alarm	DI	Connect to controller		X	COV	COV	–
Sump pump 2 alarm	DI	Connect to controller		X	COV	COV	–
Sump pump 3 alarm	DI	Connect to controller		X	COV	COV	–
Sump pump 4 alarm	DI	Connect to controller		X	COV	COV	–
Sump pump 5 alarm	DI	Connect to controller		X	COV	COV	–
Sump pump 6 alarm	DI	Connect to controller		X	COV	COV	–
Emergency generator alarm	DI	Connect to controller			COV	COV	–
Booster pump status	DI	Connect to controller		X	COV	COV	–
Booster pump alarm	DI	Connect to controller		X	COV	COV	–
Solar photovoltaic alarm	DI	Connect to PV controller alarm		X	COV	COV	–
Solar photovoltaic electricity meter	AI	Connect to pulse output of PV meter		X	1 min	15 min	−
PG&E electricity meter	AI	Connect to pulse output of (E) PG&E meter		X	1 min	15 min	−
PG&E gas meter	AI	Connect to pulse output of (E) PG&E meter		X	1 min	15 min	−
Redwood City water meter	AI	Connect to pulse output of (E) utility meter		X	1 min	15 min	−
Power to Radio Room (penthouse)	AI	PM-1 on power feeding rooftop radio room	X	X	1 min	15 min	F
Outdoor air temperature	AI	TS-4 mounted where not exposed to direct sunlight, exhaust air	X	X	1 min	15 min	F

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Install systems and materials in accordance with manufacturer’s instructions, roughing-in drawings and details indicated on Drawings.

B. Coordinate Work and Work schedule with other trades prior to construction.

C. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment.

B. Store equipment and materials inside and protect from weather.

3.3 IDENTIFICATION

A. General

1. Manufacturers' nameplates and UL or CSA labels to be visible and legible after equipment is installed.

2. Identifiers shall match record documents.

3. All plug-in components shall be labeled such that removal of the component does not remove the label.

B. Wiring and Tubing

1. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2 inches of termination with the EMCS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. All pneumatic tubing shall be labeled at each end within 2 inches of termination with a descriptive identifier.

C. Equipment and Devices

1. Valve and damper actuators: None required.

2. Sensors: Provide 1 inch x 3 inches x 1/8 inches black micarta or lamacoid labels with engraved white lettering, ¼ inches high. Indicate sensor identifier and function (for example "CHWS Temp").

3. Panels

a. Provide 2 inches x 5 inches 1/8 inches black micarta or lamacoid labels with engraved white lettering, ½ inches high. Indicate panel identifier and service.

b. Provide permanent tag indicating the electrical panel and circuit number from which panel is powered.

4. Identify room sensors relating to terminal box or valves with indelible marker on sensor hidden by cover.

3.4 CUTTING, CORING, PATCHING AND PAINTING

A. Provide canning for openings in concrete walls and floors and other structural elements prior to their construction.

B. Penetrations through rated walls or floors shall be filled with a listed material to provide a code compliant fire-stop.

C. All damage to and openings in ductwork, piping insulation, and other materials and equipment resulting from Work in this Section shall be properly sealed, repaired, or re-insulated by experienced mechanics of the trade involved. Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

D. At the completion of Work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired and repainted to original finish.

3.5 CLEANING

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, and other debris generated by Work in this Section as soon as their contents have been removed. Waste shall be collected and legally disposed of.

B. Materials stored on-site shall be protected from weather and stored in an orderly manner, neatly stacked, or piled in the designated area assigned by the Owner's Representative.

C. At the completion of work in any area, clean all work and equipment of dust, dirt, and debris.

D. Use only cleaning materials recommended by the manufacturer of the surfaces to be cleaned and on surfaces recommended by the cleaning material manufacturer.

3.6 CONTROLLERS

A. General

1. Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details indicated on Drawings.

2. Regardless of application category listed below, each Control Unit shall be capable of performing the specified sequence of operation for the associated equipment. Except as listed below, all physical point data and calculated values required to accomplish the sequence of operation shall reside within the associated CU. Refer to Paragraph 2.3B above for physical limitations of standalone functionality. Listed below are point data and calculated values that shall be allowed to be obtained from other CUs via LAN.

   a. Global points such as outdoor air temperature

   b. Requests, such as heat/cool requests, used to request operation or for setpoint reset from zones to systems and systems to plants

   c. Modes, such as system modes, used to change operating logic from plants to systems and systems to zones

3. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

B. Controller Application Categories

1. Controllers shall comply with the application table below (X under controller type indicates acceptable controller type).

Application Category	Examples	Acceptable Controller		
		ASC	AAC	BC
0	Monitoring of variables that are not used in a control loop, sequence logic, or safety, such as status of sump pumps or associated float switches, temperatures in monitored electrical rooms.	X	X	X
1	• Terminal Units (such as VAV Boxes) • Miscellaneous heaters • Constant speed exhaust fans and pumps • Packaged units with self-contained controls	X	X	X
2	• Hot Water Plant		X (note 1)	X
3	• RTU-1, 2			X

Notes:
1. AAC may be used only if all control functions and physical I/O associated with a given unit resides in one AAC

2. ASC Installation

a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use if ceiling attic is used as a return air plenum.

b. ASCs that control equipment mounted in a mechanical room may either be mounted in or on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.

c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.

d. Furnish ASCs to the VAV terminal unit manufacturer for factory mounting.

3. AAC and BC Installation

a. AACs/BCs that control equipment located above accessible ceilings shall be mounted in a NEMA 1, locking enclosure and shall be rated for plenum use if ceiling attic is used as a return air plenum.

b. AACs/BCs that control equipment located in occupied spaces or outside shall either be mounted within the equipment enclosure (responsibility for physical fit remains with the Contractor) or in a proximate mechanical/utility room in which case it shall be enclosed in a NEMA 1, locking enclosure.

3.7 COMMUNICATION DEVICES

A. General

1. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details indicated on Drawings.

2. Provide all interface devices and software to provide an integrated system.

B. LANID and LAN Routers

1. Provide as required

2. Connect networks to both sides of device

3. Thoroughly test to ensure proper operation

4. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted. The system shall automatically monitor the operation of all network devices and annunciate any device that goes off-line because it is failing to communicate.

C. Gateways and Routers

1. General

a. Wire to networks on both sides of device.

b. Map across all monitoring and control points listed in Paragraph 2.11.

c. Thoroughly test each point to ensure that mapping is accurate.

d. Initiate trends of points as indication in Paragraph 2.11.

2. Variable Speed Drive Gateway

a. Install gateway(s) in local EMCS panel or in separate NEMA 1 enclosure in mechanical or electrical room.

b. Wire each variable speed drive network card to the gateway per manufacturer's instructions.

c. Connect gateway to Primary or Secondary LAN.

3.8 EMCS INTERFACE HARDWARE

A. Provide the following EMCS Interface Hardware:

Device	Quantity
Control System Server	1
Operator Workstation	0
Portable Operator's Terminal	0
Uninterruptible Power Supply	0
Color Inkjet Printer	1

B. CSS

1. Install new CSS in existing engineer's office on furniture provided by Owner.

2. Demo of existing CSS by Owner.

3. Connect CSS

a. To Supervisory LAN

b. To DSL internet connection provided by Owner.

C. Install all hardware and software and configure all devices in accordance with manufacturer's instructions.

D. Provide all licenses, keys, etc. and all documentation and any information required to install, configure, operate, diagnose and maintain the system.

E. Backup

1. After completion and acceptance of installation, create a backup of all OWSs and server database and configuration files for permanent record of initial installation on CD. Make three copies, two for Owner and one for Contractor to retain for his records off-site.

2. All other backup configuration shall be by the Owner.

F. Anti-virus and firewall software and installation shall be by the Owner.

3.9 CONTROL POWER

A. Power wiring and wiring connections required for Work in this Section shall be provided under this Section.

B. Extend power to all EMCS devices, including 120V power to panels, from an acceptable power panel.

C. General requirements for obtaining power include the following:

1. Electrical service to controls panels and control devices shall be provided by isolated circuits, with no other loads attached to the circuit, clearly marked at its source. The location of the breaker shall be clearly identified in each panel served by it.

2. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120V source fed from a common origin.

3. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls, it may be used. If the equipment's control transformer is not large enough or not of the correct voltage to supply the controls, provide separate transformer(s).

4. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, or interruptible), the controller shall be powered by the highest level of reliability served.

5. Standalone Functionality: Refer to Paragraph 2.3B.

D. Contractor shall provide transformers for all low voltage control devices including all terminal units such as VAV boxes with hot water reheat. Transformer(s) shall be located in control panels in readily accessible locations such as Electrical Rooms.

E. Power line filtering. Provide transient voltage and surge suppression for all workstations and BCs either internally or as an external component.

3.10 CONTROL AND COMMUNICATION WIRING

A. Control and Signal Wiring

1. Line Voltage Wiring

a. All line-voltage wiring shall meet NEC Class 1 requirements.

b. All Class 1 wiring shall be installed in UL Listed approved raceway per NEC requirements and shall be installed by a licensed electrician.

c. Class 1 wiring shall not be installed in raceway containing pneumatic tubing.

2. Low Voltage Wiring

a. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

b. Class 2 wiring shall be installed in UL Listed approved raceway as follows:

1) Where located in unconcealed or inaccessible locations, such as:

a) Equipment rooms

b) Exposed to weather

c) Exposed to occupant view

d) Inaccessible locations such as concealed shafts and above inaccessible ceilings

2) Class 2 wiring shall not be installed in raceway containing Class 1 wiring.

c. Class 2 wiring need not be installed in raceway as follows:

1) Where located in concealed and easily accessible locations, such as:

a) Inside mechanical equipment enclosures and control panels

b) Above suspended accessible ceilings (e.g. lay-in and spline)

c) Above suspended drywall ceilings within reach of access panels throughout

d) In shafts within reach of access panels throughout

e) Nonrated wall cavities

2) Wiring shall be UL Listed for the intended application. For example, cables used in floor or ceiling plenums used for air transport shall be UL Listed specifically for that purpose.

3) Wiring shall be supported from or anchored to structural members neatly tied at 10 foot intervals and at least 1 foot above ceiling tiles and light fixtures. Support or anchoring from straps or rods that support ductwork or piping is also acceptable. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceilings.

4) Install wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

d. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two (for example relays and transformers).

3. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

4. All field wiring shall be properly labeled at each end, with self-laminating typed labels indicating device address, for easy reference to the identification schematic. All power wiring shall be neatly labeled to indicate service, voltage, and breaker source.

5. Use coded conductors throughout with different colored conductors.

6. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

7. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.

8. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

9. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

10. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendation and NEC requirements.

11. Include one pull string in each raceway 1 inch or larger.

12. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

13. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (for example steam pipes or flues).

14. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

15. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

16. Terminate all control or interlock wiring.

17. Maintain updated as-built wiring diagrams with terminations identified at the jobsite.

18. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than ½ inches electrical trade size shall not be used. In areas exposed to moisture liquid-tight, flexible metal raceways shall be used.

19. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings per code. Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

20. Hardwire Interlocks

    a. The devices referenced in this Section are hardwire interlocked to ensure equipment shutdown occurs even if control systems are down. Do not use software (alone) for these interlocks.

    b. Hardwire device NC contact to air handler fan starter upstream of HOA switch, or to VFD enable contact.

    c. Where multiple fans (or EMCS DI) are controlled off of one device and the device does not have sufficient contacts, provide a relay at the device to provide the required number of contacts.

d. Provide for the following devices where indicated on Drawings or in Sequences of Operation:

1) Duct smoke detector (existing)

2) High discharge static pressure (existing)

21. Shielded cable shield shall be grounded only at one end. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

22. Existing control wiring that is not to be reused shall be demolished, unless otherwise directed by the Owner's representative.

B. Communication Wiring

1. Adhere to the requirements of Paragraph 3.10A in addition to this Paragraph.

2. Communication and signal wiring may be run without conduit in concealed, accessible locations as permitted by Paragraph 3.10A only if noise immunity is ensured. Contractor is fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

3. All cabling shall be installed in a neat and workmanlike manner. Follow all manufacturers' installation recommendations for all communication cabling.

4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

5. Maximum pulling, tension, and bend radius for cable installation as specified by the cable manufacturer shall not be exceeded during installation.

6. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

7. All runs of communication wiring shall be unspliced length when that length is commercially available.

8. All communication wiring shall be labeled to indicate origination and destination data.

9. Grounding of coaxial cable shall be in accordance with NEC regulations Article on Communications Circuits, Cable and Protector Grounding.

10. Power-line carrier signal communication or transmission is not acceptable.

3.11 SENSORS AND MISCELLANEOUS FIELD DEVICES

A. This section applies to new sensors. Existing sensors may remain as-installed.

B. Install sensors in accordance with the manufacturer's recommendations.

C. Mount sensors rigidly and adequately for the environment within which the sensor operates.

D. Temperature Sensors

1. Room temperature sensors and thermostats shall be installed on concealed junction boxes properly supported by the wall framing.

   a. For sensors mounted in exterior walls or columns, seal all junction box openings with mastic sealant and pack junction box with fiberglass insulation.

   b. For sensors on exposed columns, use Wiremold or equal enclosures that are the smallest required to enclose wiring (e.g. Wiremold 400 BAC or equal) and Wiremold or equal junction boxes that are the narrowest required to enclose the temperature sensor and wiring connections (e.g. Wiremold 2348S/51 or equal). Color or raceway and boxes shall be per the architect; submit for approval prior to installation.

2. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

3. Averaging sensors shall be installed in a serpentine manner vertically across duct. Each bend shall be supported with a capillary clip. Where located in front of filters (such as mixed air sensors), access for filter removal shall be maintained.

4. All pipe-mounted temperature sensors shall be installed in wells. For small piping, well shall be installed in an elbow into pipe length. Install the sensor in the well with a thermal-conducting grease or mastic. Use a closed-cell insulation patch that is integrated into the pipe insulation system to isolate the top of the well from ambient conditions but allow easy access to the sensor. Patch insulation where it is removed to add new wells.

5. Unless otherwise noted on Drawings or Points List, temperature sensors/thermostats, CO_2 sensors, and other room wall mounted sensors shall be installed at same centerline as adjacent electrical switches, 4 feet above the finished floor where there are no adjacent electrical switches, and within ADA limitations.

E. Differential Pressure Sensors

1. Supply Duct Static Pressure: Mount transmitter in temperature control panel near or in EMCS panel to which it is wired. Connect the low-pressure port to tee in building pressure (high) signal of the building static pressure transmitter. Pipe the high-pressure tap to the existing duct static pressure tip.

2. All pressure transducers, other than those controlling VAV boxes, shall be located where accessible for service without use of ladders or special equipment. If required, locate in field device panels and pipe to the equipment monitored or ductwork.

3. The piping to the pressure ports on all pressure transducers (both air and water) shall contain a capped test port located adjacent to the transducer.

F. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current. For fans with motorized discharge dampers, adjust so that fan indicates off if damper is closed while fan is running.

G. Actuators

1. Type: All actuators shall be electric.

2. Mount and link control damper actuators per manufacturer's instructions.

3. Dampers

   a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage, or follow manufacturer's instructions to achieve same effect.

   b. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

   c. Provide all mounting hardware and linkages for actuator installation.

4. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal or down.

3.12 SOFTWARE INSTALLATION

A. System Configuration

1. Thoroughly and completely configure EMCS system software, supplemental software, network software etc. on OWS, POTs, and servers.

B. Point Structuring and Naming

1. The intent of this Paragraph is to require a consistent means of naming points across the EMCS. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, etc.

2. Point Summary Table

   a. The term "Point" includes all physical I/O points, virtual points, and all application program parameters.

   b. With each schematic, provide a Point Summary Table listing

      1) Building number and abbreviation

      2) System type

      3) Equipment type

      4) Point suffix

      5) Full point name (see Point Naming Convention Paragraph)

6) Point description

7) Ethernet backbone network number,

8) Network number

9) Device ID

10) Device MAC address

11) Object ID (object type, instance number)

12) Engineering units

13) Device make and model number; include range of device if model number does not so identify.

14) Device physical location description; include floor and column line intersection to one decimal place (for example line 6.2 and line A.3).

c. Point Summary Table shall be provided in both hard copy and in a relational database electronic format (ODBC-compliant).

d. Coordinate with the Owner's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or Project startup.

e. The Point Summary Table shall be kept current throughout the duration of the Project by the Contractor as the Master List of all points for the Project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the Owner the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.

3. Point Naming Convention

a. All point names shall adhere to the format as established below, unless otherwise agreed to by the Owner. New categories and descriptors may be created with approval of the Owner.

b. Format:

1) Building.Category.System.EquipmentTag.Component.Property.

2) Example: COB2.HVAC.Heatplant.B-1.HWS.Temperature

Building	Category	System	Equipment Tag	Component	Property	Typical units
Building address or initials	ELCT	Lighting Plug Generator Misc	(from equipment schedules)	SWITCH PHOTO CB	Command Status Light Power	On/off On/off Footcandles Watts

Building	Category	System	Equipment Tag	Component	Property	Typical units
	HVAC	Airhandling Exhaust Heatplant Coolplant Misc		CWS CWR HWS HWR CHWS CHWR OA SA RA EA GAS FLUID	Voltage Current ValvePos DamperPos Temperature Humidity Pressure Flow Energy Speed Signal	Volts Amps %open %open °F %RH Psig, "H_2O Cfm, gpm Btu %, Hz %
	PLMB	Domwater Air Natgas N2 O2 Irrigation Waste Misc				
	MISC	Weather				

4. Device Addressing Convention

   a. BACnet network numbers and Device Object IDs shall be unique throughout the network.

   b. All assignment of network numbers and Device Object IDs shall be coordinated with the Owner.

   c. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner:
   BBBFF, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.

   d. Each Device Object Identifier property shall be unique throughout the system and shall be assigned in the following manner:
   XXFFBBB, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.

   e. Coordinate with the Owner or a designated representative to ensure that no duplicate Device Object IDs occur.

   f. Alternative Device ID schemes or cross-project Device ID duplication if allowed shall be approved before Project commencement by the Owner.

5. I/O Point Physical Description

   a. Each point associated with a hardware device shall have its BACnet long-name point description field filled out with:

      1) The device manufacturer and model number. Include range of device if model number does not so identify.

2) For space sensors, include room number in which sensor is located.

C. Point Parameters

1. Provide the following minimum programming for each analog input

   a. Name

   b. Address

   c. Scanning frequency or COV threshold

   d. Engineering units

   e. Offset calibration and scaling factor for engineering units

   f. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.

   g. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides or failure of any network over which the point value is transferred.

   h. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

2. Provide the following minimum programming for each analog output

   a. Name

   b. Address

   c. Output updating frequency

   d. Engineering units

   e. Offset calibration and scaling factor for engineering units

   f. Output Range

   g. Default value to be used when the normal controlling value is not reporting.

3. Provide the following minimum programming for each digital input

   a. Name

   b. Address

   c. Engineering units (on/off, open/closed, freeze/normal, etc.)

d. Debounce time delay

e. Message and alarm reporting as specified

f. Reporting of each change of state, and memory storage of the time of the last change of state

g. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

4. Provide the following minimum programming for each digital output

a. Name

b. Address

c. Output updating frequency

d. Engineering units (on/off, open/closed, freeze/normal, etc.)

e. Direct or Reverse action selection

f. Minimum on-time

g. Minimum off-time

h. Status association with a DI and failure alarming (as applicable)

i. Reporting of each change of state, and memory storage of the time of the last change of state.

j. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

k. Default value to be used when the normal controlling value is not reporting.

D. Site-Specific Application Programming

1. All site specific application programming shall be written in a manner that will ensure programming quality and uniformity. Contractor shall ensure:

a. Programs are developed by one programmer, or a small group of programmers with rigid programming standards, to ensure a uniform style.

b. Programs for like functions are identical, to reduce debugging time and to ease maintainability.

c. Programs are thoroughly debugged before they are installed in the field.

2. Massage and tune application programming for a fully functioning system. It is the Contractor's responsibility to request clarification on sequences of operation that require such clarification.

3. All site-specific programming shall be fully documented and submitted for review and approval

    a. Prior to downloading into the panel (see Submittal Package 2, Paragraph 1.10.)

    b. At the completion of functional performance testing, and

    c. At the end of the warranty period (see Warranty Maintenance, Paragraph 1.15).

4. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the Project will be the property of the Owner and shall remain on the workstations/servers at the completion of the Project.

E. Graphic Screens

1. All site specific graphics shall be developed in a manner that will ensure graphic display quality and uniformity among the various systems.

2. Schematics of MEP systems

    a. Schematics shall be 2-D or 3-D and shall be based substantially on the schematics provided on Drawings.

    b. All relevant I/O points and setpoints being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse.

    c. Animation or equipment graphic color changes shall be used to indicate on/off status of mechanical components.

    d. Indicate all adjustable setpoints and setpoint high and low limits (for automatically reset setpoints), on the applicable system schematic graphic or, if space does not allow, on a supplemental linked-setpoint screen.

3. Displays shall show all points relevant to the operation of the system, including setpoints and setpoint limits for setpoints that are automatically reset.

4. The current value and point name of every I/O point and setpoint shall be shown on at least one graphic and in its appropriate physical location relative to building and mechanical systems.

5. Show weather conditions (local building outside air temperature and humidity) in the upper left hand corner of every graphic.

6. CAD drawings will be made available to the Contractor in AutoCAD Release 2007+ format upon request for use in developing backgrounds for specified graphic screens, such as floor plans and schematics. However the Owner does not guarantee the suitability of these drawings for the Contractor’s purpose.

7. Provide graphics for the following as a minimum

   a. Site homepage: Background shall be a site map, approximately to scale. Include links to each building.

   b. Building homepage and dashboard

      1) Background shall be a building footprint, approximately to scale, oriented as shown on the homepage.

      2) Include links to each floor and mechanical room/area, and to summary graphics described below.

      3) Include real-time building electrical and gas demand shown roughly on the map where the utilities connect to the site with link to utility cost pages.

      4) Include real-time water use and boiler plant load in kBtu/hr.

   c. Utility cost pages

      1) Demand limit. Include entries for sliding window interval and a table of On-Peak or Partial-Peak demand time periods with three adjustable demand level limits for each and adjustable deadband.

      2) Electricity rate calculation. Include a table of utility demand and consumption rates for each of the time-of-day rate periods included in the actual applicable utility rate. For each month, show actual peak kW, kWh, and cost for each time-of-day rate period. Show side-by-side as month-this-year and month-last-year, and month-to-date and year-to-date data.

      3) Natural gas rate calculation. Include a table of utility consumption rates for each of the blocks included in the actual applicable utility rate. For each month, show actual peak therm demand, therms, and cost. Show side-by-side as month-this-year and month-last-year, and month-to-date and year-to-date data.

   d. Each occupied floor plan, to scale

      1) Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints (see Paragraph 2.11D.7.h). The colors shall be updated dynamically as a zone's actual comfort condition changes. In each zone, provide links to associated terminal equipment.

      2) If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.

   e. Each equipment floor/area plan: To scale, with links to graphics of all EMCS controlled/monitored equipment.

f. Each air handler and fan-coil: Provide link to associated HW and CHW plants where applicable.

g. Each trim & respond reset: Next to the display of the setpoint that is being reset, include a link to page showing all trim & respond points (see Paragraph 3.13A.9.c) plus the current setpoint.

h. Each zone terminal: Provide link to associated air handling unit where applicable and to floor plan where terminal is located.

i. Summary graphics: Provide a single text-based page (or as few as possible) for each of the following summary screens showing key variables listed in columns for all listed equipment. Include hyperlinks to each zone imbedded in the zone tag:

1) Rooftop units: operating mode; on/off status; supply air temperature; supply air temperature setpoint; fan speed; duct static pressure; duct static pressure setpoint; outdoor air and return air damper position; coil valve positions; etc. (all key operating variables)

2) VAV Zone terminal units: operating mode; airflow rate; airflow rate setpoint; zone temperature; zone temperature setpoint; damper position; HW valve or heating damper position (reheat boxes); supply air temperature (reheat boxes); supply air temperature setpoint (reheat boxes); Static Pressure Reset current requests, cumulative request-hours, and request Importance Multiplier; Cooling SAT Reset current requests, cumulative request-hours, and request Importance Multiplier; Heating HWST Reset current requests, cumulative request-hours, and request Importance Multiplier (HW reheat).

j. For all equipment with runtime alarms specified, show on graphic adjacent to equipment the current runtime, alarm setpoint (adjustable), alarm light, and alarm reset/acknowledge button which resets the runtime counter.

k. For all equipment with lead/lag or lead/standby operation specified, adjacent to equipment the current lead/lag order and manual buttons or switches to allow manual lead

l. All other EMCS controlled/monitored equipment.

m. All equipment shall be identified on the graphic screen by the unit tag as scheduled on the drawings.

F. Alarm Configuration

1. Program alarms and alarm levels per Sequence of Operations.

2. Each programmed alarm shall appear on the alarm log screen and shall be resettable or acknowledged from those screens. Equipment failure alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, fan alarm shall be shown on graphic air handling system schematic screen). For all graphic screens, display values that are in a Level 1 or 2 condition in a red color, Level 3 and higher alarm condition in a blue color, and normal (no alarm) condition in a neutral color (black or white).

3. For initial setup, Contractor shall configure alarms as follows:

	Level 1	**Level 2**	**Level 3**	**Level 4 & 5**
Criticality	Critical	Not Critical	Not Critical	Not Critical
Acknowledgement	Required	Required	Not Required	Not Required
Acknowledgement of Return to Normal	Not Required	Not Required	Not Required	Not Required
Print to existing alarm printer	Y	Y	N	N
Email to building engineer(s)	Y	Y	Y	N
Page building engineer(s)	Y	Y	N	N
Pop-up dialog box on OWS	Y	Y	N	N
Remove from alarm log	After Acknowledged	After Acknowledged	After 2 weeks	After 2 weeks

3.13 SEQUENCES OF OPERATION

A. General

1. Contractor shall review sequences prior to programming and suggest modifications where required to achieve the design intent. Contractor may also suggest modifications to improve performance and stability or to simplify or reorganize logic in a manner that provides equal or better performance. Proposed changes in sequences shall be included as a part of Submittal Package 2.

2. Include costs for minor program modifications if required to provide proper performance of the system.

3. Unless otherwise indicated in SOOs, control loops shall be enabled and disabled based on the status of the system being controlled to prevent wind-up.

4. When SOOs use outdoor air temperature present value and there are multiple outdoor air sensors, the physically closest sensor reading shall be used.

5. The term “PID loop” or “control loop” is used generically for all control loops and shall not be interpreted as requiring proportional plus integral plus derivative gains on all loops. Unless specifically indicated otherwise, the following guidelines shall be followed:

   a. Use proportional only (P-only) loops for limiting loops (such as zone CO_2 limiting loops, etc.) to ensure there is no integral windup.

   b. Do not use the derivative term on any loops unless field tuning is not possible without it.

6. All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be capable of being adjusted by the operator without having to access programming whether indicated as adjustable in sequences or not. Software (virtual) points shall be used for these setpoints. Fixed scalar numbers shall not be imbedded in programs unless the value will never need to be adjusted.

7. Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user (e.g. for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point and the software point shall be used in all sequences. Exception: Not required for ASC hardware points.

8. VFD minimum speed setpoints

    a. Minimum speed setpoints for all VFD-driven equipment shall be determined in accordance with Paragraph 3.15D.7.

    b. Minimum speed for each piece of equipment shall be stored in a single software point that shall be used in programming (such as PID loop output range) and its value shall be assigned to the minimum speed setpoint stored in the VFD via the drive network interface. In this way there is only one minimum setpoint, rather than setpoints both in the drive and in software which could differ.

9. Trim & Respond Setpoint Reset Logic

    a. Trim & Respond setpoint reset logic and zone/system reset requests where referenced in sequences shall be implemented as described below.

    b. "Requests" are pressure, cooling, or heating setpoint reset requests generated by zones or air handling systems.

        1) For each zone or system, and for each setpoint reset request type listed for the zone/system, provide the following software points:

            a) Importance Multiplier (default = 1). This point is used to scale the number of requests the zone/system is generating. A value of zero causes the zone/system's requests to be ignored. A value greater than zero can be used to effectively increase the number of requests from the zone/system based on the critical nature of the spaces served, or to increase the requests beyond the number of ignored requests (defined below) in the Trim & Respond reset block.

            b) Request-hours

                1. This point accumulates the integral of requests (prior to adjustment of Importance Multiplier) to help identify zones/systems that are driving the reset logic. Every x minutes (adjustable, default 5 minutes), add x/60 times the current number of requests to this request-hours accumulator point.

                2. The request-hours point is reset to zero upon a global command from the system/plant serving the zone/system – this global point simultaneously resets the request-hours point for all zones/systems served by this system/plant.

                3. Cumulative %-request-hours is the zone request-hours divided by the zone run-hours (the hours in any Mode other than Unoccupied Mode) since the last reset, expressed as a percentage.

4. A Level 4 alarm is generated if the zone Importance Multiplier is greater than zero, the zone %-request-hours exceeds 70%, and the total number of zone run-hours exceeds 40.

2) See zone and air handling system control sequences for logic to generate requests.

3) Multiply the number of requests determined from zone/system logic times the Importance Multiplier and send to the system/plant that serves the zone/system. See system/plant logic to see how requests are used in Trim & Respond logic.

c. Variables. All variables below shall be adjustable from a reset graphic accessible from a hyperlink on the associated system/plant graphic. Initial values are defined in system/plant sequences below. Values for trim, respond, time step, etc. shall be tuned to provide stable control.

Variable	Definition
SP_0	Initial setpoint
SP_{min}	Minimum setpoint
SP_{max}	Maximum setpoint
T_d	Delay timer
T	Time step
I	Number of ignored requests
R	Number of requests from zones/systems
SP_{trim}	Trim amount
SP_{res}	Respond amount
$SP_{res-max}$	Maximum response per time interval

d. Trim & Respond logic shall reset setpoint within the range SP_{min} to SP_{max}. When the associated device (e.g. fan, pump) is off, the setpoint shall be SP_0. The reset logic shall be active while the associated device is proven on, starting T_d after initial device start command. When active, every time step T, trim the setpoint by SP_{trim}. If there are more than I Requests, respond by changing the setpoint by SP_{res} times (R – I), i.e. (the number of Requests minus the number of Ignored requests). But the net response shall be no more than $SP_{res-max}$. The sign of SP_{trim} must be the opposite of SP_{res} and $SP_{res-max}$. For example, if SP_{trim} = -0.1, SP_{res} = +0.15, $SP_{res-max}$ = +0.35, R = 3, I = 2, then each time step, the setpoint change = -0.1 + (3-2)*0.15 = +0.05. If R=10, then setpoint change = -0.1 + (10-2)*0.15 = 1.1 but limited to a maximum of 0.35. If R≤2, the setpoint change is -0.1.

10. Lead/lag and lead/standby alternation

a. Even Wear

1) Lead/lag. Unless otherwise noted, parallel staged devices (such as pumps, towers) shall be lead/lag alternated when more than one is off or more than one is on so that the device with the most operating hours is made the later stage device and the one with the least number of hours is made the earlier stage device. For example, assuming there are three devices, if all three are off or all are on, the staging order will simply be based on run hours from lowest to highest. If two devices are on, the one with the most hours will be set to be stage 2 while the other is set to stage 1; this may be the reverse of the operating order when the

devices were started. If two devices are off, the one with the most hours will be set to be stage 3 while the other is set to stage 2; this may be the reverse of the operating order when the devices were stopped.

2) Lead/standby. Unless otherwise noted, parallel devices (such as pumps, towers) that are 100% redundant shall be lead/standby alternated when more than one is off so that the device with the most operating hours is made the later stage device and the one with the least number of hours is made the earlier stage device. For example, assuming there are three devices, if all three are off, the staging order will be based on run hours from lowest to highest. If devices run continuously, lead/standby shall switch at an adjustable runtime; standby device shall first be started and proven on before former lead device is changed to standby and shut off.

b. Exceptions

1) Operators shall be able to manually fix staging order via software points on graphics overriding the Even Wear logic above, but not overriding the Failure or Hand Operation logic below.

2) Failure: If the lead device fails or has been manually switched off, the device shall be placed into high level alarm (Level 2) and set to the last stage position in the lead/lag order until alarm is reset by operator. Staging position of remaining devices shall follow the Even Wear logic. A failed device in alarm can only automatically move up in the staging order if another device fails. Note that a device in alarm will be commanded to run if the sequence calls for it to run. In this way the EMCS will keep trying to run device(s) until it finds enough that will operate. Failure is determined by:

a) Variable Speed Fans and Pumps

1. VFD critical fault is ON

2. Status point not matching its on/off point for 15 seconds when device is commanded on

3. Supervised HOA at control panel in OFF position

4. Loss of power (e.g. VFD DC Bus voltage = zero)

b) Constant Speed Fans and Pumps

1. Status point not matching its on/off point for 15 seconds when device is commanded on

2. Supervised HOA at control panel in OFF position

c) Boilers

1. Boiler alarm point is ON

2. If its leaving water temperature remains 15°F below setpoint for 30 minutes

3) Hand Operation. If a device is on in Hand (for example via an HOA switch or local control of VFD), the device shall be set to the lead device and a low level alarm (Level 4) shall be generated. The device will remain as lead until the alarm is reset by the operator. Hand operation is determined by

a) Variable Speed Fans and Pumps

1. Status point not matching its on/off point for 15 seconds when device is commanded off

2. VFD in local “hand” mode

3. Supervised HOA at control panel in ON position

b) Constant Speed Fans and Pumps

1. Status point not matching its on/off point for 15 seconds when device is commanded off

2. Supervised HOA at control panel in ON position

B. Demand Limiting and Rate Calculator

1. Electricity Demand Limiting

a. Sliding Window: The demand control function shall utilize a sliding window method selectable in increments of one minute, up to 60 minutes, 15 minute default.

b. Demand Levels: Demand time periods shall be set up as per utility rate schedule. For each On-Peak or Partial-Peak period, three demand level limits can be defined. When the measured demand exceeds the limit, the Demand Limit Level switch for that level shall be set; when demand is less than 10% (adjustable) below the limit, the switch shall be reset. These levels are used at the zone level (see Zone Control sequences) to shed demand.

2. Electricity Rate Calculation

a. A program shall be created that calculates electricity cost as would be billed by the utility using the applicable utility rate schedule.

b. Utility cost shall be calculated real-time and summed for each month and year. For each month, store peak kW, kWh, and cost for each time-of-day rate period. Retain data for one year so that data may be displayed side-by-side as month-this-year and month-last-year. Also store month-to-date and year-to-date data.

c. Enter latest applicable rate schedule from utility upon start-up. Rates shall be stored in software points so that they may be easily displayed and edited.

3. Natural Gas Rate Calculation

a. A program shall be created that calculates gas cost as would be billed by the utility using the applicable utility rate schedule.

b. Conversion of volumetric flow to therms shall be adjustable, default 1000 Btu/ft3 or 10-2 therms/ft3.

c. Utility cost shall be calculated real-time and summed for each month and year. For each month, store peak therms/hour, therms, and cost for each time-of-day rate period. Retain data for one year so that data may be displayed side-by-side as month-this-year and month-last-year. Also store month-to-date and year-to-date data.

d. Enter latest applicable rate schedule from utility upon start-up. Rates shall be stored in software points so that they may be easily displayed and edited.

C. Zones

1. This section applies to all single zone systems and sub-zones of air handling systems, such as VAV boxes, fan-powered boxes, etc. It also applies to monitored zone temperatures of AHUs with pneumatic or no zone controls. (This is to allow zone loops, requests, and modes, to be used for setpoint reset.)

2. Setpoints

a. Each zone shall have separate unoccupied and occupied setpoints, and separate heating and cooling setpoint. As a default:

1) VAV zones

a) The occupied heating setpoint shall be 70°F and the occupied cooling setpoint shall be 74°F in exterior zones and 73°F interior zones.

b) The unoccupied heating setpoint shall be 60°F and the unoccupied cooling setpoint shall be 90°F.

2) Electrical and mechanical rooms

a) The unoccupied and occupied heating setpoint shall be 65°F and the unoccupied and occupied cooling setpoint shall be 85°F.

3) IDF and computer rooms

a) The unoccupied and occupied heating setpoint shall be 65°F and the unoccupied and occupied cooling setpoint shall be 78°F.

b. The software shall prevent

1) The heating setpoint from exceeding the cooling setpoint minus 1°F (in other words the minimum deadband shall be 1°F);

2) The unoccupied heating setpoint from exceeding the occupied heating setpoint; and

3) The unoccupied cooling setpoint from being less than the occupied cooling setpoint.

c. Where the zone has a local occupant adjustable setpoint adjustment knob/button

1) The adjustment shall be capable of being limited in software.

a) As a default, occupied cooling setpoint shall be limited between 72°F and 80°F.

b) As a default, occupied heating setpoint shall be limited between 65°F and 72°F.

2) The adjustment shall move both the existing heating and cooling setpoints upwards or downwards by the same amount unless the limit has been reached.

3) The adjustment shall only be active in Occupied mode.

4) If a demand limit setpoint adjustment is in place, the local setpoint adjustment shall be disabled.

d. Demand Limit Setpoint Adjustment: Cooling setpoints shall be increased upon demand limit requests from the associated Zone Group.

1) At Demand Limit Level 1, increase current setpoint by 1°F.

2) At Demand Limit Level 2, increase current setpoint by 2°F.

3) At Demand Limit Level 3, increase current setpoint by 4°F.

e. Occupancy sensors. For zones that have an occupancy switch associated with the zone, when the switch indicates the space is unoccupied during the Occupied mode, the heating setpoint shall be reset to 4°F lower than the active setpoint and the cooling setpoint shall be reset to 4°F higher than the active setpoint.

f. The operative setpoint shall be determined by the Zone Group's mode

1) The setpoints shall be the occupied setpoint during Occupied mode, Warm-up mode, and Cool-down mode.

2) The setpoints shall be unoccupied setpoints during Unoccupied mode, Setback mode, and Setup mode.

g. Hierarchy of Setpoint Adjustments: The following adjustment restrictions shall prevail in order from highest to lowest priority:

1) Setpoint overlap restriction (Paragraph 3.13C.2.b.1))

2) Demand limit.

3) Occupancy sensors.

4) Local setpoint adjustment

5) Scheduled setpoints based on Zone Group mode

3. Local override: When thermostat override buttons are depressed, the request for Occupied Mode operation shall be sent up to the Zone Group control for 60 minutes. (This will cause all zones in the Zone Group to operate in Occupied Mode to ensure that the system has adequate load to operate stably.)

4. Control Loops

   a. Two separate control loops shall operate to maintain space temperature at setpoint, the Cooling Loop and the Heating Loop. Both loops shall be continuously active.

   b. The Cooling Loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a virtual point ranging from 0% (no cooling) to 100% (full cooling).

   c. The Heating Loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a virtual point ranging from 0% (no heating) to 100% (full heating).

   d. Loops shall be use proportional + integral logic or fuzzy logic. Proportional-only control is not acceptable, although the integral gain shall be small relative to the proportional gain. P and I gains shall be adjustable from the Operator Workstation.

   e. See other sections for how the outputs from these loops are used.

5. Zone Modes

   a. Heating Mode: when the output of the space heating control loop is less than zero.

   b. Cooling Mode: when the output of the space cooling control loop is greater than zero and the output of the heating loop is equal to zero.

   c. Deadband Mode: when not in either the Heating or Cooling Mode.

6. Alarms

   a. Inhibit alarms after zone setpoint is changed for a period of 10 minutes per degree of change (for example if setpoint changes from 68°F to 70°F, inhibit alarm for 20 minutes after the change) and while Zone Group is in Warm-up or Cool-down Modes.

      1) If the zone is 3°F above cooling or below heating setpoint, generate Level 3 alarm.

      2) If the zone is 5°F above cooling or below heating setpoint, generate Level 2 alarm.

   b. For zones with CO_2 sensors

1) If the CO_2 concentration is less than 300 ppm, or the zone is in unoccupied mode for more than 2 hours and zone CO_2 concentration exceeds 600 ppm, generate a Level 4 alarm, indicating sensor may be out of calibration.

2) If the CO_2 concentration exceeds setpoint plus 10% for more than 10 minutes generate a Level 3 alarm.

D. VAV Cooling-only boxes

1. See Paragraph 3.13C for setpoints, loops, control modes, alarms, etc.

   a. If supply air temperature from air handler is greater than room temperature, Cooling Mode shall be locked out.

2. Design airflow rates shall be as scheduled:

   a. Zone maximum cooling airflow setpoint (Vcool-max)

   b. Zone minimum airflow setpoint (Vmin)

3. The occupied cooling minimum Vmin* shall be equal to Vmin except as follows:

   a. If the zone has an occupancy sensor, Vmin* shall be equal to Varea-min when the room is unoccupied.

   b. If Vmin is non-zero and less than the lowest possible airflow setpoint allowed by the controls (Vm), Vmin* shall be set equal to Vm. The minimum setpoint Vm shall be determined as follows:

      1) Determine the velocity pressure sensor reading VP_m in inches H_2O that results in a digital reading from the transducer and A/D converter of 12 bits or counts (assuming a 10 bit A/D converter). This is considered sufficient resolution for stable control. See Paragraph 2.9G.5.c.

      2) Using the velocity pressure sensor amplification factor F provided by the sensor manufacturer for each VAV box sensor size, calculated the minimum velocity v_m for each VAV box size as

$$v_m = 4005\sqrt{\frac{VP_m}{F}}$$

Where F is not known it can be calculated from the measured CFM at 1 inch signal from the VP sensor

$$F = \left(\frac{4005A}{CFM_{@1"}}\right)^2$$

where A is the nominal duct area (ft^2), equal to

$$A = \pi\left(\frac{D}{24}\right)^2$$

where D is the nominal duct diameter (inches).

3) Calculate the minimum airflow setpoint allowed by the controls (*Vm*) for each VAV box size as

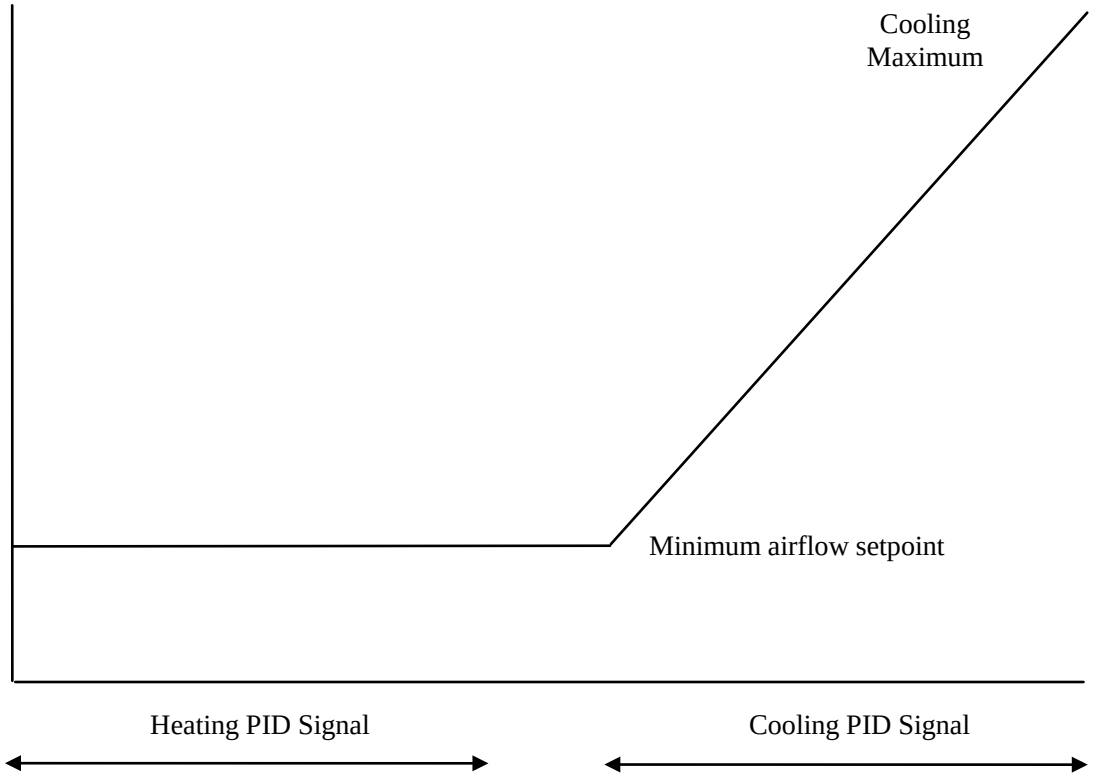
$$Vm = v_m A$$

c. If the zone has a CO_2 sensor, during Occupied Mode, a P-only loop shall maintain CO_2 concentration at 1000 ppm; reset 0% at 800 ppm and 100% at 1,000 ppm of CO2. The loop output from 0 to 100% shall reset the minimum airflow setpoint to the zone from Vmin up to maximum cooling airflow setpoint Vcool-max. Loop is disabled and output set to zero when the zone is not in Occupied Mode.

4. Active maximum and minimum setpoints shall vary depending on the mode of the Zone Group the zone is a part of:

Setpoint	Occupied	Cool-down	Setup	Warm-up	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Minimum	Vmin*	0	0	0	0	0
Heating maximum	Vmin*	0	0	0	0	0

5. Control logic is depicted schematically in the figure below and described in the following sections.



a. When the zone is in the Cooling Mode, the Cooling Loop output shall be mapped to the airflow setpoint from the cooling maximum to the minimum airflow setpoints.

b. When the zone is in the Deadband Mode or Heating Mode, the airflow setpoint shall be the minimum airflow setpoint.

c. The VAV damper shall be modulated to maintain the measured airflow at setpoint.

6. Alarms

a. Low airflow

1) If the measured airflow is less than 70% of setpoint for 5 minutes, generate a Level 3 alarm.

2) If the measured airflow is less than 50% of setpoint for 5 minutes, generate a Level 2 alarm.

b. Airflow sensor calibration. If the fan serving the zone has been shut off for 10 minutes and airflow sensor reading is above 20 cfm, generate a Level 3 alarm.

7. Testing/Commissioning Overrides: Provide software points that interlock to a system level point to

a. Force zone airflow setpoint to zero

b. Force zone airflow setpoint to Vcool-max.

c. Force zone airflow setpoint to Vmin

d. Force damper full closed/open

e. Reset request-hours accumulator point to zero (provide one point for each reset type listed below)

8. System Requests

a. Cooling SAT Reset Requests

1) If the Cooling Loop is less than 85%, send 0 requests.

2) If the Cooling Loop is greater than 95%, send 1 request.

3) If the zone temperature exceeds the zone temperature cooling setpoint sufficient to generate a Level 3 alarm (see zone sequence above), send 2 requests.

4) If the zone temperature exceeds the zone temperature cooling setpoint sufficient to generate a Level 2 alarm (see zone sequence above), send 3 requests.

b. Static Pressure Reset Requests

1) If the Damper Loop is less than 85%, send 0 requests.

2) If the Damper Loop is greater than 95%, send 1 request.

3) If the zone airflow is below the airflow setpoint sufficient to generate a Level 3 alarm (see alarms above), send 2 requests.

4) If the zone airflow is below the airflow setpoint sufficient to generate a Level 2 alarm (see alarms above), send 3 requests.

E. VAV Reheat boxes

1. See Paragraph 3.13C for setpoints, loops, control modes, alarms, etc.

a. If supply air temperature from air handler is greater than room temperature, Cooling Mode shall be locked out.

2. Design airflow rates shall be as scheduled on schedules (schedules will be provided by addendum):

a. Zone maximum cooling airflow setpoint (Vcool-max)

b. Zone minimum airflow setpoint (Vmin)

c. Zone maximum heating airflow setpoint (Vheat-max)

3. The occupied cooling minimum Vmin* shall be equal to Vmin except as follows:

a. If the zone has an occupancy sensor, Vmin* shall be zero when the room is unoccupied.

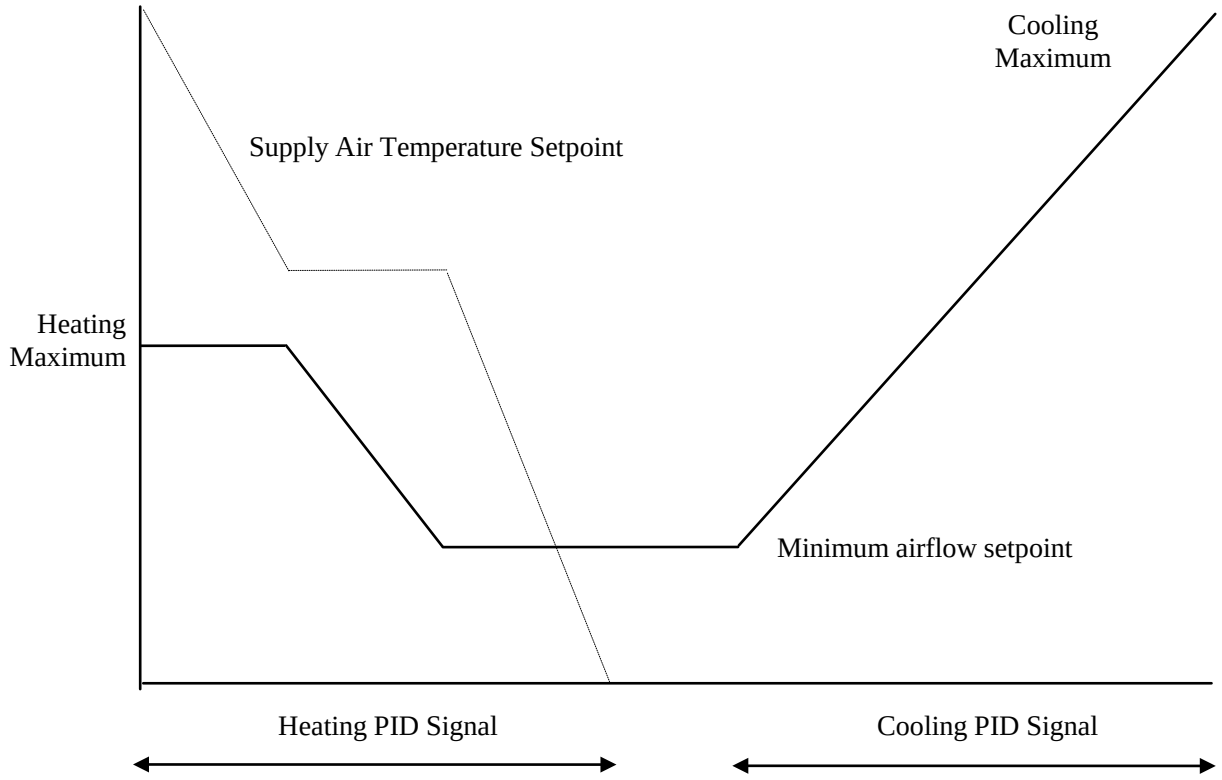
b. If Vmin is non-zero and less than the lowest possible airflow setpoint allowed by the controls (Vm), Vmin* shall be set equal to Vm. The minimum setpoint Vm shall be determined in accordance with 3.13D.3.b.

c. If the zone has a CO_2 sensor, during Occupied Mode, a P-only loop shall maintain CO_2 concentration at 1000 ppm; reset 0% at 800 ppm and 100% at 1,000 ppm of CO2. The loop output from 0 to 100% shall reset the minimum airflow setpoint to the zone from Vmin up to maximum cooling airflow setpoint Vcool-max. Loop is disabled and output set to zero when the zone is not in Occupied Mode.

4. Active maximum and minimum setpoints shall vary depending on the mode of the Zone Group the zone is a part of:

Setpoint	Occupied	Cool-down	Setup	Warm-up	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Minimum	Vmin*	0	0	0	0	0
Heating maximum	Max(Vheat-max, Vmin*)	Vheat-max	0	Vcool-max	Vcool-max	0

5. Control logic is depicted schematically in the figure below and described in the following sections.



a. When the zone is in the Cooling Mode, the Cooling Loop output shall be mapped to the airflow setpoint from the cooling maximum to the minimum airflow setpoints. Hot water valve is closed.

b. When the zone is in the Deadband Mode, the airflow setpoint shall be the minimum airflow setpoint. Hot water valve is closed.

c. When the zone is in the Heating Mode, the Heating Loop shall maintain space temperature at the heating setpoint as follows:

1) From 0-33%, the Heating Loop output shall reset the discharge temperature from 55°F to 95°F.

2) From 33%-66%, if the lead hot water pump is enabled the Heating Loop output shall reset the zone airflow setpoint from the minimum airflow setpoint to the maximum heating airflow setpoint.

3) From 66-100%, the Heating Loop output shall reset the discharge temperature from 95°F to 115°F.

4) The hot water valve shall be modulated using P+I loop to maintain the discharge temperature at setpoint. (Directly controlling HW valve off zone temperature PID loop is not acceptable.)

d. The VAV damper shall be modulated to maintain the measured airflow at setpoint.

6. Alarms

a. Low airflow

1) If the measured airflow is less than 70% of setpoint for 5 minutes, generate a Level 3 alarm.

2) If the measured airflow is less than 50% of setpoint for 5 minutes, generate a Level 2 alarm.

b. Low supply air temperature

1) If boiler plant is proven on and the supply air temperature is 15°F less than setpoint for 10 minutes, generate a Level 3 alarm.

2) If boiler plant is proven on and the supply air temperature is 30°F less than setpoint for 10 minutes, generate a Level 2 alarm.

c. Airflow sensor calibration. If the fan serving the zone has been shut off for 10 minutes and airflow sensor reading is above 20 cfm, generate a Level 3 alarm.

7. Testing/Commissioning Overrides: Provide software points that interlock to a system level point to

a. Force zone airflow setpoint to zero

b. Force zone airflow setpoint to Vcool-max

c. Force zone airflow setpoint to Vmin

d. Force damper full closed/open

e. Force heating to off/closed

f. Reset request-hours accumulator point to zero (provide one point for each reset type listed below)

8. System Requests

a. Cooling SAT Reset Requests

1) If the Cooling Loop is less than 85%, send 0 requests.

2) If the Cooling Loop is greater than 95%, send 1 request.

3) If the zone temperature exceeds the zone temperature cooling setpoint sufficient to generate a Level 3 alarm (see zone sequence above), send 2 requests.

4) If the zone temperature exceeds the zone temperature cooling setpoint sufficient to generate a Level 2 alarm (see zone sequence above), send 3 requests.

b. Static Pressure Reset Requests

1) If the Damper Loop is less than 85%, send 0 requests.

2) If the Damper Loop is greater than 95%, send 1 request.

3) If the zone airflow is below the airflow setpoint sufficient to generate a Level 3 alarm (see alarms above), send 2 requests.

4) If the zone airflow is below the airflow setpoint sufficient to generate a Level 2 alarm (see alarms above), send 3 requests.

c. Heating HWST Reset Requests

1) If the Heating Output is less than 85%, send 0 requests.

2) If the Heating Output is greater than 95%, send 1 request.

3) If the supply air temperature is below setpoint sufficient to generate a Level 3 alarm (see alarms above), send 2 requests.

4) If the supply air temperature is below setpoint sufficient to generate a Level 2 alarm (see alarms above), send 3 requests.

d. Boiler Plant Requests. Send the boiler plant that serves the zone a Boiler Plant Request as follows:

1) If the Heating Output is less than 10%, send 0 requests.

2) If the Heating Output is greater than 95%, send 1 request.

F. Zone Groups (aka Isolation Areas)

1. Each system shall be broken into separate Zone Groups composed of a collection of one or more zones served by the air handling system.

2. Each Zone Group shall have separate occupancy schedules and operating modes from other Zone Groups served by the air handling system. All zones in the Zone Group shall be in the same operating mode.

3. Individual Zone Groups shall be created for zones served by each air-handling unit separately. For air handling units serving multiple floors, each floor shall be a separate Zone Group. Program occupied schedules to match current schedules.

4. Provide commissioning software switches to override all zones served by the Zone Group. Provide a single software switch for each of the zone override switches listed under terminal box control above. When the Zone Group override switch value is changed, the terminal box zone override switch value for each zone in the Zone Group shall change to the same value. This only occurs when the switch changes value; the switch at each zone shall be capable of being changed to a different value from the Zone Group switch. These software switches are for commissioning and need not be shown on graphics.

5. Individual Zone Groups shall be as defined below. The default schedule is also listed; confirm schedules with Owner prior to programming.

   a. Occupied: 8:00 am to 5 pm Monday to Friday

6. Zone Group Operating Modes: Each Zone Group shall have the following modes:

   a. Normal (Occupied) Mode: An Zone Group is in the occupied mode when any of the following is true:

      1) The time of day is between the Zone Group's scheduled occupied start and stop times.

      2) Any zone local override timer (initiated by local override button) is nonzero.

   b. Warm-up Mode: Warm-up start time shall be determined based on the zone in the Zone Group whose space temperature is furthest below its occupied heating temperature setpoint, the outside air temperature (using global outdoor air temperature sensor, not any associated with AHUs), and a building mass/capacity factor. This factor shall be manually adjusted or self-tuned by the program based on internal trending so that all zones in the Zone Group are brought up to their occupied setpoint by the scheduled occupied start hour. The tuning period mode shall be turned on or off by a software switch (to allow tuning to be stopped after the system has been trained). Warm-up mode shall start no earlier than 3 hours before the scheduled occupied start hour and shall end at the scheduled occupied start hour.

   c. Cool-Down Mode: Cool-down shall be determined based on the zone in the Zone Group whose space temperature is furthest above its occupied cooling temperature

setpoint, the outside air temperature (using global outdoor air temperature sensor, not any associated with AHUs), and a building mass/capacity factor. This factor shall be manually adjusted or self-tuned by the program based on internal trending so that all zones in the Zone Group are brought down to their occupied setpoint by the scheduled occupied start hour. The tuning period mode shall be turned on or off by a software switch (to allow tuning to be stopped after the system has been trained). Cool-down mode shall start no earlier than 3 hours before the scheduled occupied start hour and shall end at the scheduled occupied start hour.

d. Setback Mode: During other than normal mode and warm-up mode, if any 5 (adjustable; set to all zones if there are 5 or fewer in Zone Group) zone(s) in the Zone Group falls 2°F below its active unoccupied setback setpoint, until all spaces in the Zone Group are above their active setback setpoints.

e. Setup Mode: During other than normal mode, warm-up mode, and setback mode, if any 5 (adjustable; set to all zones if there are 5 or fewer in Zone Group) zone(s) in the isolation rises 2°F above its active unoccupied setup setpoint until all spaces in the Zone Group are below their active setup setpoints.

f. Unoccupied Mode: When the Zone Group is not in any other mode.

G. Air Handling Unit System Modes:

1. AHU system modes are the same as the mode of the Zone Groups served by the system. When Zone Groups served by an air handling system are in different modes, the following hierarchy applies (highest one sets AHU mode)

a. Occupied mode

b. Cool-down mode

c. Setup mode

d. Warm-up mode

e. Setback mode

f. Unoccupied mode

H. VAV Air Handlers

1. Supply Fan Control

a. Supply Fan Start/Stop

1) AH unit fan shall run when system is in any mode other than Unoccupied Mode.

a) Units with supply air and return air smoke dampers, first command dampers open, wait for end switches to indicate dampers are full open, then start fan.

2) Where shown on schematics, fan VFDs shall be hard-wire interlocked through high discharge static pressure safety mounted in the control panel in each fan room area.

3) Totalize current airflow rate from VAV boxes and display on AHU graphic at discharge duct.

b. Static Pressure Setpoint Reset

1) Static pressure setpoint: Setpoint shall be reset using Trim & Respond logic (see Paragraph 3.13A.9) with the following parameters:

Variable	Value
SP_0	0.5 inches
SP_{min}	0.1 inches
SP_{max}	Existing setpoint
T_d	10 minutes
T	2 minutes
I	2
R	Zone Cooling Static Pressure Reset Requests
SP_{trim}	-0.05 inches
SP_{res}	+0.06inches
$SP_{res-max}$	+0.13 inches

c. Static Pressure Control

1) Fan speed shall be controlled to rise very slowly to prevent high pressure trips in case all VAV boxes are closed (they should close during unoccupied periods) or in case fire/smoke dampers are closed (in some FSD designs, the dampers are interlocked to the fan status rather than being controlled by smoke detectors). This can be done by configuring the VFD ramp rate or controlling ramp rate in EMCS software.

2) Supply fan speed is controlled to maintain duct static pressure at setpoint when the fan is proven on. See Paragraph 3.13A.8 for minimum speed setpoint. Where the Zone Groups served by the system are small, provide multiple sets of PID gains that are used in the PID loop as a function of a load indicator (such as supply fan airflow rate, the area of the Zone Groups that are occupied, etc.).

2. Supply Air Temperature Control

a. Control loop is enabled when the supply air fan is proven on, and disabled and output set to zero otherwise.

b. Supply Air Temperature Setpoint

1) During occupied mode: Setpoint shall be reset from T-min (53°F) when the outdoor air temperature is 70°F and above, proportionally up to T-max when the

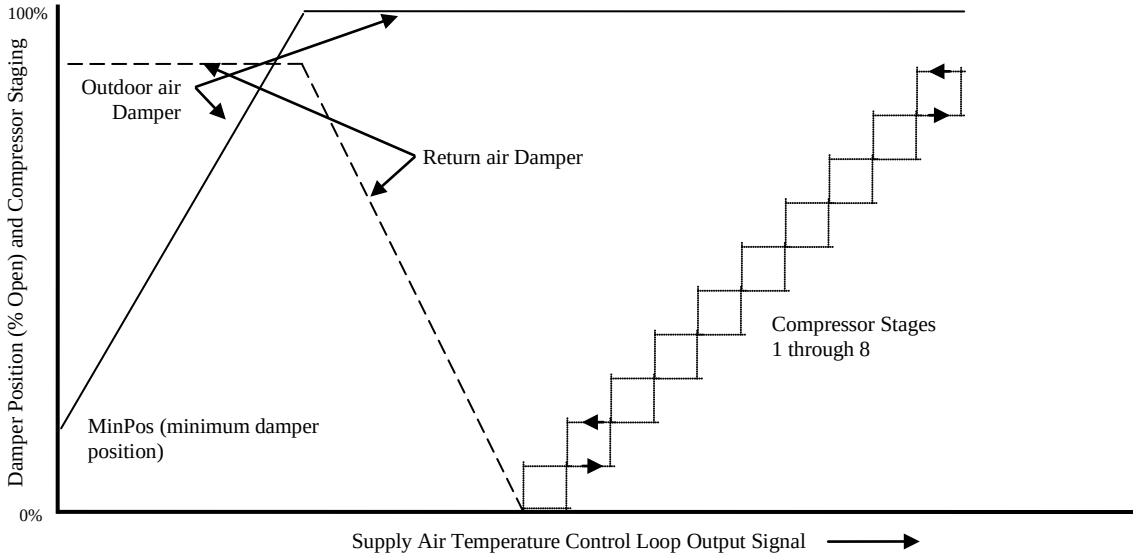
outdoor air temperature is 60°F and below. T-max shall be reset using Trim & Respond logic (see Paragraph 3.13A.9) with the following parameters:

Variable	Value
SP_0	SP_{max}
SP_{min}	55ºF
SP_{max}	65ºF
T_d	10 minutes
T	2 minutes
I	2
R	Zone Cooling SAT Requests
SP_{trim}	+0.2ºF
SP_{res}	-0.3ºF
$SP_{res-max}$	-1.0ºF

2) During Setup or Cool-Down Modes: Setpoint shall be T-min.

3) During Warm-Up and Setback Modes: Setpoint shall be 95°F.

c. Supply air temperature shall be controlled to setpoint using a PID loop whose output is mapped to sequence outdoor damper, return air damper, and compressor stages as shown in the diagram below. Outdoor air and return air dampers are sequenced rather than complementary (as per most standard sequences) to reduce fan power at part loads. Exact x-axis points in the figure shall be determined by Contractor to provide stable control. Outdoor air and return air damper minimum and maximum positions are limited for economizer lockout and to maintain minimum outdoor airflow rate as indicated below. Minimum stage on-time shall be 1 minute and minimum off-time shall be 4 minutes.



3. Evaporative cooled condenser

a. Evaporative condenser shall be enabled when any compressor is proven on. Fan and pump shall be off when all compressors are off.

b. The refrigerant head pressure shall be enabled as a control point when its associated compressor is commanded; it shall be ignored in control sequences if the compressor is commanded off.

c. Pump shall start when any refrigerant discharge pressure is above 200 psi (adjustable) and all operating compressors are above 190 psi, and shall stop when any are below 180 psi (adjustable).

d. The condenser fans shall be lead/lag alternated per Paragraph 3.13A.10. The lead fan shall start when any refrigerant discharge pressure is above 205 psi (adjustable). The lag fan shall start when any refrigerant pressure is above 210 psi (adjustable). The fans shall stop for at least 1 minute when they have been running for at least 1 minute and any operating compressor's refrigerant pressure falls below 190 psi (adjustable).

4. Minimum Outdoor Air Control

a. Outdoor air minimum setpoints for systems with multiple Zone Groups

1) DesMinOA design minimum outdoor air cfm for each Zone Group is as follows:

Floor	RTU-1	RTU-2
B	0	310
1	955	2155
2	845	1535
3	1740	1220
4	2190	1390
5	1750	885
TDesMinOA	7,480	7,495

b. Two minimum outdoor air damper positions (MinPosDes and MinPos30) required to deliver TDesMinOA at two operating percent speeds (design speed, Des%, and 30% of design speed) shall be determined in accordance with Paragraph 3.14A.3.b.

c. Minimum damper position MinPos in Paragraph 3.13H.2.c. shall be determined from the following equation:

$$MinPos = \left[\frac{DesMinOA^*}{TDesMinOA}\right]\left[\frac{(MinPosDes - MinPos30)(\%Spd - 30)}{(Des\% - 30)} - MinPos30\right]$$

Where

DesMinOA* = the sum of the design minimum outdoor air DesMinOA for all Zone Groups in Occupied Mode only. (Outdoor air is zero for Zone Groups in any mode other than Occupied Mode.)

TDesMinOA = total DesMinOA for all Zone Groups served by the system as indicated in the table above

%Spd = the current supply fan speed

5. Economizer Lockout: The normal sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air temperature is greater than return air temperature or greater than 75°F, and enabled otherwise. Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa. When economizer is first disabled, the return air damper shall be fully opened, wait 15 seconds, then the economizer outdoor air damper shall be shut. After 3 minute time delay, return air damper shall be released for minimum outdoor air control (described above).

6. Return Fans

    a. Return fan operates whenever associated supply fan is proven on.

    b. Return/exhaust fan speed shall be set to 90% (adjustable) of the associated supply fan speed.

7. Alarms

    a. Maintenance interval alarm when fan has operated for more than 1500 hours: Level 5. Reset interval counter when alarm is acknowledged.

    b. Fan alarm is indicated by the status input being different from the output command after a period of 15 seconds after a change in output status.

        1) Commanded on, status off: Level 2

        2) Commanded off, status on: Level 4

    c. High supply air temperature (more than 5°F above setpoint) off cooling coils when coil control loop is active for longer than 15 minutes: Level 3.

    d. If the outside air temperature is above the supply air temperature setpoint and the economizer is enabled and the mixed air temperature is more than 2°F different from the outside air temperature for more than 30 minutes continuously; OR if the outdoor air temperature is more than 5°F below the supply air temperature setpoint and the compressors are on: Level 4 indicating economizer damper control problems.

    e. Low static pressure (more than 0.25 inches below setpoint) when fan control loop is active for longer than 5 minutes: Level 3.

I. Auxiliary AC Units

1. Supply fan control

    a. For occupied spaces (e.g. office): The unit fan shall run when the system is in any mode other than Unoccupied Mode.

    b. For unoccupied spaces (e.g. server rooms): The unit fan shall run when the zone is in Heating Mode or Cooling Mode.

2. Cooling control

    a. Cooling is enabled when the zone is in Cooling Mode.

    b. The zone Cooling Loop output shall be mapped to stage the compressor on at 100% and off at 0%.

3. Alarms

    a. Maintenance interval alarm when fan has operated for more than 1500 hours: Level 5. Reset interval counter when alarm is acknowledged.

b. Fan alarm is indicated by the status input being different from the output command after a period of 15 seconds after a change in output status.

1) Commanded on, status off: Level 2.

2) Commanded off, status on: Level 4.

c. Generate a Level 3 alarm if:

1) Heating outputs are on and supply air fan is proven on and supply air temperature is below 80°F for more than 3 minutes indicating heating system failure.

2) Cooling outputs are on and supply air fan is proven on and supply air temperature is above 65°F for more than 3 minutes indicating cooling system failure.

J. Condenser Water Plant

1. Pumps

a. Condenser water pumps shall be lead/standby alternated per Paragraph 3.13A.10.

b. Lead pump shall both run on a time schedule. The initial schedule shall be 24/7.

2. CW temperature control

a. The CWST setpoint shall be 75°F.

b. Tower spray pump shall run when CWST is above setpoint less 5ºF and shall stop when CWST falls below setpoint less 8ºF.

c. Tower fans shall be enabled when CWST is at or above setpoint.

1) Two speed fans

a) PID loop shall maintain CWST at setpoint. PID loop output shall be mapped to fans as follows:

1. Low on at 50%, off at 25%

2. High on at 100%, off at 75%.

3. Alarms

a. Generate a Level 5 maintenance alarm when tower fan or pump has operated for more than 3000 hours. Reset interval counter when alarm is acknowledged.

b. Fan or pump alarm is indicated by the status input being different from the output command after a period of 15 seconds after a change in output status.

1) Commanded on, status off: Level 2

2) Commanded off, status on: Level 4

c. High supply water temperature (more than scheduled design tower leaving water temperature +2ºF for longer than 20 minutes) when any CWP is on: Level 1.

d. Low supply water temperature (more than 5°F below setpoint for longer than 10 minutes) when any CWP is on: Level 2.

K. Boiler Plant

1. Boilers and associated primary pumps shall be lead/lag alternated per Paragraph 3.13A.10.

2. Lead boiler and associated pump

a. The lead system shall be enabled if:

1) The outdoor air temperature is less than a lockout temperature of 75°F, and

2) There are more than 1 (adjustable) Boiler Plant Requests from zones or air handlers.

b. The lead system shall be disabled if it has run at least 10 minutes and either:

1) The outdoor air temperature is greater than 3°F above the lockout setpoint; or

2) There are no Boiler Plant Requests from zones or air handlers for more than 10 minutes (adjustable)

3. Lag boiler and associated pump

a. The lag system shall be enabled if:

1) The lead boiler is enabled and either

a) The lead boiler's HWST remains 10°F below setpoint (as set on boiler controller) for 15 minutes or

b) Any Air Handler served is in Warm-up Mode

b. The lag system shall be disabled if:

1) The lead system is disabled or

2) The lag system has run at least 10 minutes and the 10 minute rolling average HW load in Btuh (500 * HW GPM * HW ΔT) is less than 90% of the nominal capacity of the lead boiler in Btuh and no air handlers are in Warm-up Mode.

4. When the lead system is enabled, first start the lead pump, then after 30 seconds enable the boiler. When the lead system is disabled, first disable the boiler, then after 3 minutes turn off the lead pump. Use similar logic for the lag system.

5. Hot water supply temperature setpoint shall be 170°F (set on the boiler controllers).

6. Alarms

    a. Maintenance interval alarm when pump has operated for more than 1500 hours: Level 5. Reset interval counter when alarm is acknowledged.

    b. Maintenance interval alarm when boiler has operated for more than 2000 hours: Level 5. Reset interval counter when alarm is acknowledged.

    c. Boiler alarm: Level 2

    d. Low boiler leaving hot water temperature (more than 15°F below setpoint) for more than 15 minutes when boiler has been enabled for longer than 15 minutes: Level 3

    e. Pump alarm is indicated by the status input being different from the output command after a period of 15 seconds after a change in output status.

        1) Commanded on, status off: Level 2

        2) Commanded off, status on: Level 4

L. Domestic Water Heating Plant

1. Temperature is controlled locally at unit.

2. Alarms

    a. Hot water supply temperature to building less than 110°F: Level 2.

M. Toilet Exhaust Fan

1. Exhaust fan shall operate when any of the associated system supply fan is proven on and the system is in the Occupied Mode.

2. Alarms

    a. Generate a Level 5 maintenance alarm when fan has operated for more than 3000 hours. Reset interval counter when alarm is acknowledged.

    b. Fan alarm is indicated by the status input being different from the output command after a period of 15 seconds after a change in output status.

        1) Commanded on, status off: Level 2

        2) Commanded off, status on: Level 4

N. Miscellaneous Alarms

1. Points in Hand (Operator Override) via Workstation command (including name of operator who made the command) or via supervised HOA switch at output: Level 4

2. Equipment alarm (for equipment with alarm contacts such as VFDs, AC units): Level 2

3. Panel or LAN failure: Level 2

4. Loss of communication with any device via Gateway (e.g. VFD) for more than 30 seconds: Level 2 (alarm shall indicate which specific device is not responding).

3.14 TESTING, ADJUSTING, AND BALANCING (TAB)

A. TAB Work

1. Contractor shall be member of Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing, Adjusting and Balancing Bureau (TABB)

2. Test equipment shall be calibrated within 6 months of use, or according to the manufacturer's recommended interval, whichever is shorter, and when dropped or damaged. Calibration tags shall be affixed or certificates readily available and proof of calibration shall be included reports.

3. Minimum Outdoor Air

   a. For constant volume units, minimum damper position setpoint shall be the current minimum position. No work required.

   b. For VAV AHUs

      1) Determine minimum outdoor air damper signals required to deliver design minimum outdoor airflow rate by adjusting the minimum damper signal through the EMCS at the following conditions:

         a) Design supply fan airflow and speed

         b) 30 percent of design supply fan speed

      2) Convey the two minimum signals and associated fan speeds to the EMCS installer (see Paragraph 3.13H.4) and note on air balance report.

      3) Report: airflow readings and associated DP readings

4. VAV Zones

   a. Install default calibration coefficients for VAV box controllers based on VAV box inlet size.

   b. Set VAV box setpoints per Paragraphs 2.12D.7 and 2.12D.8.

5. Provide one copy of TAB report to Owner in pdf format.

3.15 SYSTEM COMMISSIONING

A. Taylor Engineering shall serve as Commissioning Authority.

B. Sequencing. The following list outlines the general sequence of events for submittals and commissioning:

1. Submit Submittal Package 1 (Hardware and Shop Drawings) and receive approval.
2. Initiate installation of EMCS hardware, devices and wiring.
3. Develop point database and application software.
4. Simulate sequencing and debug programming off-line to the extent practical.
5. Submit Submittal Package 2 (Programming and Graphics) and receive approval.
6. Complete installation of EMCS hardware, devices and wiring.
7. Install point database and application software in field panels.
8. Submit Submittal Package 3 (Functional Testing) and receive approval.
9. Perform EMCS Pre-functional Tests (start up, calibration and tuning) and submit completed Pre-functional Test Forms for approval.
10. Field test application programs prior to functional testing.
11. Receive EMCS Pre-functional Test Report approval and approval to schedule Functional Tests.
12. Prepare and initiate commissioning Trend Logs.
13. Perform and record functional tests and submit Functional Test Report for approval.
14. Submit Package 4 (Training Materials) and receive approval.
15. Receive EMCS Functional Test Report approval and approval to schedule Demonstration Tests.
16. Perform Demonstration Tests to Commissioning Authority and Owner’s Representatives and submit Demonstration Test Report.
17. Receive acceptance of Demonstration Tests.
18. Train Owner personnel on EMCS operation and maintenance.
19. Substantial Completion
20. Submit Package 5 (Post-Construction Trend Logs) in format specified for review and approval.
21. Receive approval of successful Trend Log tests, or retest as required.
22. Complete all items in Completion Requirements per Paragraph 1.11.
23. Provide administration level password access to the Owner.
24. Final Acceptance

25. Begin Warranty Period.

26. Update all software as specified.

27. End of Warranty Period

C. Test Documentation

1. Pre-functional Tests

a. Prepare forms to document the proper startup of the EMCS components.

b. All equipment shall be included on test forms including but not limited to

1) Wiring: End-to-end checkout of all wiring at terminations. Power to all controllers and actuators. Confirmation of emergency power where specified.

2) Digital Outputs: Proper installation, normal position, response to command at CU

3) Digital Inputs: Proper installation, device test, response at CU

4) Analog Outputs: Proper installation of devices, verification of maximum and minimum stroke.

5) Analog Inputs: Proper installation of sensors, calibration

6) Panels: Confirmation of location, power source (electrical circuit used), confirmation of emergency power where specified.

7) Alarms and Safeties: Verification of alarm routing to all specified devices and correct hierarchy. Example: confirm alarm routing to cell phones, email, servers, remote workstations. Confirm that appropriate alarm levels are routed to appropriate devices.

8) Loop Tuning: Document setting of P/I parameters for all loops, chosen setpoints, time delays, loop execution speed.

9) Network Traffic: Document speed of screen generation, alarm and signal propagation in system with all required commissioning trends active.

c. Each form shall have a header or footer where the technician performing the test can indicate his/her name and the date of the test.

d. Submit forms for approval in Submittal Package 3.

e. Complete work, document results on forms, and submit for approval as Pre-Functional Test Report.

2. Functional Tests

a. Commissioning Authority will prepare functional testing forms after Submittal Package 2 has been reviewed and approved. Tests will be designed to test all sequences in a formal manner with simulations and expected outcomes.

b. Review tests and recommend changes that will improve ease of testing or avoid possible system damage, etc.

c. Adapt forms from Owner's Representative into electronic format. Each form shall have a header or footer where the technician performing the test can indicate his/her name and the date of the test.

d. Submit forms for approval in Submittal Package 3.

e. Complete work, document results on forms, and submit for approval as Functional Test Report.

D. Pre-functional tests

1. General

a. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.

b. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.

c. Verify integrity/safety of all electrical connections.

d. Verify that shielded cables are grounded only at one end.

e. Verify that all sensor locations are as indicated on drawings and are away from causes of erratic operation.

2. Digital Outputs

a. Verify that all digital output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

3. Digital Inputs

a. Adjust setpoints, where applicable.

1) For current switches used as status on fans, adjust current setpoint so that fan status is OFF when fan discharge damper (if present) is fully closed and when belt is broken (temporarily remove belt).

2) For current switches used as status on pumps, adjust current setpoint so that pump status is OFF when pump is dead-headed (temporarily close discharge valve).

3) For differential pressure sensors on pumps and fans, set so that status is on when pump operating with all valves open (out on its curve).

4. Analog Outputs

a. Verify start and span are correct and control action is correct.

b. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.

c. Check all normal positions of actuators with spring return.

d. For outputs to reset other manufacturer's devices (for example, chiller setpoint) and for feedback from them, calibrate ranges to establish proper parameters.

5. Analog Input Calibration

a. Sensors shall be calibrated as specified on the points list. Calibration methods shall be one of the following:

1) Factory: Calibration by factory, to standard factory specifications. Field calibration is not required.

2) Handheld: Field calibrate using a handheld device with accuracy meeting the requirements of Paragraph 2.10.

b. The calibrating parameters in software (such as slope and intercept) shall be adjusted as required. A calibration log shall be kept and initialed by the technician indicating date and time, sensor and hand-held readings, and calibration constant adjustments and included in the Pre-functional Test Report.

c. Inaccurate sensors must be replaced if calibration is not possible.

6. Alarms and Interlocks

a. A log shall be kept and initialed by the technician indicating date and time, alarm/interlock description, action taken to initiate the alarm/interlock, and resulting action, and included in the Pre-functional Test Report.

b. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

c. Coordinate with Division 26 to test fire and life safety systems alarm contacts.

d. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

e. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

7. Variable Frequency Drive Minimum Speed

a. Minimum speed for VFD-driven fans and pumps shall be determined in accordance with this Paragraph. Tests shall be done for piece of equipment, except that for multiple pieces of identical equipment used for identical applications, only one piece of equipment need be tested with results applied to all. Note that for fans and pumps, there is no minimum speed required for motor cooling. Power drops with cube of speed, causing motor losses to be minimal at low speeds.

b. This work shall be done only after fan/pump system is fully installed and operational.

c. Determine minimum speed setpoint as follows:

1) Start the fan or pump.

2) Manually set speed to 6 Hz (10%) unless otherwise indicated in control sequences. For cooling towers with gear boxes, use 20% or whatever minimum speed is recommended by tower manufacturer.

3) Observe fan/pump in field to ensure it is visibly rotating.

a) If not, gradually increase speed until it is.

4) The speed at this point shall be the minimum speed setpoint for this piece of equipment.

5) Record minimum speeds in log and store in software point as indicated in Paragraph 3.13A.8.

8. Tuning

a. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-functional Test Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted)

Controlled Variable	Control Accuracy
Duct Pressure	±0.1 inches w.g.
Building and relief plenum	±0.01 inches w.g.
Airflow and water flow	±10%
Space Temperature	±1.5ºF
Chilled Water Temperature	±1ºF
Hot Water Temperature	±3ºF
Duct Temperature	±2ºF
Water Differential Pressure	±1.5 psi
Others	±2 times reported accuracy

9. Interface and Control Panels

a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the Record Drawings.

b. Ensure that terminations are safe, secure and labeled in accordance with the Record Drawings.

c. Check power supplies for proper voltage ranges and loading.

d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.

e. Check for adequate signal strength on communication networks.

f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.

g. Ensure that buffered or volatile information is held through power outage.

h. With all system and communications operating normally, sample and record update and annunciation times for critical alarms fed from the panel to the Operator Interface.

i. Check for adequate grounding of all EMCS panels and devices.

10. Operator Interfaces

a. Verify that all elements on the graphics are functional and are properly bound to physical devices or virtual points, and that hot links or page jumps are functional and logical.

b. Verify that the alarm logging, paging, emailing etc. are functional and per requirements.

E. Functional Tests

1. Test schedule shall be coordinated with the Commissioning Authority, Commissioning Coordinator, and Owner's Representative.

2. Functional tests may be witnessed by Owner's Representative at the Owner's option.

3. All approved Functional Tests shall be conducted by the Contractor with results confirmed and signed by the Contractor's start-up technician.

a. Seasonal Impacts: It shall be assumed that not all tests will be possible due to weather conditions. Those that are not possible shall be deferred until the next season, performed during the warranty period.

4. Test documentation shall be submitted to the Owner for review and approval.

F. Demonstration Test

1. Demonstration tests consist of a small representative sample of functional tests and systems randomly selected by the Commissioning Authority. Tests will be designed to occur over no longer than 3 working days.

2. Schedule the demonstration with the Commissioning Authority and Owner's Representative at least 1 week in advance. Demonstration shall not be scheduled until the Functional Test Report has been approved.

3. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel shall be those who conducted the Functional tests or who are otherwise competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems.

4. The system will be demonstrated following procedures that are the same or similar to those used in the Pre-Functional and Functional Tests. The Commissioning Authority will supply the test forms at the site at the start of the tests.

5. Demonstration tests may be witnessed by Owner's Representative at the Owner's option.

6. Contractor shall conduct tests as directed by and in the presence of the Commissioning Authority and complete test forms. Completed forms shall be submitted as the Demonstration Test Report to the Commissioning Authority after tests are complete.

7. Demonstration Tests shall be successfully completed and approved prior to Substantial Completion.

G. Trend Log Tests

1. Trends shall be fully configured to record and store data to the server for the points and at the interval listed in Paragraph 2.11 as follows:

   a. Commissioning: Configure trends prior to functional testing phase. Retain configuration until post-construction commissioning trend review has been completed successfully and accepted by the Owner's representative. Trends shall be deactivated after acceptance.

   b. Continuous: After system acceptance, configure trends for the purpose of long term future diagnostics. Configure trends to overwrite the oldest trends at the longest interval possible without filling the server hard disk beyond 80%.

2. Post-Construction Trend Test

   a. Trend logging shall not commence until Demonstration Tests are successfully completed.

   b. Hardware Points. Contractor shall configure points to trend as indicated in the Commissioning Trend column listed in Paragraph 2.11 points list.

   c. Software Points. Include the following in trends of systems and zones whose hardware points are being trended as called for above. Time interval shall be the same as associated hardware point.

      1) All setpoints and limits that are automatically reset, such as supply air temperature and fan static pressure setpoints, plus the points that are driving the reset, such as zone level cooling and static pressure requests

2) All setpoints that are adjustable by occupants

3) Outputs of all control loops, other than those driving a single AO point that is already being trended

4) System mode points (e.g. Warm-up, Occupied, etc.)

5) Global overrides such as demand shed signals

6) Calculated performance monitoring points, such as chiller efficiency

d. Submit for review and approval by the by Commissioning Authority a table of points to be trended along with trend intervals or change-of-value a minimum of 14 days prior to trend collection period.

e. Trends shall be uploaded to the CSS in data format specified in Paragraph 2.11D.11.

f. Trend logs of all points indicated above shall be collected for a 4 week Trend Period.

g. At the completion of the Trend Period, data shall be reviewed by the Contractor to ensure that the system is operating properly. If so, data shall be submitted to the Owner in an electronic format agreed to by the Owner and Contractor (such as CD-ROM or via direct access to the CSS via the internet).

h. Data will be analyzed by the Commissioning Authority.

i. The system shall be accepted only if the trend review indicates proper system operation without malfunction, without alarm caused by control action or device failure, and with smooth and stable control of systems and equipment in conformance with these specifications. If any but very minor glitches are indicated in the trends, steps f to h above shall be repeated for the same Trend Period until there is a complete Trend Period of error free operation.

j. After successfully completing the Post-Construction Trend Tests, the Contractor shall configure all points to trend as indicated in the Continuous Trend column listed in Paragraph 2.11 points list.

H. Remedial Work

1. Repair or replace defective Work, as directed by Owner's Representative in writing, at no additional cost to the Owner.

2. Restore or replace damaged Work due to tests as directed by Owner's Representative in writing, at no additional cost to the Owner.

3. Restore or replace damaged Work of others, due to tests, as directed by Owner's Representative in writing, at no additional cost to the Owner.

4. Remedial Work identified by site reviews, review of submittals, demonstration test, trend reviews, etc. shall be performed to the satisfaction of the Owner's Representative, at no additional cost to the Owner.

5. Contractor shall compensate Owner's Representatives and Commissioning Authority on a time and material basis at standard billing rates for any additional time required to witness additional demonstration tests or to review additional EMCS trends beyond the initial tests, at no additional cost to the Owner.

3.16 TRAINING

A. Coordinate schedule and materials with Commissioning Authority.

B. Interim Training

1. Provide minimal training so the operating staff can respond to occupant needs and other operating requirements during start-up and commissioning phase.

C. Formal Training

1. Provide training sessions for personnel indicated in Paragraph 3.16G.

2. Training shall be conducted after all commissioning is complete and systems are fully operational.

3. Off-site Primary System Training

a. Training on basic EMCS functions as listed in Paragraph 3.16C.3 shall be given off-site by the primary manufacturer's training staff, either at the factory or at a permanent training facility. Training by Contractor staff is not acceptable.

b. The appropriate level of training shall be provided for each of the persons listed in Paragraph 3.16G.

c. The length of each training period will depend on the complexity of the system and the audience, described below. Minimum training shall be 24 hours per trainee, but period shall be longer if required to complete the training tasks described below.

d. Expenses for transportation to and from the training facility, hotel, and meals shall be provided by the Owner and excluded from the EMCS bid. Cost for books, manuals and any other type of training equipment or material shall be included in the EMCS bid.

4. On-Site Training

a. Include 32 hours total of on-site training to assist personnel in becoming familiar with site-specific issues, systems, control sequences, etc.

b. Owner shall be permitted to videotape training sessions.

c. Training may be in non-contiguous days at the request of the Owner.

5. During the warranty period, provide unlimited telephone support for all trained operators.

D. Operators are divided into three categories and shall receive training including but not limited to the tasks listed.

1. Day-to-day Operators shall be trained to
    a. Proficiently operate the system
    b. Understand control system architecture and configuration
    c. Understand EMCS system components
    d. Understand system operation and control sequences
    e. Operate the workstation and peripherals
    f. Log on and off the system
    g. Access graphics, point reports, and logs
    h. Adjust and change system set points, time schedules, and holiday schedules
    i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
    j. Understand and acknowledge alarms
    k. Understand system drawings, and Operation and Maintenance manual
    l. Understand the Project layout and location of control components
    m. Print point and predefined reports
2. Advanced Operators shall be trained to do all items for Day-to-Day operators plus
    a. Make and change graphics on the workstation
    b. Create, delete, and modify alarms, including annunciation and routing
    c. Create, delete, and modify point trend logs, and graph or print these both on an ad-hoc basis and at user-definable time intervals
    d. Create, delete, and modify reports
    e. Add, remove, and modify system's physical points
    f. Create, modify, and delete programming
    g. Add control panels
    h. Add Operator Workstations
    i. Create, delete, and modify system displays — both graphical and otherwise
    j. Perform EMCS system field checkout procedures
    k. Perform EMCS controller unit operation and maintenance procedures

l. Perform workstation and peripheral operation and maintenance procedures

m. Perform EMCS system diagnostic procedures

n. Configure hardware including PC boards, switches, communication, and I/O points

o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware

p. Adjust, calibrate, and replace system components

q. Maintain software and prepare backups

3. System Managers/Administrators shall be trained to do all items for Day-to-Day operators plus

a. Maintain software and prepare backups

b. Create and print custom reports, including tenant billing summaries

c. Interface with project-specific, third-party operator software

d. Add new users and understand password security procedures

E. Training materials shall include step-by-step instructions (including illustrations, screen captures, etc.) for how to perform all task identified in Paragraph 3.16C.3 such that a new Operator, who has not attended the training in person and has minimal familiarity with this EMCS system, can easily follow the instructions and successfully perform all of the identified tasks. One copy of training material shall be provided per student. An electronic copy of the materials shall be stored on the OWS.

F. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

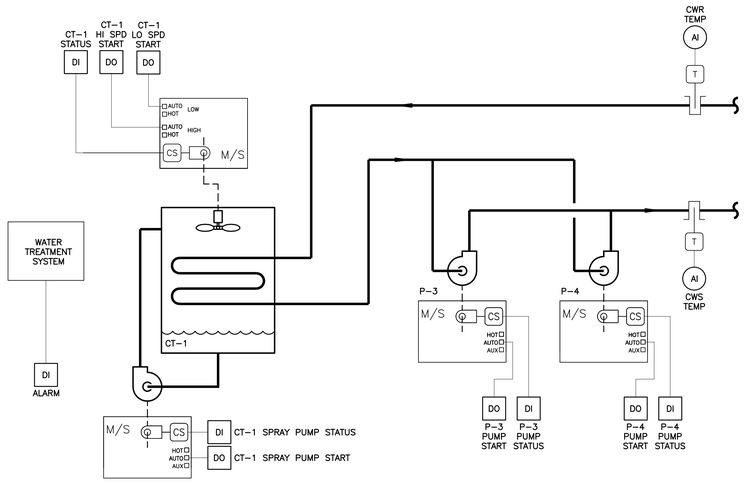
G. The type and number of personnel and location for training shall include

1. Day-to-day Operator: 3

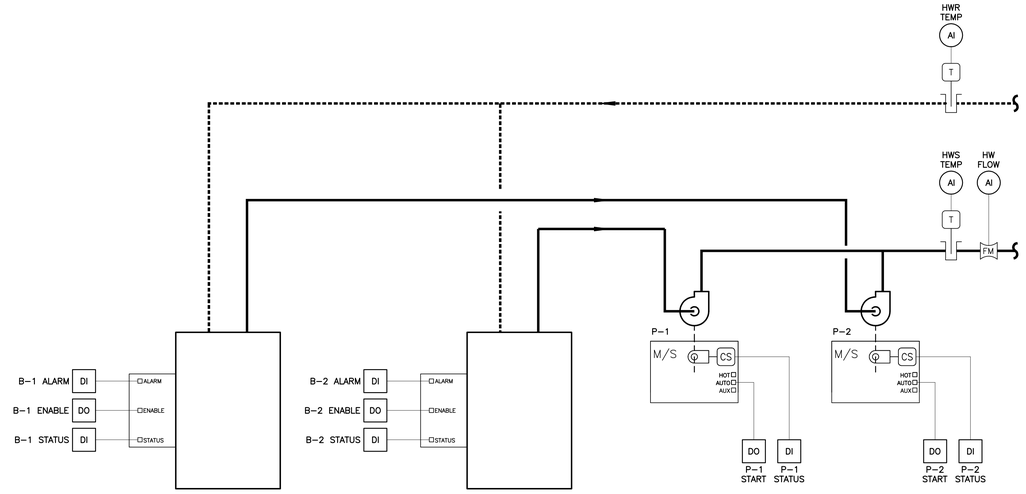
2. Advanced Operator: 2

3. System Managers/Administrators: 2

END OF SECTION 250000



1 M6.1 CW SYSTEM SCHEMATIC
NO SCALE



2 M6.1 HW SYSTEM SCHEMATIC
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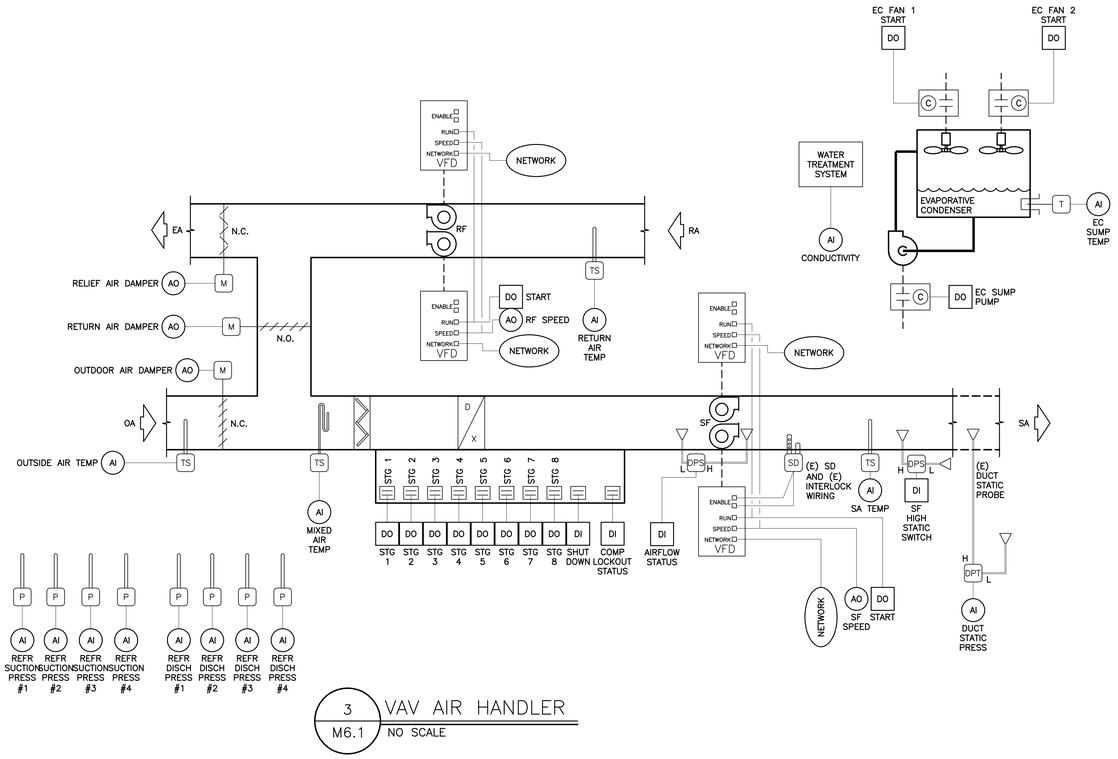


3 M6.1 VAV AIR HANDLER
NO SCALE

Taylor Engineering LLC
1080 Marina Village Parkway
Suite 501
Alameda CA, 94501-6427
Phone: (510) 749-9135
Fax: (510) 749-9136

ISSUES/REVISIONS

NO.	DATE	DESCRIPTION
–	9/11/2013	PROGRESS SET
	10/18/2013	ISSUED FOR BID
	3/27/2014	ISSUED FOR BID

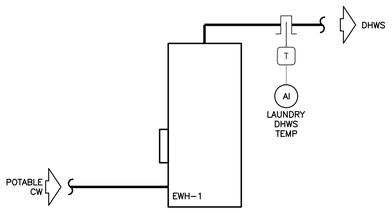
REGISTERED PROFESSIONAL ENGINEER
STEVEN T. TAYLOR
No. 20819
Exp. 06/30/13
MECHANICAL
STATE OF CALIFORNIA

SAN MATEO COUNTY OFFICE BUILDING II
EMCS UPGRADE
REDWOOD CITY, CA

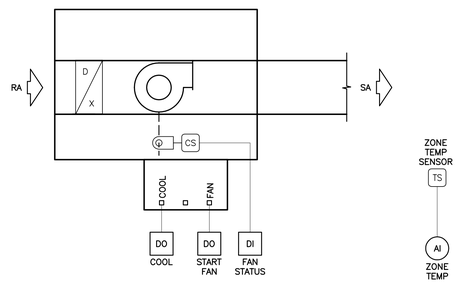
DRAWN BY: HC/ST
SCALE: NTS

HVAC CONTROL SCHEMATICS

CS–1

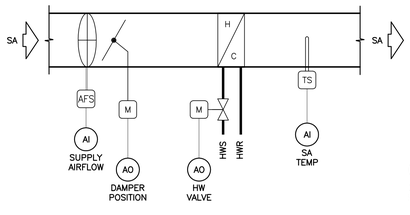


1 M6.2 DHW SYSTEM
NOT TO SCALE

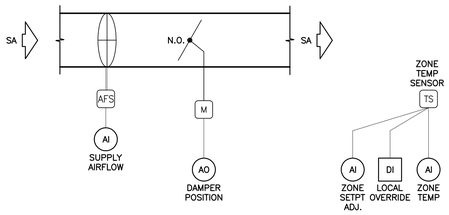


2 M6.2 AC UNITS & HEAT PUMPS
NO SCALE

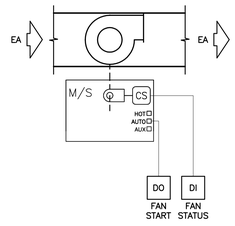
3 M6.2 AUX AC UNITS
NO SCALE



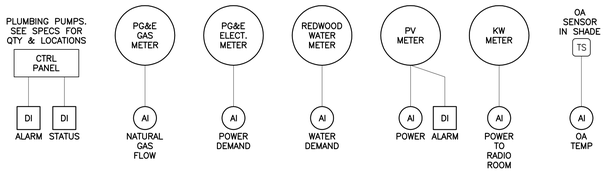
4 M6.2 VAV REHEAT ZONE
NO SCALE



5 M6.2 VAV COOLING ONLY ZONE
NO SCALE



6 M6.2 EXHAUST FAN
NO SCALE



7 M6.2 MISCELLANEOUS POINTS
NO SCALE

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Alameda CA, 94501-6427
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HVAC CONTROL SCHEMATICS

CS–2