ARTICLE VII
OWNER'S RIGHTS AND RESPONSIBILITIES

7.1 Project Site; Title. The Owner shall provide the lands upon which the Work under the Contract Documents is to be done, except that the Contractor shall provide all necessary additional land required for the erection of temporary construction facilities and storage of his materials, together with right of access to same. The Owner hereby represents to the Contractor that it currently has and will maintain up through and including the Substantial Completion Date, good title to all of the real property constituting the Project Site. Owner agrees to resolve, at its expense, any disputes relating to the ownership and use of the Project Site which might arise during construction.

7.2 Project Plans and Specifications; Architect/Engineer. The parties hereto acknowledge and agree that Owner has previously entered into an agreement with Architect/Engineer. Pursuant to the terms of such agreement, the Architect/Engineer, as an agent and representative of Owner, is responsible for the preparation of Project Plans and Specifications which consist of drawings, specifications, and other documents setting forth in detail the requirements for the construction of the Project. All such Project Plans and Specifications shall be provided either by Owner or the Architect/Engineer, and Contractor shall be under no obligation to provide same and shall be entitled to rely upon the accuracy and completeness of the Project Plans and Specifications provided by the Architect/Engineer and all preliminary drawings prepared in connection therewith. The Contractor will be furnished a reproducible set of all drawings and specifications reasonably necessary for the performance of Contractor's services hereunder and otherwise ready for printing. The Contractor shall be notified of any written modification in the agreement between Owner and Architect/Engineer.

7.3 Surveys; Soil Tests and Other Project Site Information. Owner shall be responsible for providing a legal description and certified land survey of the Project Site in a form and content and with such specificity as may be required by the Architect/Engineer and Contractor to perform their services. To the extent deemed necessary by Owner and Architect/Engineer, and solely at Owner's expense, Owner may engage the services of a geotechnical consultant to perform test borings and other underground soils testing as may be deemed necessary by the Architect/Engineer or the Contractor. Contractor shall not be obligated to provide such surveys or soil tests and shall be entitled to rely upon the accuracy and completeness of the information provided; subject, however, to the provisions of Section 2.4.S hereof. Owner shall provide Contractor, as soon as reasonably possible following the execution of the Contract Documents, all surveys or other survey information in its possession describing the physical characteristics of the Project Site, together with soils reports, subsurface investigations, utility locations, deed restrictions, easements, and legal descriptions then in its possession or control. Upon receipt of all surveys, soils tests, and other Project Site information, Contractor shall promptly advise Owner of any inadequacies in such information and of the need for any additional surveys, soils or subsoil tests. In performing this Work, Contractor shall use the standard of care of experienced contractors and will use its best efforts timely to identify all problems or omissions. Owner shall not be responsible for any delay or damages to the Contractor for any visible or disclosed site conditions or disclosed deficiencies in the Project Site which should have been identified by Contractor and corrected by Owner prior to the execution of the Contract Documents.

7.4 Information; Communication; Coordination. The Owner's Project Representative shall examine any documents or requests for information submitted by the Contractor and shall advise Contractor of Owner's decisions pertaining thereto within a reasonable period of time to avoid unreasonable delay in the progress of the Contractor's services. Contractor shall indicate if any such documents or requests warrant

priority consideration. However, decisions pertaining to approval of the Project Schedule as it relates to the date of Substantial Completion, the Project Cost, Contractor's compensation, approving or changing the Contract Sum shall only be effective when approved by Owner in the form of a written Change Order or amendment to the Contract Documents. Owner reserves the right to designate a different Owner's Project Representative provided Contractor is notified in writing of any such change. Owner and Architect/Engineer may communicate with Subcontractors, materialmen, laborers, or suppliers engaged to perform services on the Project, but only for informational purposes. Neither the Owner nor the Architect/Engineer shall attempt to direct the Work of or otherwise interfere with any Subcontractor, materialman, laborer, or supplier, or otherwise interfere with the Work of the Contractor. Owner shall furnish the data required of Owner under the Contract Documents promptly.

7.5 Governmental Body. The Contractor recognizes that the Owner is a governmental body with certain procedural requirements to be satisfied. The Contractor has and will make reasonable allowance in its performance of services for such additional time as may be required for approvals and decisions by the Owner and any other necessary government agency.

7.6 Pre-Completion Acceptance. The Owner shall have the right to take possession of and use any completed portions of the Work, although the time for completing the entire Work or such portions may not have expired, but such taking possession and use shall not be deemed an acceptance of any Work not completed in accordance with the Contract Documents.

7.7 Ownership and Use of Drawings, Specifications and Other Instruments of Service.

(1) The Architect/Engineer and the Architect/Engineer's consultants shall be deemed the authors and owners of their respective instruments of service, including the Project Plans and Specifications, and will retain all common law, statutory and other reserved rights, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the instruments of service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be constructed as publication in derogation of the Architect/Engineer's or Architect/Engineer's consultants' reserved rights.

(2) The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the drawings and specifications provided to them solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Project Plans and Specifications or other instruments of service. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers may not use the drawings or specifications on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Architect/Engineer and the Architect/Engineer's consultants.

7.8 Owner's Project Representative. Owner's Project Representative is Owner's Agent, who will act as directed by and under the supervision of the Owner, and who will confer with Owner/Architect/Engineer regarding his actions. The Owner's Project Representative's dealings in matters pertaining to the on-site Work shall, in general, be only with the Owner/Architect/Engineer and Contractor

and dealings with Subcontractors shall only be through or with the full knowledge of Contractor.

A. Responsibilities. Except as otherwise instructed in writing by Owner, the Owner's Project Representative will:

(1) Attend preconstruction conferences; arrange a schedule of progress meetings and other job conferences as required in consultation with Owner/Architect/Engineer and notify those expected to attend in advance; and attend meetings and maintain and circulate copies of minutes thereof;

(2) Serve as Owner/Architect/Engineer's liaison with Contractor, working principally through Contractor's superintendent, to assist in understanding the intent of the Contract Documents. As requested by Owner/Architect/Engineer, assist in obtaining additional details or information when required at the job site for proper execution of the Work;

(3) Report to Owner/Architect/Engineer whenever he believes that any Work is unsatisfactory, faulty or defective or does not conform to the Contract Documents;

(4) Accompany visiting inspectors representing public or other agencies having jurisdiction over the project; record the outcome of these inspections and report to Owner/Architect/Engineer;

(5) Review applications for payment with Contractor for compliance with the established procedure for their submission and forward them with recommendations to Owner/Architect/Engineer; and

(6) Perform those duties as set forth elsewhere within the Contract Documents.

B. Limitations. Except upon written instructions of Owner, Owner's Project Representative shall not:

(1) Authorize any deviation from the Contract Documents or approve any substitute materials or equipment;

(2) Exceed limitations on Owner/Architect/Engineer's authority as set forth in the Contract Documents;

(3) Undertake any of the responsibilities of Contractor, Subcontractors or Contractor's superintendent, or expedite the Work;

(4) Advise on or issue directions relative to any aspect of the means, methods, techniques, sequences or procedures of construction unless such is specifically called for in the Contract Documents;

(5) Advise on or issue directions as to safety precautions and programs in connection with the Work;

(6) Authorize Owner to occupy the project in whole or in part; or

(7) Participate in specialized field or laboratory tests.

ARTICLE VIII
RESOLUTION OF DISAGREEMENTS; CLAIMS FOR COMPENSATION

8.1 Owner to Decide Disputes. The Owner shall reasonably decide all questions and disputes, of any nature whatsoever, that may arise in the execution and fulfillment of the services provided for under the Contract Documents, in accordance with the Procurement Ordinance.

8.2 Finality. The decision of the Owner upon all claims, questions, disputes and conflicts shall be final and conclusive, and shall be binding upon all parties to the Contract Documents, subject to judicial review as provided in Section 8.5 below.

8.3 No Damages for Delay. If at any time Contractor is delayed in the performance of Contractor's responsibilities under the Contract Documents as the result of a default or failure to perform in a timely manner by Owner or Owner's agents or employees, Contractor shall not be entitled to any damages except for compensation specifically authorized in Article III. Contractor's sole remedy will be a right to extend the time for performance. Nothing herein shall preclude Contractor from any available remedy against any responsible party other than Owner. Contractor shall be responsible for liquidated damages for delay pursuant to Section 3 of the Agreement.

8.4 Permitted Claims Procedure. Where authorized or permitted under the Contract Documents, all claims for additional compensation by Contractor, extensions of time affecting the Substantial Completion Date, for payment by the Owner of costs, damages or losses due to casualty, Force Majeure, Project Site conditions or otherwise, shall be governed by the following:

(1) All claims must be submitted as a request for Change Order in the manner as provided in Article V.

(2) The Contractor must submit a notice of claim to Owner's Project Representative and to the Architect/Engineer within fifteen (15) days of when the Contractor was or should have been aware of the fact that an occurrence was likely to cause delay or increased costs. Failure to submit a claim within the requisite 15-day period shall constitute a waiver of the right to pursue said claim.

(3) Within twenty (20) days of submitting its notice of claim, the Contractor shall submit to the Owner's Project Representative its request for Change Order, which shall include a written statement of all details of the claim, including a description of the Work affected.

(4) After receipt of a request for Change Order, the Owner's Project Representative, in consultation with the Architect/Engineer, shall deliver to the Contractor, within twenty (20) days after receipt of request, its written response to the claim.

(5) In the event the Owner and Contractor are unable to agree on the terms of a Change Order, the Owner shall have the option to instruct the Contractor to proceed with the Work. In that event, the Owner shall pay for those parts of the Work, the scope and price of which are not in dispute. The balance of the disputed items in the order to proceed will be resolved after completion of the Work, based upon completed actual cost.

(6) The rendering of a decision by Owner with respect to any such claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment) will be a condition precedent to any exercise by Owner or Contractor of such right or remedies as either may otherwise have under the Contract Documents or by laws or regulations in respect of any such claim, dispute or other matter.

8.5 Contract Claims and Disputes. After completion of the process set forth in Section 8.4 above, any unresolved dispute under this Agreement shall be decided by the Purchasing Official in accordance with Section 2-26-63 of the Manatee County Code of Laws, subject to an administrative hearing process as provided in Section 2-26-64. The decision of the Board of County Commissioners in accordance with Section 2-26-64 of the Manatee County Code of Laws shall be the final and conclusive County decision subject to exclusive judicial review in circuit court by a petition for certiorari.

8.6 Claims for Consequential Damages. The Contractor and Owner waive claims against each other for consequential damages arising out of or relating to this Agreement. This mutual waiver includes:

(1) damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

(2) damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article XIV. Nothing contained in this Section 8.6 shall be deemed to preclude assessment of liquidated direct damages, when applicable, in accordance with the requirements of the Contract Documents.

ARTICLE IX
INDEMNITY

9.1 Indemnity.

A. Indemnification Generally. To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect/Engineer, Architect/Engineer's consultants, and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorney's fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether such claim, damage, loss or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity which would otherwise exist as to a party or person described in this Section 9.1.

B. Claims by Employees. In claims against any person or entity indemnified under this Section 9.1 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under Section 9.1.A. shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts or other employee benefit acts.

9.2 Duty to Defend. The Contractor shall defend the Owner in any action, lawsuit mediation or arbitration arising from the alleged negligence, recklessness or intentionally wrongful conduct of the Contractor and other persons employed or utilized by the Contractor in the performance of the Work. So long as Contractor, through its own counsel, performs its obligation to defend the Owner pursuant to this Section, Contractor shall not be required to pay the Owner's costs associated with the Owner's participation in the defense.

ARTICLE X
ACCOUNTING RECORDS; OWNERSHIP OF DOCUMENTS

10.1 Accounting Records. Records of expenses pertaining to all services performed shall be kept in accordance with generally accepted accounting principles and procedures.

10.2 Inspection and Audit. The Contractor's records shall be open to inspection and subject to examination, audit, and/or reproduction during normal working hours by the Owner's agent or authorized representative to the extent necessary to adequately permit evaluation and verification of any invoices, payments or claims submitted by the Contractor or any of its payees during the performance of the Work. These records shall include, but not be limited to, accounting records, written policies and procedures, Subcontractor files (including proposals of successful and unsuccessful bidders), original estimates, estimating worksheets, correspondence, Change Order files (including documentation covering negotiated settlements), and any other supporting evidence necessary to substantiate charges related to the Contract Documents. They shall also include, but not be limited to, those records necessary to evaluate and verify

direct and indirect costs (including overhead allocations) as they may apply to costs associated with the Contract Documents. For such audits, inspections, examinations and evaluations, the Owner's agent or authorized representative shall have access to said records from the effective date of the Contract Documents, for the duration of Work, and until three (3) years after the date of final payment by the Owner to the Contractor pursuant to the Contract Documents.

10.3 Access. The Owner's agent or authorized representative shall have access to the Contractor's facilities and all necessary records to conduct audits in compliance with this Article. The Owner's agent or authorized representative shall give the Contractor reasonable advance notice of intended inspections, examinations, and/or audits.

10.4 Ownership of Documents. Upon obtainment of Substantial Completion or termination of the Agreement, all records, documents, tracings, plans, specifications, maps, evaluations, reports, transcripts and other technical data, other than working papers, prepared or developed by the Contractor shall be delivered to and become the property of the Owner. The Contractor at its own expense may retain copies for its files and internal use.

ARTICLE XI
PUBLIC CONTRACT LAWS

11.1 Equal Opportunity Employment.

A. Employment. The Contractor shall not discriminate against any employee or applicant for employment because of race, creed, sex, color, national origin, disability or age, and will take affirmative action to ensure that all employees and applicants are afforded equal employment opportunities without discrimination because of race, creed, sex, color, national origin, disability or age. Such action will be taken with reference to, but shall not be limited to, recruitment, employment, job assignment, promotion, upgrading, demotion, transfer, layoff or termination, rates of training or retraining, including apprenticeship and on-the-job training.

B. Participation. No person shall, on the grounds of race, creed, sex, color, national origin, disability or age, be excluded from participation in, be denied the proceeds of, or be subject to discrimination in the performance of the Agreement.

11.2 Immigration Reform and Control Act of 1986. Contractor acknowledges that it is responsible for complying with the provisions of the Immigration Reform and Control Act of 1986, located at 8 U.S.C. Section 1324, et seq., and regulations relating thereto. Failure to comply with the above statutory provisions shall be considered a material breach and shall be grounds for immediate termination of this Agreement.

11.3 No Conflict of Interest. The Contractor warrants that it has not employed or retained any company or person, other than a bona fide employee working solely for the Contractor to solicit or secure this Agreement, and that it has not paid or agreed to pay any person, company, corporation, individual, or firm other than a bona fide employee working solely for the Contractor, any fee, commission, percentage, gift or any other consideration, contingent upon or resulting from the award or making of this Agreement.

A. No Interest in Business Activity. By accepting award of this Agreement, the Contractor, which shall include its directors, officers and employees, represents that it presently has no interest in and shall acquire no interest in any business or activity which would conflict in any manner with the performance of services required hereunder, including without limitation as described in the Contractor's own professional ethical requirements. An interest in a business or activity which shall be deemed a conflict includes but is not limited to direct financial interest in any of the material and equipment manufacturers, suppliers, distributors, or contractors who will be eligible to supply material and equipment for the Project for which the Contractor is furnishing its services required hereunder.

B. No Appearance of Conflict. The Contractor shall not knowingly engage in any contractual or professional obligations that create an appearance of a conflict of interest with respect to the services provided pursuant to the Agreement. The Contractor has provided the Affidavit of No Conflict, incorporated into the Contract Documents as Exhibit "C", as a material inducement for Owner entering the Agreement. If, in the sole discretion of the County Administrator or designee, a conflict of interest is deemed to exist or arise during the term of this Agreement, the County Administrator or designee may cancel this Agreement, effective upon the date so stated in a written notice of cancellation, without penalty to the Owner.

11.4 Truth in Negotiations. By execution of the Contract Documents, the Contractor certifies to truth-in-negotiations and that wage rates and other factual unit costs supporting the compensation are accurate, complete and current at the time of contracting. Further, the original Contract Sum and any additions thereto shall be adjusted to exclude any significant sums where the Owner determines the Contract Sum was increased due to inaccurate, incomplete or non-current wage rates and other factual unit costs. Such adjustments must be made within one (1) year after final payment to the Contractor.

11.5 Public Entity Crimes. The Contractor is directed to the Florida Public Entity Crimes Act, Section 287.133, Florida Statutes, specifically section 2(a), and the Owner's requirement that the Contractor comply with it in all respects prior to and during the term of the Agreement.

ARTICLE XII
FORCE MAJEURE, FIRE OR OTHER CASUALTY

12.1 Force Majeure.

A. Unavoidable Delays. Delays in any performance by any party contemplated or required hereunder due to fire, flood, sinkhole, earthquake or hurricane, acts of God, unavailability of materials, equipment or fuel, war, declaration of hostilities, revolt, civil strife, altercation or commotion, strike, labor dispute, or epidemic, archaeological excavation, lack of or failure of transportation facilities, or any law, order, proclamation, regulation, or ordinance of any government or any subdivision thereof, or for any other similar cause to those enumerated, beyond the reasonable control and which with due diligence could not have been reasonably anticipated, shall be deemed to be events of Force Majeure and any such delays shall be excused. In the event such party is delayed in the performance of any Work or obligation pursuant to the Contract Documents for any of the events of Force Majeure stated in this Section 12.1, the date for performance required or contemplated by the Contract Documents shall be extended by the number of calendar days such party is actually delayed

B. Concurrent Contractor Delays. If a delay is caused for any reason provided in 12.1.A. or because of an extension of time provided by Change Order, and during the same time period a delay is caused by Contractor, the date for performance shall be extended as provided in 12.1.A. but only to the extent the time is or was concurrent.

C. Notice; Mitigation. The party seeking excuse for nonperformance based on Force Majeure shall give written notice to the Owner, if with respect to the Contractor, or to the Contractor if with respect to the Owner, specifying its actual or anticipated duration. Each party seeking excuse from nonperformance based on Force Majeure shall use its best efforts to rectify any condition causing a delay and will cooperate with the other party, except that neither party shall be obligated to incur any unreasonable additional costs and expenses to overcome any loss of time that has resulted.

12.2 Casualty; Actions by Owner and Contractor. During the construction period, if the Project or any part thereof shall have been damaged or destroyed, in whole or in part, the Contractor shall promptly make proof of loss; and Owner and Contractor shall proceed promptly to collect, or cause to be collected, all valid claims which may have arisen against insurers or others based upon such damage or destruction. The Contractor shall diligently assess the damages or destruction and shall prepare an estimate of the cost, expenses, and other charges, including normal and ordinary compensation to the Contractor, necessary for reconstruction of the Project substantially in accordance with the Project Plans and Specifications. Within fifteen (15) days following satisfaction of the express conditions described in subsections (1), (2) and (3) below, the Contractor covenants and agrees diligently to commence reconstruction and to complete the reconstruction or repair of any loss or damage by fire or other casualty to the Project to substantially the same size, floor area, cubic content, and general appearance as prior to such loss or damage:

(1) Receipt by the Owner or the trustee of the proceeds derived from collection of all valid claims against insurers or others based upon such damage or destruction, and receipt of other sums from any source such that the funds necessary to pay the Project Cost and any additions to the Project Cost necessitated for repair or reconstruction are available;

(2) Written agreement executed by the Contractor and the Owner, by amendment to the Contract Documents or otherwise, authorizing and approving the repair or reconstruction and any additions to the Project Cost necessitated thereby, including any required adjustment to the Contract Sum; and

(3) Final approval by the Owner of the Project Plans and Specifications for such repair or reconstruction and issuance of any required building permit.

12.3 Approval of Plans and Specifications. The Owner agrees to approve the plans and specifications for such reconstruction or repair if the reconstruction or repair contemplated by such plans and specifications is economically feasible, and will restore the Project, or the damaged portion thereof, to substantially the same condition as prior to such loss or damage, and such plans and specifications conform to the applicable laws, ordinances, codes, and regulations. The Owner agrees that all proceeds of any applicable insurance or other proceeds received by the Owner or the Contractor as a result of such loss or damage shall be used for payment of the costs, expenses, and other charges of the reconstruction or repair of the Project.

12.4 Notice of Loss or Damage. The Contractor shall promptly give the Owner written notice of any significant damage or destruction to the Project, defined as loss or damage which it is contemplated by Contractor will increase the Contract Sum or extend the Substantial Completion Date, stating the date on which such damage or destruction occurred, the then expectations of Contractor as to the effect of such damage or destruction on the use of the Project, and the then proposed schedule, if any, for repair or reconstruction of the Project. Loss or damage which the Contractor determines will not affect the Contract Sum or Substantial Completion Date will be reported to Owner and Architect/Engineer immediately, and associated corrective actions will be undertaken without delay.

ARTICLE XIII
REPRESENTATIONS, WARRANTIES AND COVENANTS

13.1 Representations and Warranties of Contractor. The Contractor represents and warrants to the Owner each of the following.

A. The Contractor is a construction company, organized under the laws of the State of _____, authorized to transact business in the State of Florida, with _____ as the primary qualifying agent. Contractor has all requisite power and authority to carry on its business as now conducted, to own or hold its properties, and to enter into and perform its obligations hereunder and under each instrument to which it is or will be a party, and is in good standing in the State of Florida.

B. Each Contract Document to which the Contractor is or will be a party constitutes, or when entered into will constitute, a legal, valid, and binding obligation of the Contractor enforceable against the Contractor in accordance with the terms thereof, except as such enforceability may be limited by applicable bankruptcy, insolvency, or similar laws from time to time in effect which affect creditors' rights generally and subject to usual equitable principles in the event that equitable remedies are involved.

C. There are no pending or, to the knowledge of the Contractor, threatened actions or proceedings before any court or administrative agency, within or without the State of Florida, against the Contractor or any partner, officer, or agent of the Contractor which question the validity of any document contemplated hereunder, or which are likely in any case, or in the aggregate, to materially adversely affect the consummation of the transactions contemplated hereunder, or materially adversely affect the financial condition of the Contractor.

D. The Contractor has filed or caused to be filed all federal, state, local, or foreign tax returns, if any, which were required to be filed by the Contractor, and has paid, or caused to be paid, all taxes shown to be due and payable on such returns or on any assessments levied against the Contractor.

E. Neither Contractor nor any agent or person employed or retained by Contractor has acted fraudulently or in bad faith or in violation of any statute or law in the procurement of this Agreement.

F. The Contractor shall timely fulfill or cause to be fulfilled all of the terms and conditions expressed herein which are within the control of the Contractor or which are the responsibility of the Contractor to fulfill. The Contractor shall be solely responsible for the means and methods of construction.

G. It is recognized that neither the Architect/Engineer, the Contractor, nor the Owner has control over the cost of labor, materials, or equipment, over a Subcontractor's methods of determining bid prices, or over competitive bidding, market, or negotiating conditions.

H. During the term of the Contract Documents, and the period of time that the obligations of the Contractor under the Contract Documents shall be in effect, the Contractor shall cause to occur and to continue to be in effect those instruments, documents, certificates, and events contemplated by the Contract Documents that are applicable to, and the responsibility of, the Contractor.

I. The Contractor shall assist and cooperate with the Owner and shall accomplish the construction of the Project in accordance with the Contract Documents and the Project Plans and Specifications, and will not knowingly violate any laws, ordinances, rules, regulations, or orders that are or will be applicable thereto.

J. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective, and that Owner, representatives of Owner, governmental agencies with jurisdictional interests will have access to the Work at reasonable time for their observation, inspecting and testing. Contractor shall give Architect/Engineer timely notice of readiness of the Work for all required approvals and shall assume full responsibility, including costs, in obtaining required tests, inspections, and approval certifications and/or acceptance, unless otherwise stated by Owner.

K. If any Work (including Work of others) that is to be inspected, tested, or approved is covered without written concurrence of Architect/Engineer, it must, if requested by Architect/Engineer, be uncovered for observation. Such uncovering shall be at Contractor's expense unless Contractor has given Architect/Engineer timely notice of Contractor's intention to cover the same and Architect/Engineer has not acted with reasonable promptness in response to such notice. Neither observations by Architect/Engineer nor inspections, tests, or approvals by others shall relieve Contractor from Contractor's obligations to perform the Work in accordance with the Contract Documents.

L. If the Work is defective, or Contractor fails to supply sufficient skilled workers, or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof and terminate payments to the Contractor until the cause for such order has been eliminated. Contractor shall bear all direct, indirect and consequential costs for satisfactory reconstruction or removal and replacement with non-defective Work, including, but not limited to fees and charges of Architect/Engineers, attorneys and other professionals and any additional expenses experienced by Owner due to delays to other Contractors performing additional Work and an appropriate deductive change order shall be issued. Contractor shall further bear the responsibility for maintaining the schedule and shall not be entitled to an extension of the Contract Time or the recovery of delay damages due to correcting or removing defective Work.

M. If Contractor fails within seven (7) days after written notice to correct defective Work, or fails to perform the Work in accordance with the Contract Documents, or fails to comply with any other provision of the Contract Documents, Owner may correct and remedy any such deficiency to the extent necessary to complete corrective and remedial action. Owner may exclude Contractor from all or part of the site, take possession of all or part of the Work, Contractor's tools, construction equipment and machinery at

the site or for which Owner has paid Contractor but which are stored elsewhere. All direct and indirect costs of Owner in exercising such rights and remedies will be charged against Contractor in an amount approved as to reasonableness by Architect/Engineer and a Change Order will be issued incorporating the necessary revisions.

N. If within three (3) years after the Substantial Completion Date or such longer period of time as may be prescribed by laws or regulations or by the terms of any applicable special guarantee required by the Contract Documents, any Work is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions, either correct such defective Work or if it has been rejected by Owner, remove it from the site and replace it with non-defective Work. If Contractor does not promptly comply with the terms of such instruction, Owner may have the defective Work corrected/removed and all direct, indirect and consequential costs of such removal and replacement will be paid by Contractor. Failing payment by the Contractor and notwithstanding any other provisions of the Contract Documents to the contrary, Owner shall have the right to bring a direct action in the Circuit Court to recover such costs.

13.2 Representations of the Owner. To the extent permitted by law, the Owner represents to the Contractor that each of the following statements is presently true and accurate:

A. The Owner is a validly existing political subdivision of the State of Florida.

B. The Owner has all requisite corporate or governmental power and authority to carry on its business as now conducted and to perform its obligations under the Contract Documents and each Contract Document contemplated hereunder to which it is or will be a party.

C. The Contract Documents and each Contract Document contemplated hereby to which the Owner is or will be a party has been duly authorized by all necessary action on the part of, and has been or will be duly executed and delivered by, the Owner, and neither the execution and delivery thereof nor compliance with the terms and provisions thereof or hereof: (a) requires the approval and consent of any other person or party, except such as have been duly obtained or as are specifically noted herein; (b) contravenes any existing law, judgment, governmental rule, regulation or order applicable to or binding on the Owner; or (c) contravenes or results in any breach of, default under, or result in the creation of any lien or encumbrance upon the Owner under any indenture, mortgage, deed of trust, bank loan, or credit agreement, the charter, ordinances, resolutions, or any other agreement or instrument to which the Owner is a party, specifically including any covenants of any bonds, notes, or other forms of indebtedness of the Owner outstanding on the date of the Contract Documents.

D. The Contract Documents and each document contemplated hereby to which the Owner is or will be a party constitutes, or when entered into will constitute, a legal, valid, and binding obligation of the Owner enforceable against the Owner in accordance with the terms thereof, except as such enforceability may be limited by applicable bankruptcy, insolvency, or similar laws from time to time in effect which affect creditors' rights generally, and subject to usual equitable principles in the event that equitable remedies are involved.

E. There are no pending or, to the knowledge of the Owner, threatened actions or proceedings before any court or administrative agency against the Owner which question the validity of the

Contract Documents or any document contemplated hereunder, or which are likely in any case or in the aggregate to materially adversely affect the consummation of the transactions contemplated hereunder or the financial or corporate condition of the Owner.

F. The Owner shall use due diligence to timely fulfill or cause to be fulfilled all of the conditions expressed in the Contract Documents which are within the control of the Owner or which are the responsibility of the Owner to fulfill.

G. During the pendency of the Work and while the obligations of the Owner under the Contract Documents shall be in effect, the Owner shall cause to occur and to continue to be in effect and take such action as may be necessary to enforce those instruments, documents, certificates and events contemplated by the Contract Documents that are applicable to and the responsibility of the Owner.

H. The Owner shall assist and cooperate with the Contractor in accomplishing the construction of the Project in accordance with the Contract Documents and the Project Plans and Specifications, and will not knowingly violate any laws, ordinances, rules, regulations, orders, contracts, or agreements that are or will be applicable thereto or, to the extent permitted by law, enact or adopt any resolution, rule, regulation, or order, or approve or enter into any contract or agreement, including issuing any bonds, notes, or other forms of indebtedness, that will result in the Contract Documents or any part thereof, or any other instrument contemplated by and material to the timely and effective performance of a party's obligations hereunder, to be in violation thereof.

ARTICLE XIV
TERMINATION AND SUSPENSION

14.1 Termination for Cause by Owner. This Agreement may be terminated by Owner upon written notice to the Contractor should Contractor fail substantially to perform a material obligation in accordance with the terms of the Contract Documents through no fault of the Owner. In the event Owner terminates for cause and it is later determined by a court of competent jurisdiction that such termination for cause was not justified, then in such event such termination for cause shall automatically be converted to a termination without cause pursuant to Section 14.2.

A. Nonperformance. If the Contractor fails to timely perform any of its obligations under the Contract Documents, including any obligation the Contractor assumes to perform Work with its own forces, or if it persistently or repeatedly refuses or fails, except in case for which extension of time is provided, to supply enough properly skilled workmen or proper materials, or fails, without being excused, to maintain an established schedule (failure to maintain schedule shall be defined as any activity that falls thirty (30) days or more behind schedule) which has been adopted by the Construction Team, or it fails to make prompt payment to Subcontractors for materials or labor, or disregards laws, rules, ordinances, regulations, or orders of any public authority having jurisdiction, or otherwise is guilty of substantial violations of the Agreement the Owner may, after seven (7) days written notice, during which period the Contractor fails to perform such obligation, make good such deficiencies and perform such actions. The Contract Sum shall be reduced by the cost to the Owner of making good such deficiencies, and the Contractor's compensation shall be reduced by an amount required to manage the making good of such deficiencies. Provided, however, nothing contained herein shall limit or preclude Owner from pursuing additional damages from Contractor

because of its breach.

B. Insolvency. If the Contractor is adjudged bankrupt, or if it makes a general assignment for the benefit of its creditors, or if a receiver is appointed because its insolvency, then the Owner may, without prejudice to any other right or remedy, and after giving the Contractor and its surety, if any, fourteen (14) days written notice, and during which period the Contractor fails to cure the violation, terminate the Agreement. In such case, the Contractor shall not be entitled to receive any further payment. Owner shall be entitled to recover all costs and damages arising because of failure of Contractor to perform as provided in the Contract Documents, as well as reasonable termination expenses, and costs and damages incurred by the Owner may be deducted from any payments left owing the Contractor.

C. Illegality. Owner may terminate the Agreement if Contractor disregards laws or regulations of any public body having jurisdiction.

D. Rights of Owner. The Owner may, after giving Contractor (and the Surety, if there is one) seven (7) days written notice, terminate the services of Contractor for cause; exclude Contractor from the Project Site and take possession of the Work and of all Contractor's tools, construction equipment and machinery at the Project Site and use the same to the full extent they could be used (without liability to Contractor for trespass or conversion); incorporate in the Work all materials and equipment stored at the Project Site or for which Owner has paid Contractor but which are stored elsewhere, and finish the Work as Owner may deem expedient. In such case, Contractor shall not be entitled to receive any further payment beyond an amount equal to the value of material and equipment not incorporated in the Work, but delivered and suitably stored, less the aggregate of payments previously made. If the direct and indirect costs of completing the Work exceed the unpaid balance of the Contract Sum, Contractor shall pay the difference to Owner. Such costs incurred by Owner shall be verified by Owner in writing; but in finishing the Work, Owner shall not be required to obtain the lowest quote for the Work performed. Contractor's obligations to pay the difference between such costs and such unpaid balance shall survive termination of the Agreement. In such event and notwithstanding any other provisions of the Contract Documents to the contrary, Owner shall be entitled to bring a direct action in the Circuit Court to recover such costs.

14.2 Termination without Cause by Owner. The Owner, through its County Administrator or designee, shall have the right to terminate the Agreement, in whole or in part, without cause upon sixty (60) calendar days' written notice to the Contractor. In the event of such termination for convenience, the Owner shall compensate Contractor for payments due through the date of termination, and one subsequent payment to cover costs of Work performed through the date of termination, subject to the terms and conditions of Section 3.1. The Contractor shall not be entitled to any other further recovery against the Owner, including, but not limited to, anticipated fees or profit on Work not required to be performed, or consequential damages or costs resulting from such termination.

A. Release of Contractor. As a condition of Owner's termination rights provided for in this subsection, Contractor shall be released and discharged from all obligations arising by, through, or under the terms of the Contract Documents, and the Payment and Performance Bond shall be released. Owner shall assume and become responsible for the reasonable value of Work performed by Subcontractors prior to termination plus reasonable direct close-out costs, but in no event shall Subcontractors be entitled to unabsorbed overhead, anticipatory profits, or damages for early termination.

B. Waiver of Protest. Contractor hereby waives any right to protest the exercise by Owner of its rights under this Section that may apply under the Procurement Ordinance.

14.3 Suspension without Cause. Owner may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety (90) days by written notice to Contractor, which will fix the date on which Work will be resumed. Contractor shall be allowed an increase in the Contract Sum or an extension of the Contract Time, or both, directly attributable to any suspension if Contractor makes an approved claim therefor.

14.4 Termination Based Upon Abandonment, Casualty or Force Majeure. If, after the construction commencement date (i) Contractor abandons the Project (which for purposes of this paragraph shall mean the cessation of all construction and other activities relating to the Project, excluding those which are necessary to wind down or otherwise terminate all outstanding obligations with respect to the Project, and no recommencement of same within one hundred twenty (120) days following the date of cessation), or (ii) the Project is stopped for a period of thirty (30) consecutive days due to an instance of Force Majeure or the result of a casualty resulting in a loss that cannot be corrected or restored within one hundred twenty (120) days (excluding the time required to assess the damage and complete the steps contemplated under Section 12.2), the Owner shall have the right to terminate the Agreement and pay the Contractor its compensation earned or accrued to date.

14.5 Vacation of Project Site; Delivery of Documents. Upon termination by Owner pursuant to Section 14.2 or 14.4, Contractor shall withdraw its employees and its equipment, if any, from the Project Site on the effective date of the termination as specified in the notice of termination (which effective date shall not be less than two (2) working days after the date of delivery of the notice), regardless of any claim the Contractor may or may not have against the Owner. Upon termination, the Contractor shall deliver to the Owner all original papers, records, documents, drawings, models and other material set forth and described in the Contract Documents.

14.6 Termination by the Contractor. If, through no act or fault of Contractor, the Work is suspended for a period of more than ninety (90) consecutive days by Owner or under an order of court or other public authority, or Owner fails to act on any Application for Payment or fails to pay Contractor any sum finally determined to be due; then Contractor may, upon fourteen (14) days written notice to Owner terminate the Agreement and recover from Owner payment for all Work executed, any expense sustained plus reasonable termination expenses. In lieu of terminating the Agreement, if Owner has failed to act on any Application for Payment or Owner has failed to make any payment as aforesaid, Contractor may upon fourteen (14) days written notice to Owner stop the Work until payment of all amounts then due.

SECTION D

BID ATTACHMENTS

ATTACHMENT 1
INSURANCE AND BOND REQUIREMENTS
DESOTO CENTER, MANATEE COUNTY SHERIFF'S OFFICE
REPLACMENT OF AIR CONDITIONING UNITS AND UNINTERRUPTIBLE POWER SOURCE
SOLICITATION NO. IFBC No. R068954OV

Work under the resulting Agreement cannot commence until all insurance coverages indicated herein have been obtained. The cost for insurance coverages is the sole responsibility of successful Proposer. The Successful Proposer shall obtain and submit to the Procurement Division within ten (10) calendar days from the date of notice of intent to award, proof the following minimum amounts of insurance on a standard ACORD form (inclusive of any amounts provided by an umbrella or excess policy):

STANDARD INSURANCES	REQUIRED LIMITS
1. ☒ **Automobile Liability Insurance:**	Coverage must be afforded under a per occurrence policy form including coverage for all owned, hired and non-owned vehicles for bodily injury and property damage of not less than: • $ 1,000,000 Combined Single Limit; OR • $ 500,000 Bodily Injury and $ 500,000 Property Damage • $10,000 Personal Injury Protection (No Fault) • $ 500,000 Hired, Non-Owned Liability • $10,000 Medical Payments *This policy shall contain severability of interests' provisions.*
2. ☒ **Commercial General Liability Insurance:** ***(Per Occurrence form only; claims-made form is not acceptable)***	Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $ 1,000,000 Single Limit Per Occurrence • $ 1,000,000 Aggregate • $ 1,000,000 Products/Completed Operations Aggregate • $ 1,000,000 Personal and Advertising Injury Liability • $ 50,000 Fire Damage Liability • $ 10,000 Medical Expense, and • $ 1,000,000, Third Party Property Damage • $ _____ Project Specific Aggregate (Required on projects valued at over $10,000,000) *This policy shall contain severability of interests' provisions.*
3. ☒ **Employer's Liability Insurance**	Coverage limits of not less than: • $100,000 Each Accident • $500,000 Disease Each Employee • $500,000 Disease Policy Limit
4. ☒ **Worker's Compensation Insurance**	Coverage limits of not less than: • Statutory workers' compensation coverage shall apply for all employees in compliance with the laws and statutes of the State of

☐ **US Longshoremen & Harbor Workers Act Coverage** ☐ **Jones Act Coverage**	Florida and the federal government. • If any operations are to be undertaken on or about navigable waters, coverage must be included for the US Longshoremen & Harbor Workers Act and Jones Act. Should 'leased employees' be retained for any part of the project or service, the employee leasing agency shall provide evidence of Workers' Compensation coverage and Employer's Liability coverage for all personnel on the worksite and in compliance with the above Workers' Compensation requirements. NOTE: Workers' Compensation coverage is a firm requirement. Elective exemptions are considered on a case-by-case basis and are approved in a very limited number of instances.
OTHER INSURANCES	**REQUIRED LIMITS**
5. ☐ **Aircraft Liability Insurance**	Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $ _____ Each Occurrence Property and Bodily Injury with no less than $100,000 per passenger each occurrence or a 'smooth' limit. • $ _____ General Aggregate
6. ☐ **Unmanned Aircraft Liability Insurance (Drone)**	Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $ _____ Each Occurrence Property and Bodily Injury; Coverage shall specifically include operation of Unmanned Aircraft Systems (UAS), including liability and property damage. • $ _____ General Aggregate
7. ☒ **Installation Floater Insurance**	When the contract or agreement **does not** include construction of, or additions to, above ground building or structures, but does involve the installation of machinery or equipment, Installation Floater Insurance shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • 100% of the completed value of such addition(s), building(s), or structure(s)
8. ☐ **Professional Liability and/or Errors and Omissions (E&O) Liability Insurances**	Coverage shall be afforded under either an occurrence policy form or a claims-made policy form. If the coverage form is on a claims-made basis, then coverage must be maintained for a minimum of three years from termination of date of the contract. Limits must not be less than: • $ _____ Bodily Injury and Property Damage Each Occurrence • $ _____ General Aggregate

9. ☐ **Builder's Risk Insurance**	When the contract or agreement includes the construction of roadways and/or the addition of a permanent structure or building, including the installation of machinery and/or equipment, Builder's Risk Insurance shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • An amount equal to 100% of the completed value of the project, or the value of the equipment to be installed • The policy shall not carry a self-insured retention/deductible greater than $10,000 Coverage shall be for all risks and include, but not be limited to, storage and transport of materials, equipment, supplies of any kind whatsoever to be used on or incidental to the project, theft coverage, and Waiver of Occupancy Clause Endorsement, where applicable.
10. ☐ **Cyber Liability Insurance**	Coverage shall comply with Florida Statute 501.171, shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $_____ Security Breach Liability • $_____ Security Breach Expense Each Occurrence • $_____ Security Breach Expense Aggregate • $_____ Replacement or Restoration of Electronic Data • $_____ Extortion Threats • $_____ Business Income and Extra Expense • $_____ Public Relations Expense NOTE: Policy must not carry a self-insured retention/deductible greater than $25,000.
11. ☐ **Hazardous Materials Insurance (As Noted)**	Hazardous materials include all materials and substances that are currently designated or defined as hazardous by the law or rules of regulation by the State of Florida or federal government. All coverage shall be afforded under either an occurrence policy form or a claims-made policy form, and the policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured. If the coverage form is on a claims-made basis, then coverage must be maintained for a minimum of three years from termination of date of the contract. Limits must not be less than: ☐ ***Pollution Liability*** • Amount equal to the value of the contract, subject to a $1,000,000 minimum, for Bodily Injury and Property Damage to include sudden and gradual release, each claim and aggregate.

	☐ ***Asbestos Liability (If handling within scope of Contract)*** • Amount equal to the value of the contract, subject to a $1,000,000 minimum, for Bodily Injury and Property Damage to include sudden and gradual release, each claim and aggregate. ☐ ***Disposal*** When applicable, Successful Proposer shall designate the disposal site and furnish a Certificate of Insurance from the disposal facility for Environmental Impairment Liability Insurance covering liability. • Amount equal to the value of the contract, subject to a $1,000,000 minimum, for Liability for Sudden and Accidental Occurrences, each claim and an aggregate. • Amount equal to the value of the contract, subject to a $1,000,000 minimum, for Liability for Non-Sudden and Accidental Occurrences, each claim and an aggregate.
12. ☐ Hazardous Waste Transportation Insurance	Successful Proposer shall designate the hauler and have the hauler furnish a Certificate of Insurance for Automobile Liability insurance with Endorsement MCS-90 for liability arising out of the transportation of hazardous materials. EPA identification number shall be provided. All coverage shall be afforded under either an occurrence policy form or a claims-made policy form and the policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured. If the coverage form is on a claims-made basis, then coverage must be maintained for a minimum of three years from termination of date of the contract. Limits must not be less than: • Amount equal to the value of the contract, subject to a $1,000,000 minimum, per accident.
13. ☐ Liquor Liability Insurance	Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $1,000,000 Each Occurrence and Aggregate

14. ☐ **Garage Keeper's Liability Insurance**	Coverage shall be required if the maintenance, servicing, cleaning or repairing of any County motor vehicles is inherent or implied within the provision of the contract. Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • Property and asset coverage in the full replacement value of the lot or garage.
15. ☐ **Bailee's Customer Liability Insurance**	Coverage shall be required for damage and/or destruction when County property is temporarily under the care or custody of a person or organization, including property that is on, or in transit to and from the person or organization's premises. Perils covered should include fire, lightning, theft, burglary, robbery, explosion, collision, flood, earthquake and damage or destruction during transportation by a carrier. Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • Property and asset coverage in the full replacement value of the County asset(s) in the Successful Proposer's care, custody and control.
16. ☐ **Hull and Watercraft Liability Insurance**	Coverage shall be afforded under a per occurrence policy form, policy shall be endorsed and name "Manatee County, a political subdivision of the State of Florida" as an Additional Insured, and include limits not less than: • $ _____ Each Occurrence • $ _____ General Aggregate • $ Fire Damage Liability • $10,000 Medical Expense, and • $ _____ Third Party Property Damage • $ _____ Project Specific Aggregate (Required on projects valued at over $10,000,000)
17. ☐ **Other (Please Specify)**	

BOND REQUIREMENTS	
18. ☒ Bid Bond	A Bid Bond in the amount of $_____ or ____% of the total offer. Bid bond shall be submitted with the sealed response and shall include project name, location, and / or address and project number. In lieu of the bond, the bidder may file an alternative form of security in the amount of $_____ or __5__% of the total offer. in the form of a money order, a certified check, a cashier's check, or an irrevocable letter of credit issued to Manatee County. NOTE: A construction project over $200,000 requires a Bid Bond in the amount of 5% of the total bid offer.
19. ☒ Payment and Performance Bond	A Payment and Performance Bond shall be submitted by Successful Bidder for 100% of the award amount and shall be presented to Manatee County within ten (10) calendar days of issuance of the notice of intent to award. NOTE: A construction project over $200,000 requires a Payment and Performance Bond.

Approved by Risk: Linda D. Klasing Date: 05/03/2018

INSURANCE REQUIREMENTS

I. **THE POLICIES BELOW ARE TO CONTAIN, OR BE ENDORSED TO CONTAIN, THE FOLLOWING PROVISIONS:**

1. Commercial General Liability and Automobile Liability Coverages

a. **"Manatee County, a Political Subdivision of the State of Florida," is to be named as an Additional Insured in respect to:** Liability arising out of activities performed by or on behalf of the Successful Proposer, his agents, representatives, and employees; products and completed operations of the Successful Proposer; or automobiles owned, leased, hired or borrowed by the Successful Proposer. The coverage shall contain no special limitation(s) on the scope of protection afforded to the County, its officials, employees or volunteers.

In addition to furnishing a Certificate of Insurance, the Successful Proposer shall provide the endorsement that evidences Manatee County being listed as an Additional Insured. This can be done in one of two ways: (1) an endorsement can be issued that specifically lists "Manatee County, a Political Subdivision of the State of Florida," as Additional Insured; or, (2) an endorsement can be issued that states that all Certificate Holders are Additional Insured with respect to the policy.

b. The Successful Proposer's insurance coverage shall be primary insurance with respect to the County, its officials, employees and volunteers. Any insurance or self-insurance maintained by the County, its officials, employees or volunteers shall be excess of Successful Proposer's insurance and shall be non-contributory.

c. The insurance policies must be on an occurrence form, unless specifically noted otherwise.

2. Workers' Compensation and Employers' Liability Coverages

The insurer shall agree to waive all rights of subrogation against the County, its officials, employees and volunteers for losses arising from work performed by the Successful Proposer for the County.

II. **GENERAL INSURANCE PROVISIONS APPLICABLE TO ALL POLICIES:**

1. Prior to the execution of contract, or issuance of a Purchase Order, and then annually upon the anniversary date(s) of the insurance policy's renewal date(s) for as long as this contract remains in effect, Successful Proposer shall furnish the County with a Certificate(s) of Insurance (using an industry accepted certificate form, signed by the Issuer, with applicable endorsements, and containing the solicitation or contract number, and title or description) evidencing the coverage set forth above and naming "Manatee County, a Political Subdivision of the State of Florida" as an Additional Insured on the applicable coverage(s) set forth above. In addition, when requested in writing from the County, Successful Proposer will provide the County with a certified copy of all applicable insurance policies. The address where such certificates and certified policies shall be sent or delivered is as follows unless otherwise provided:

Manatee County, a Political Subdivision of the State of Florida
Attn: Purchasing Division - Procurement

2. The project's solicitation number and title shall be listed on each Certificate of Insurance or policy.
3. If the policy contains an aggregate limit, confirmation is needed in writing (letter, email, etc.) that the aggregate limit has not been eroded to procurement representative when supplying Certificate of Insurance.
4. Successful Proposer shall provide thirty (30) days written notice of any cancellation, non-renewal, termination, material change, or reduction in coverage of any insurance policies to procurement representative including solicitation number and title with all notices.
5. Successful Proposer agrees that should at any time Successful Proposer fail to meet or maintain the required insurance coverage(s) as set forth herein, the County may terminate this contract.
6. The Successful Proposer waives all subrogation rights against Manatee County, a Political Subdivision of the State of Florida, for all losses or damages which occur during the contract and for any events occurring during the contract period, whether the suit is brought during the contract period or not.
7. The Successful Proposer has sole responsibility for all insurance premiums and policy deductibles.
8. It is the Successful Proposer's responsibility to ensure that his agents, representatives and subcontractors comply with the insurance requirements set forth herein. Successful Proposer shall include his agents, representatives, and subcontractors working on the project or at the worksite as insured under its policies, or Successful Proposer shall furnish separate certificates and endorsements for each agent, representative, and subcontractor working on the project or at the worksite. All coverages for agents, representatives, and subcontractors shall be subject to all the requirements set forth to the procurement representative.
9. All required insurance policies must be written with a carrier having a minimum A.M. Best rating of A- FSC VII or better. In addition, the County has the right to review the Successful Proposer's deductible or self-insured retention and to require that it be reduced or eliminated.

II. Successful Proposer understands and agrees that the stipulated limits of coverage listed herein in this insurance section shall not be construed as a limitation of any potential liability to the County, or to others, and the County's failure to request evidence of this insurance coverage shall not be construed as a waiver of Successful Proposer's obligation to provide and maintain the insurance coverage specified.

III. Successful Proposer understands and agrees that the County does not waive its immunity and nothing herein shall be interpreted as a waiver of the County's rights, including the limitation of waiver of immunity, as set forth in Florida Statutes 768.28, or any other statutes, and the County expressly reserves these rights to the full extent allowed by law.

IV. The enclosed Hold Harmless Agreement shall be signed by the Successful Proposer and shall become a part of the contract.

V. No award shall be made until the Procurement Division has received the Certificate of Insurance and Hold Harmless Agreement in accordance with this section.

INSURANCE STATEMENT

THE UNDERSIGNED has read and understands the insurance requirements applicable to any contract resulting from this solicitation and shall provide the insurances required by this Attachment within ten (10) days from the date of Notice of Intent to Award.

Proposer Name: _____ Date: _____

Signature (Authorized Official): _____

Printed Name/Title: _____

Insurance Agency: _____

Agent Name: _____ Agent Phone: _____

Return this signed statement with your bid or proposal.

Bid Attachment 2

TECHNICAL SPECIFICATIONS

DIVISION 01—GENERAL REQUIREMENTS

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SECTION 01 20 00

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SCOPE

A. The scope of this section of the Contract Specifications is to further define the items included in each Bid Item in the Bid Form section of the Contract Documents. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the Bid Form section will be full compensation for all required work, identified or not, required, including but not limited to shop drawings, working drawings, labor, materials, tools, equipment, incidentals and mobilization necessary to complete the requirements of this project, as shown on the Drawings and/or as specified in the Contract Specifications to be performed under this Contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction in the manner set up for each item in this section of the Specifications. Payment for all items listed in the Bid Form will constitute full compensation for all work required to render a complete product, specified to be performed under this Contract.

1.2 EXPLANATION AND DEFINITIONS

A. The following explanation of the Measurement and Payment for the Bid Schedule items is made for information and guidance. The omission of reference to any item in this description shall not, however, alter the intent of the Bid Schedule or relieve the CONTRACTOR of the necessity of furnishing such as a part of the Contract. Measurement and payment for all Bid Items shall be in accordance with this section.

1.3 MEASUREMENT

A. The quantities set forth in the Bid Form are approximate and are given to establish a uniform basis for the comparison of bids. The COUNTY reserves the right to increase or decrease the quantity of any class or portion of the work during the progress of construction in accord with the terms of the Contract.

1.4 PAYMENT

A. Make payment for the items listed on the Bid Form on the basis of the work actually performed and completed, such work including but not limited to, the furnishing of all necessary labor, materials, equipment, transportation, clean up, restoration of disturbed areas, and all other appurtenances to complete the construction and installation of the work as shown on the drawings and described in the specifications.

B. Unit prices are used as a means of computing the final figures for bid and contract purposes, for periodic payments for work performed, for determining value of additions or deletions and wherever else reasonable.

C. Lump sum items

1. Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum items. Lump sum contracts shall be complete, tested and fully operable prior to request for final payment. Contractor shall be required to provide a break-down of the lump sum totals in their schedule of values.

D. Unit price items

1. Separate payment will be made for the items of work described herein and listed on the Bid Form as a unit price item. Any related work not specifically listed, but required for satisfactory completion of the work shall be considered to be included in the scope of the appropriate listed work items.

2. No separate payment will be made for the following items and the cost of such work shall be included in the applicable pay items of work. Final payments shall not be requested by the Contractor or made by the County until as-built (record) drawings have been submitted and approved by the County.

a. Shop Drawings, Working Drawings

b. Cleanup and miscellaneous work

c. Testing and placing systems in operation

d. Any material and equipment required to be installed and utilized for the tests

e. Maintaining the existing quality of service during construction

f. Maintaining or detouring of traffic

g. Appurtenant work as required for a complete and operable system

h. As-built record drawings

1.5 SCHEDULE OF VALUES

A. Approval of Schedule: Submit for approval a schedule of values, in duplicate, for all of the Work. Prepare schedule of values as based on the County provided schedule of values, and submit within 10 calendar days after the Effective Date of the Agreement. Submit final schedule of values in accordance with the Terms and Conditions of the Agreement.

B. Format: Utilize a format similar to the Table of Contents of the Project Specifications. Identify each line item with number and title of the major specification items. Identify site mobilization, bonds and insurance. Include within each line item, a direct proportional amount of Contractor's overhead profit.

C. Contractor to use County provided pay application form only for payment submission. All other forms shall be rejected.

D. Revisions: With each application for Payment, revise schedule to list approved Change Orders.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 MEASUREMENT AND PAYMENT (BID FORM ITEMS)

A. Make payment on the basis of work actually performed completing each item in the Bid, such work including, but not limited to, the furnishing of all necessary labor, materials, equipment, transportation, cleanup, and all other appurtenances to complete the construction and installation of the work to the configuration and extent as shown on the drawings and described in the specifications. Payment for each item includes compensation for cleanup and restorations. Cost of cleanup and surface restorations will be considered as the percentage retained in accordance with the Contract Documents, and complete payment will not be made until cleanup, restorations and as-builts are completed.

1. 1.01 Mobilization: Measurement and payment for the Mobilization Bid Item shall include full compensation for the required 100 percent (100%) Performance Bond, 100 Percent (100%) Payment Bond, all required insurance for the project, and any permits not already obtained by the County. This may include those operations necessary for the movement of personnel, equipment, supplies, and incidentals to the project site and for the establishment of temporary offices, safety equipment and first aid supplies, and sanitary and other facilities/utilities. The mobilization pay item also includes demobilization of all equipment, personnel, supplies and incidentals from the project site upon final completion. Payment for mobilization shall not exceed 10 percent (10%) of the total Contract cost unless the Contractor can prove to the County that his actual mobilization cost exceeds 10 percent (10%). The basis of payment for all work associated with Mobilization shall be paid for under the Lump Sum Pay Item and in accordance with the following schedule:

Percent of the Total Contract Amount Earned	Allowable Percent of the Lump Sum Price for Mobilization
5	25
10	50
25	75
100	100

2. 1.02 Limited Demolition (Electrical, Mechanical and Fire Related): Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, the removal of specified Electrical, Mechanical, and Fire Related items in and around the site. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included in Sheets A3.0, FP2.0, FX2.0. **Note – Contractor shall be responsible for coordinating demolition with Manatee County Property Management**.

3. 23.01 HVAC - CRAC Units and Condensers: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install the CRAC units and condensers as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum bid for the work required. All work covered for this Item is included on the Mechanical and Electrical Sheets. Contractor to provide a separate schedule of values for the individual components of this system along with their payment requests. Before final payment is completed the CRAC units and condensers shall be inspected and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

4. 23.02 HVAC - Controls: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install all HVAC controls as shown on the plans and as required by the existing building automation system. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum bid for the work required. All work covered for this Item is included on the Mechanical and Electrical Sheets. Contractor to provide a separate schedule of values for the individual components of this system along with their payment requests. Before final payment is completed the HVAC controls shall be inspected and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

5. 23.03 HVAC – Test and Balance: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Contractor shall test and balance the new HVAC system. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum bid for the work required. All work covered for this Item is included on the Mechanical and Electrical Sheets. Before final payment is completed the test and balance report shall be reviewed and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

6. 23.04 HVAC - Miscellaneous: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install all miscellaneous mechanical and plumbing items required to support the installation of the new CRAC units as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included on the Mechanical Sheets. Before final payment is completed, the miscellaneous components shall be inspected and accepted by the Architect and Manatee County Property Management.

7. 23.05 HVAC – Temporary AC: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install all temporary AC mechanical items required to support the air conditioning of the existing data center for a not to exceed period of 3 Days. Temporary AC capacity shall be a minimum of 20 tons. Payment for all work included under this Bid Item shall represent full compensation in accordance with the unit price bid per day for the work required. All work covered for this Item is included on the Mechanical Sheets. Before final payment is completed, the temporary AC components shall be inspected and accepted by the Architect and Manatee County Property Management.

8. 26.01 Electrical - Wiring: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install the electrical wiring, pathways, and conduits as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included on the Electrical Sheets. Contractor to provide a separate schedule of values for the individual components of this system along with their payment requests. Before final payment is completed the electrical wiring, pathways and conduits shall be inspected and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

9. 26.02 Electrical - UPS: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install the UPS equipment and related components as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included on the Electrical Sheets. Contractor to provide a separate schedule of values for the individual components of this system along with their payment requests. Before final payment is completed the UPS equipment and related components shall be inspected and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

10. 26.03 Electrical – PDU Gear: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install the PDU gear and related components as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included on the Electrical Sheets. Contractor to provide a separate schedule of values for the individual components of this system along with their payment requests. Before final payment is completed the PDU gear and related components shall be inspected and accepted by the Architect, Manatee County Property Management and the City of Bradenton.

11. 26.04 Electrical – Electrical Miscellaneous: Measurement and payment for this Bid Item shall include full compensation for all required work included to complete this portion of this project, rendering a complete and operable system. Provide and install all miscellaneous electrical items required to support the installation of new electrical equipment as shown on the plans. Payment for all work included under this Bid Item shall represent full compensation in accordance with the lump sum price bid for the work required. All work covered for this Item is included on the Electrical Sheets. Contractor to provide a separate schedule of values for the miscellaneous components of this system along with their payment requests. Before final payment is completed the miscellaneous equipment shall be inspected and accepted by the Architect, Manatee County Property Management, the City of Bradenton, and the City of Bradenton Fire Marshall.

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SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

This Section includes the following:

A. Basic plumbing requirements specifically applicable to Division 22 Sections, in addition to Division 1—General Requirements, General Conditions and Supplementary General Conditions.

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. The term “Basis of Design” used throughout this document shall be understood to mean a particular manufacturer’s equipment (as scheduled specifically on the drawings or specifications) has been used as the basis by the Design Engineer to establish physical dimensions, quality, and performance required, in addition to providing a basis for interaction with other ancillary components and/or other trades. Therefore, it shall be understood that use of a piece of equipment other than that identified as the Basis of Design may impact performance of an overall engineered system or may require revisions to ancillary interfacing equipment, and thus any manufacturer’s equipment other than that listed as Basis of Design shall require written approval via Addendum prior to bid except where the manufacturer’s name is specifically listed in these specifications as a pre-approved substitute or an accepted manufacturer. All substitutes, pre-approved substitutes, accepted manufacturers, and/or Basis of Design are subject to all requirements of quality, physical characteristics (i.e., dimension, sound, etc), and performance, etc., as set forth in these specifications and contract documents.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents. (See Paragraph 1.06, B.)

D. Samples, drawings, specifications, and catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

F. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

G. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

H. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

I. Submit all Division 22 submittals at one time in one integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

J. Routing and methods of support of piping shall be shown on shop drawings and shall have the review of the Engineer prior to fabrication and installation. Spacing of supports shall be as specified in Section 22 05 29, or if not specified, shall not exceed the suggested maximum spacing recommended in ANSI B31.1 for each type of line. Supports shall be fabricated as detailed on reviewed shop drawings. Provide supports so located that temporary supports are not required during removal of valves or equipment. Insofar as possible, support lines directly from Building structure.

K. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance:

1. Equipment warranties;

2. Contractor's warranty;

3. Parts list and manuals for all equipment;

4. Balance and test readings;

5. Operating instructions (in writing);

6. Written instructions on maintenance and care of the system.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.

2. Dielectric fittings.

3. Mechanical sleeve seals.

4. Escutcheons.

B. Welding certificates.

C. Submit Manufacturer's published technical data, catalog cuts, wiring diagrams, shop drawings, samples and testing and balancing logs for all elements of the plumbing work. Submit under provisions of General Conditions and Supplementary General Conditions.

D. No equipment, piping, ductwork or components shall be fabricated, delivered, erected, or connected other than from shop drawings reviewed and approved by the Engineer.

E. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

F. Equipment Supports: Submit detailed shop drawings indicating equipment weight and dimensions, support material, connections, anchoring, and vibration isolation.

G. Submittals shall include, but not be limited to the following:

1. All equipment; water heaters, plumbing, pumps, etc.

2. Voltage, phase, and amps of each electrical item, such as motors, etc.

3. All auxiliary equipment.

4. Pipe, valves, insulation, etc.

1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

3. Welded pipe joints shall be made by the oxyacetylene or electric process in accordance with the Code of Pressure Piping ASA B31.1.

4. Welding shall be done with good quality modern welding equipment, by competent operators, and in thorough, first class manner, conforming to AWS Standards.

5. The Contractor shall be required to furnish proof of the competency of each welding operator for both field and shop welds and shall at the request of the Architect/Engineer have all or any of such welding operators pass a standard qualification test such as ASME, AWS, or Hartford Insurance Company procedure and tests.

6. Filler-metal for the welding process shall conform to ASTM A233 "Specification for Mild Steel Arc-Welding Electrodes". Classification of electrodes shall be one of the following: E6010, E6015, E7016, E7018.

7. When welding is to be performed, precautionary measures must be taken to prevent fire. Remove flammable materials and debris from the area. Provide an appropriate extinguisher nearby.

8. Pipes shall be cut short and cold sprung into place before welding or fabricating to compensate for expansion of lines when hot.

9. Welds shall be of the single vee butt type. Pipe end shall be shop beveled to 45 degrees to within 1/16 inch of the inside wall surface.

10. The abutting ends of the joints shall be separated before welding to permit complete fusion, tacked in two or more points to maintain alignment, and welded. Welding shall be continuous around the pipe.

11. Welds shall be of sound weld metal, thoroughly fused into the ends of the pipe and to the bottom of the vee, and shall be built up in excess of the pipe wall to give a reinforcement of one-quarter (1/4) the pipe wall thickness and in such a manner that one weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be 2-1/2 times the pipe wall thickness.

12. The fillet welds from the flanges of fittings shall be fused into the pipe and plate for minimum distance of 1-1/2 times the pipe wall thickness and shall be built up to present a minimum throat thickness of depth of weld of 1-1/4 times the pipe wall thickness.

13. Branch connections shall be fabricated by welding. Openings cut into pipe for welded connections shall be accurately made to give carefully matched intersections and welding fittings shall be carefully welded into the pipe system.

14. Welding ells shall be used at all turns in welded pipe lines; no mitered ells will be approved.

15. Where branch piping is three times smaller than the main, branch connections shall be made up with the appropriate manufactured weld-on fitting. Welded tees shall be used for all other branch connections, unless otherwise approved by the Architect/Engineer for a specific case.

    a. Approved Manufacturers

        1) Allied Piping Products.

        2) Bonney Forge.

        3) Branch Connections.

        4) Branchlets.

        5) Tube Turn.

        6) Thread-O-Lets.

16. Welds in piping shall be annealed after welding to remove the welding strains. The temperature need not exceed that causing a dull red, and shall be uniform around the pipe. Welds made in place shall be annealed, but the pipe shall be free to expand and shall be properly supported so as to avoid stresses. Annealing shall always be followed by slow cooling.

D. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.8 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Mechanical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed below equipment indicated as “Basis of Design” shall be considered as substitutes. Manufacturers other than the Basis of Design shall submit catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute. The comparative shall list capacities, pressure drops, horse power, electrical requirements, etc.

Request for approval of substitutions shall be made in writing no less than ten (10) days (unless otherwise directed in Division 1) prior to bid. Substitutions shall not be considered approved unless the approval appears in an Addendum or unless so named in the specifications as a pre-approved substitute. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.06, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution. Differences shall include, but shall not be limited to, data as follows for both the specified and substituted products.

1. Principle of operation;

2. Materials of construction or finishes;

3. Thickness or gauge of materials;

4. Weight of item;

5. Deleted features or items;

6. Added features or items;

7. Changes in other Contractor's work caused by the substitution;

8. Physical dimensions;

9. Electrical requirements.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the plumbing or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.10 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

D. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

E. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

F. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.11 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Re-builts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.12 SCAFFOLDING, RIGGING, AND HOISTING

A. Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.13 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

B. All plaster, concrete, cement, etc. shall be removed from all pipe, hangers, and equipment prior to painting and/or concealment.

1.14 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.15 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.16 LUBRICATION

A. Where necessary, provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a lubrication tube with suitable fitting to an accessible location and suitably identify it.

B. After installation, properly lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.

1.17 VALVE CHARTS, TAGS, AND NAMEPLATES

A. Provide at a location designated by the Engineer and the Owner, a valve chart enclosed in an aluminum frame with clear plastic shield. Chart shall show the designated number of each valve, its location and service. Valve numbers shall be same as those shown on the "As-Built" drawings.

B. Each valve shown on the chart shall have a 1-1/2" diameter, 18 gauge brass tag with clearly visible stamped numbers, securely fastened to the valve stem or handle with a heavy brass hook or chain.

C. Each panel mounted switch, thermometer, gauge, or controller for fans, pumps, or other electrically operated equipment shall be clearly designated by a black plastic nameplate of size approved by the Engineer securely fastened with metal pins or screws to the panel directly under the item designated.

D. Refer to Section 22 05 53 for additional information.

1.18 WIRING DIAGRAMS

A. Furnish for use under Division 16 all wiring diagrams as may be required for the installation of the wiring to insure proper operation and control of the equipment provided under this Division. Provide the diagrams in time to avoid delays.

1.19 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.20 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner. Vibration control shall be by means of approved vibration eliminators in a manner as specified in Section 23 05 48.

1.21 ACCESSIBILITY

A. This Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with all other Contractors whose work is in the same space, and shall advise them of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

B. This Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to, valves, traps, clean-outs, motors, controllers, switchgear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

C. This Contractor shall provide the access panels for concealed mechanical equipment, valves, controls, dampers, or other device requiring service. (Refer to Paragraph 1.24 of this section.)

1.22 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for mechanical equipment shall be a minimum of 12" larger than equipment all around.

1.23 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

1) ASA .....American Standards Association.

2) ASTM.....American Society for Testing Materials.

3) ASME .....American Society of Mechanical Engineers Code of Unfired Pressure Vessels.

4) NEMA .....National Electrical Manufacturers Association.

5) UL .....Underwriters Laboratories.

6) ANSI .....American National Standards Institute.

7) ASHRAE.....American Society of Heating, Refrigerating and Air Conditioning Engineers.

8) SMACNA .....Sheet Metal and Air Conditioning Contractor's National Association.

9) AMCA .....Air Moving and Conditioning Association.

10) ARI.....Air Conditioning and Refrigeration Institute.

11) AMA.....Acoustical Materials Association.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes And Rules

a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

1) National Electric Code.

2) Regulations of the Florida Industrial Commission Concerning Safety.

3) Applicable County, State and Local Building Codes.

4) Local and State Fire Marshal Rules and Regulations.

5) Occupational Safety and Health Agency Standards (OSHA).

6) Florida State Board of Health Rules and Regulations.

7) Florida Building Code—Mechanical.

8) Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.

Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees And Inspections

a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.24 SCOPE OF WORK

A. The scope of the work included under this Division of the Specifications shall include complete plumbing systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, plant, and any and all other items necessary to complete the plumbing systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

B. Systems shall include all appurtenances as required to achieve the operating conditions as shown and specified and shall result in a superior installation.

C. Scope of work shall include, but not be limited to, the following:

1. New Work

a. Modify existing domestic cold water system as shown on drawings.

b. Final connections of piping to HVAC equipment.

1.25 REMOVALS, RELOCATIONS, RECONNECTIONS, AND RESTORATIONS

A. Demolition of existing piping, equipment, etc., shall be done as indicated on the Drawings. Existing piping and/or equipment to be removed shall be offered to the Owner. If the Owner wishes to utilize the existing equipment elsewhere, this Contractor shall move the equipment to a site designated by the Owner. All material to be removed shall be discarded by the Contractor and they shall not be used again.

B. All demolition work shall be completely coordinated with the Owner. Demolition and reconnections requiring shut-down of existing systems shall be scheduled with the Owner/Engineer. If shut-down can only be accommodated on the weekend, or after normal working hours, such work shall be done at no additional cost to the Owner. If it is not possible to schedule sufficient Owner coordinated and approved downtime to complete the entire demolition and reconnection scope such that all or a part of the facility's service(s) will be disrupted, affecting the normal business operation of the facility (i.e., loss of plumbing), the Contractor shall provide temporary accommodations (i.e., temporary portable toilets, etc), for the duration of the shutdown at no additional cost to the Owner.

C. Location, capacity, size, etc. of existing equipment, piping, etc., was obtained from field survey and as built drawings. Verify all conditions at site prior to commencing with work. Notify Engineer of any discrepancies prior to starting work or ordering material.

D. Survey existing facilities and utilities as necessary to determine location of shut-off or disconnect devices, drains, vents, etc. Drain, refill, and purge existing water piping circuits to make new piping connections. It is the Contractor's responsibility to verify the existing piping and identify which is supply and return, chilled water, and hot water, prior to starting demolition for new piping connections.

E. Temporarily store all items to be relocated, if required. Contractor shall be responsible for safe storage of all such items and shall replace any items lost or damaged during storage removal or reinstallation.

1.26 PROJECT/SITE CONDITION

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Owner/Engineer before proceeding.

1.27 CLOSE-OUT DOCUMENTS

A. This Contractor shall furnish Operating and Maintenance (O&M) manuals and As-built drawings before final payment will be issued.

1. O&M manuals shall be submitted in accordance with Division 1, General Requirements, and shall consist of the following (at a minimum):

a. All Contractor and Manufacturer warranties.

b. List of Contractors and Parts and Equipment Suppliers—complete with contact person, proper company name, address, and telephone numbers.

c. Parts list for supplied equipment—including a checklist of recommended components to be stocked on-site.

d. Maintenance and replacement parts manuals.

e. Start-up and shutdown operating instructions.

f. Manufacturer's literature describing the equipment, which shall include wiring diagrams and operating specifications.

g. Control system sequence of operation, system diagram, and backup disks of the system configuration.

h. Copies of final test and balance reports.

2. The Contractor shall provide AutoCAD as-built drawings and copies of each AutoCAD file on CD before final payment will be issued.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Dresser Industries, Inc.; DMD Div.

c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.

d. JCM Industries.

e. Smith-Blair, Inc.

f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Available Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company.

d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Available Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Hart Industries, International, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS—COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.

f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.

g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION—COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

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DIVISION 23—MECHANICAL

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SECTION 23 81 23

COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. These specifications describe requirements for a computer room air conditioning (CRAC) system. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment.

1.2 DESIGN REQUIREMENTS

A. The CRAC system shall be a Liebert self-contained, factory-assembled unit with downflow air delivery. The unit shall be supplied with 460 volt 3 ph 60 Hz electrical service. The system cooling capacity shall be factory-certified per ASHRAE127-2007.

1.3 SUBMITTALS

A. Submittals shall be provided after the agreement of the proposal and shall include: Single-Line Diagrams; Dimensional, Electrical and Capacity Data; Piping and Electrical Connection Drawings.

PART 2 PRODUCTS

2.1 FRAME

A. The frame shall be MIG welded, formed sheet metal. It shall be protected against corrosion using the autophoretic coating process. The frame shall be capable of being separated into three parts in the field to accommodate rigging through small spaces.

1. Downflow Air Supply: The supply air shall exit from the bottom front face of the unit.

2. Air Return: The return air shall enter the unit from the top.

3. Exterior Panels: The exterior panels shall be insulated with a minimum 1 in. (25mm), 1.5 lb. (0.68 kg) density fiber insulation. The main front panel shall have captive 1/4 turn fasteners. The main unit color shall be ZP-7021 black.

2.2 FILTERS

A. The filter chamber shall be located within the cabinet, and filters shall be removable from the top of the unit. Filters shall be arranged in a V-bank configuration to minimize air pressure drop.

1. Filters, 4" MERV8: Filters shall be deep pleated 4" filters with an ASHRAE 52.2 MERV8 rating

2. Extra Filter Set: 2 extra sets of filters shall be provided per system.

2.3 FAN SECTION

A. Electronically Commutated (EC) Fan:

The fans shall be plug/plenum type, single inlet and shall be dynamically balanced. The drive package shall be direct drive, electronically commutated and variable speed. The fans shall be located to draw air over the A-frame coil to ensure even air distribution and maximum coil performance. EC fans may operate within the Liebert DS cabinet, instead of under the floor.

EC fans shall be available on upflow models and fans shall operate outside the unit in a factory-provided plenum with a minimum height of 24" (610mm).

2.4 HUMIDIFIER

A. A humidifier shall be factory-installed inside the unit. Bypass air slots shall be included to enable moisture to be absorbed into the air stream. The humidifier capacity shall be 22 lbs./hr. The humidifier shall be removable from the front of the cabinet.

1. Infrared Humidifier: The humidifier shall be of the infrared type, consisting of high-intensity quartz lamps mounted above and out of the water supply. The humidifier pan shall be stainless steel and arranged to be removable without disconnecting high-voltage electrical connections. The complete humidifier section shall be pre-piped, ready for field connection to the water supply. The humidifier shall be equipped with an automatic water supply system and shall have an adjustable water-overfeed to prevent mineral precipitation. A high-water detector shall shut down the humidifier to prevent overflowing. A factory-provided air-gap shall prevent backflow of the humidifier supply water.

2.5 REHEAT

A. The environmental control unit shall include a factory-installed reheat to control temperature during dehumidification.

1. Three-Stage Electric Reheat: The electric reheat coils shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches, shall be 25 kW controlled in three stages. The reheat elements shall be removable from the front of the cabinet.

2.6 COOLING SYSTEM

A. The DX CRAC unit shall include two (2) independent refrigeration circuits and shall include hot gas mufflers (semi-hermetic compressors units only), liquid line filter dryers, refrigerant sight glass with moisture indicator, externally equalized expansion valves and liquid line solenoid valves. Compressors shall be located outside the airstream and shall be removable and serviceable from the front of the unit.

1 Digital Scroll Compressors: The compressor shall be scroll-type with a variable capacity operation capability. The compressor solenoid valve shall unload the compressor and allow for variable capacity operation. The compressor shall be suction gas cooled motor, vibration isolators, thermal overloads, automatic reset high-pressure switch with lockout after three failures, rotalock service valves, pump down low pressure transducer, suction line strainer and a maximum operating speed of 3500 rpm. Consult factory for 575V availability.

a. Crankcase Heaters: Compressors shall include crankcase heaters, powered from the indoor unit electric panel.

b. R-407C Refrigerant: The system shall be designed for use with R-407C refrigerant, which meets the EPA clean air act for phase-out of HCFC refrigerants.

2. Evaporator Coil: The evaporator coil shall be A-frame design with offset orientation and have 24.7 sq. ft. face area, three rows deep. It shall be constructed of rifled copper tubes and aluminum fins and shall have a maximum face velocity of 319.8 ft. per minute at 8,000 CFM. A stainless steel condensate drain pan shall be provided.

3 Chilled Water Coil: The CHW CRAC shall have a chilled water coil (Liebert Econ-O-Coil™), a modulating control valve and a comparative temperature sensor.

4. Chilled Water Control Valve: The water circuit shall include a 2-way modulating valve. The microprocessor positions the valve in response to room conditions. Cooling capacity will be controlled by modulating CHW flow through the coil. The modulating valve travel for dehumidification shall be proportional.

2.7 AIR-COOLED SYSTEMS

A. The indoor evaporator unit shall include refrigerant piping, with a factory holding charge of nitrogen. The hot-gas and liquid lines shall be spun shut and shall include a factory-installed Schrader valve. Field relief of the Schrader valve shall indicate a leak-free system.

B. Air-Cooled Condenser - the Liebert manufactured outdoor air-cooled condenser shall be the low profile, multiple direct drive, propeller fan type. The condenser shall balance the heat rejection of the compressor at 95 °F ambient. The condenser shall be constructed of aluminum and contain a copper tube, aluminum fin coil arranged for (horizontal) (vertical) air discharge.

C. Fan Speed Control - the winter control system for the air-cooled condenser shall be Liebert Fan Speed Control. The variable speed motor shall operate from 0 to 230 volts single phase, 10 to 1050 RPM. It shall be designed with ball bearings, permanent lubrication, internal overload protection, 40°C rise at full speed, 65°C rise at 10 RPM. The control system shall be complete with transducers, thermostats and electrical control circuit, factory prepackaged in the integral condenser control box. The transducer shall automatically sense the highest head pressure of either operating compressor and control the variable speed fan on the air-cooled condenser to properly maintain the head pressure. The fan speed control system shall provide positive startup and operation in ambient temperature as low as -20°F (-28.9°C). The air-cooled condenser shall have a 460 volt, 3 ph 60 Hz power supply.

2.8 LIEBERT ICOM® MICROPROCESSOR CONTROL WITH 9-INCH COLOR TOUCHSCREEN

A. The Liebert iCOM shall be microprocessor-based with a 9" color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the front panel is open or closed. The controls shall be menu-driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode.

1. Password Protection - The Liebert iCOM shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature shall allow the user to see applicable information based on the login used.

2. Unit Backup and Restore - The user shall be able to create safe copies of important control parameters. The Liebert iCOM shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.

3. Download - The Liebert iCOM shall enable the user to download a report that lists parameter names, factory default settings and user programmed settings in .csv format for remote reference.

4. Parameter Search - The Liebert iCOM shall have search fields for efficient navigation and parameter lookup.

5. Setup Wizards - The Liebert iCOM shall contain step-by-step tutorials or wizards to provide easy setup of the control.

6. Context-Sensitive Help - The Liebert iCOM shall have an onboard help database. The database shall provide context-sensitive help to assist with setup and navigation of the menus.

7. Display Setup - The user shall be able to configure the display information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, backlight timer and the hide/show of certain readouts shall be configurable through the display.

8. Additional Readouts - The display shall enable the user to configure custom widgets on the main screen. Widget options will include items such as fan speed, call for cooling, call for free-cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling capacity.

9. Status LED's - The Liebert iCOM shall show the unit's operating status using an integral LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.

10. Event Log - The Liebert iCOM shall automatically store the last 400 unit-only events (messages, warnings, and alarms).

11. Service Contact Information - The Liebert iCOM shall be able to store the local service or sales contact information.

12. Upgradeable - Liebert iCOM upgrades shall be performed through a USB connection.

13. Timers/Sleep Mode – The menus shall allow various customer settings for turning the unit On or Off.

14. Menu Layout - The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be designed for service personnel and shall provide access to advanced control setup features and diagnostic information.

15. Calibration - The menus shall allow unit sensors to be calibrated with external sensors.

16. Maintenance/Wellness Settings - The menus shall allow reporting of potential component problems before they occur.

17. Options Setup - The menus shall provide operation settings for the installed components.

18. Auxiliary Boards - The menus shall allow setup of optional expansion boards.

19. Various Sensors: The menus shall allow setup and display of optional custom sensors. The control shall include four customer accessible analog inputs for field-supplied sensors. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.

20. Diagnostics/Service Mode - The Liebert iCOM control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.

2.9 ALARMS

A. All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customers Building Management System/Building Automation System. The Liebert iCOM control shall activate an audible and visual alarm in event of any of the following conditions:

1. High Temperature
2. Low Temperature
3. High Humidity
4. Low Humidity
5. EC Fan Fault
6. Change Filters
7. Loss of Air Flow
8. Loss of Power
9. Compressor Overload (Optional)
10. Humidifier Problem
11. High Head Pressure
12. Low Suction Pressure
13. Custom Alarms

B. Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels. Frequently used alarm inputs include:

1. Leak Under Floor
2. Smoke Detected
3. Standby Unit On

C. Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.

2.10 LIEBERT ICOM® CONTROL METHODS AND OPTIONS

A. The Liebert iCOM shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity based control sensors installed. Proportional and Tunable PID shall also be user-selectable options.

1. Controlling Sensor Options: Liebert iCOM shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:

a. Cooling Capacity

(1) Supply (1 sensor per CRAC unit)

(2) Remote (5 sensors per CRAC unit located in rack aisle directly in front of each CRAC unit)

(3) Return (1 sensor per CRAC unit)

b. Fan Speed

(1) Supply

(2) Remote

(3) Return

(4) Manual (for diagnostic or to receive a signal from the BMS through the Liebert remote monitoring devices or analog input)

(5) Static Pressure

2. Temperature Compensation: The Liebert iCOM shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating to highest efficiency.

3. Humidity Control: Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.

2.11 STANDBY LEAD-LAG

A. The Liebert iCOM® shall allow scheduled rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units. A vNSA-8 iCom wall mounted controller that requires 120V power is required.

2.12 STANDBY UNIT CASCADING

A. The Liebert iCOM cascade option shall allow the units to turn On and Off based on heat load when utilizing Optimized Aisle, Teamwork Mode 3 and remote temperature sensors. Cascade mode dynamically coordinates the fan speed to save energy and to meet the cooling demands. For instance, with a Liebert iCOM group of six units and only 50% of the heat load, the Liebert iCOM shall operate only four units at 80% fan speed and leave the other two units in standby. As the heat load increases, the Liebert iCOM shall automatically respond to the additional load and bring on another unit, increasing the units in operation to five. As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them into standby.

2.13 WIRED SUPPLY SENSOR

A. Each Liebert iCOM shall have factory-supplied and connected supply air sensors that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

2.14 VIRTUAL MASTER

A. As part of the robust architecture of the Liebert iCOM control, it shall allow for a virtual master that coordinates operation. The Virtual Master function shall provide smooth control operation if the group's communication is compromised. When the lead unit, which is in charge of component staging in teamwork, unit staging and standby rotation, becomes disconnected from the network, the Liebert iCOM shall automatically assign a virtual master. The virtual master shall assume the same responsibilities as the master until communication is restored.

2.15 VIRTUAL BACK-DRAFT DAMPER

A. The Liebert iCOM shall allow the use of a virtual back-draft damper, eliminating the need for a mechanical damper. This shall allow the fans to spin slower (15% or less) to act as a damper.

2.16 COMPRESSOR SHORT CYCLE CONTROL

A. To help maximize the life of the compressor(s), there shall be start-to-next start delay for each single compressor. The control shall monitor the number of compressor starts in an hour. If the compressor starts more than 10 times in 60 minutes, the local display and remote monitoring shall notify the user through a Compressor 1 or 2 Short Cycle event.

2.17 LIEBERT MC™

A. Units may be matched to a premium efficiency condenser control with enhanced monitoring, alarming and diagnostics. The condenser control shall have an automated, low-noise mode and fan reversal for cleaning mode.

2.18 SYSTEM AUTO RESTART

A. The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. An optional capacitive buffer may be provided for continuous control operation through a power failure.

2.19 SEQUENTIAL LOAD ACTIVATION

A. On initial startup or restart after power failure, each operational load shall be sequenced with a minimum delay of one second to minimize total inrush current.

2.20 LOW-PRESSURE MONITORING

A. Units shall ship standard with low-pressure transducers for monitoring individual compressor suction pressure. If the pressure falls due to loss of charge or other mechanical cause, the corresponding circuit shall shut down to prevent equipment damage. The user shall be notified of the low-pressure condition through the local display and remote monitoring.

2.21 ADVANCED FREEZE PROTECTION

A. Units shall ship standard with advanced freeze protection enabled. The advanced freeze protection shall monitor the pressure of each circuit using a transducer. The control shall interact with the fan and compressor to prevent the unit coil from freezing if circuit suction pressure drops. If a freeze condition is detected, the user shall be notified through the local display and remote monitoring systems.

2.22 ADVANCED HIGH-PRESSURE PROTECTION—WATER/GLYCOL-COOLED MODELS WITH DIGITAL SCROLL COMPRESSORS

A. When the compressor is initially activated, the system shall be monitored for high pressure. When high pressure is detected, the control shall alter the compressor operation to reduce the system discharge pressure, preventing circuit shut down. If the unit is unsuccessful in correcting the problem through this interaction, an alarm shall occur and the affected compressor shall be immediately locked off. The control shall re-enable the compressor when the pressure returns to a safe level.

2.23 REFRIGERANT PRESSURE TRANSDUCER FAILURE

A. The control shall monitor the high-side and low-side refrigerant pressure transducers. If the control senses the transducer has failed, has been disconnected, has shorted or the reading has gone out of range, the user shall be notified through an event on the local display and remote monitoring. The corresponding circuit that the failure has occurred on shall be disabled to prevent unit damage.

2.24 OIL RETURN PROTECTION

A. The control shall monitor compressor operation and staging to ensure that liquid and hot gas velocity are maintained for proper oil return to the compressor.

2.25 DIGITAL SCROLL HIGH-TEMPERATURE PROTECTION

A, The control shall monitor digital scroll temperature during unit operation. A compressor temperature limit shall be imposed to help prevent damage to the compressor. If the temperature reaches the maximum temperature limit, the compressor shall be locked out and an alarm shall be annunciated on the local display and through monitoring. After the initial lockout, the control shall continue to monitor compressor temperature during the off-cycle and re-enable the circuit once a safe operating temperature is reached. The control shall store the number of high-temperature trips. The number of trips shall be accessible through the local display.

2.26 DIGITAL SCROLL SENSOR FAILURE

A. The control shall monitor the status of the digital scroll sensor(s). If the control senses that the thermistor is disconnected, shorted or the reading goes out of range, the user shall be notified through an event on the local display and remote monitoring.

2.27 COMPRESSOR SEQUENCING

A. A user-selectable compressor sequencing parameter shall be provided and shall be accessible through the local display. This sequencing parameter shall present the user with three choices:

1. Always use Compressor 1 as the lead compressor.

2. Always use Compressor 2 as the lead compressor.

3. Auto: The unit shall automatically stage compressors to keep each unit's run time within 8 hours of the other's run time.

a. First priority: If the safety timings are acceptable for only one compressor, then it is the next to be started/stopped.

b. Second priority: If both compressors are Off: The compressor with fewer working hours is the next to start.

c. Third priority: If both compressors are in operation: the compressor that has been operating longer since the last start is the next to be stopped.

2.28 COMPRESSOR HIGH- AND LOW-TEMPERATURE LIMIT PROTECTION

A. The control shall monitor the return air to ensure that the compressor(s) are operated within the manufacturer's defined window of operation. If the return air temperature deviates from the manufacturer's window of operation, the Liebert iCOM shall automatically adjust to prevent damage to the cooling unit or reduction in its reliability.

2.29 COMPRESSOR RUN TIME MONITORING

A. The control shall log these compressor statistics:

1. Number of compressor starts

2. Run hours

3. Average run time

4. Starts per day

5. Starts per day worst

6. Number of high-pressure alarms

7. Operating phase in which the high-pressure alarm occurred

8. Number of low-pressure alarms

9. Operating phase in which the low-pressure alarm occurred

10. Number of compressor overloads

11. Number of high-temperature alarms (scroll compressors)

B. The user shall have the ability to monitor compressor operating temperature and pressure from the local display to be used as a diagnostic tool.

2.30 MANUAL COMPRESSOR DISABLEMENT

A. The user shall have the ability to disable compressor operation using a set of either normally open or normally closed dry contacts tied directly to the control or through remote monitoring. An additional enable/disable feature shall be provided to allow the user to permanently disable an individual compressor circuit for maintenance using the local display.

2.31 MANUAL COMPRESSOR OPERATION

A. The user shall be able to operate each compressor(s) manually from the local display. The user shall be able to energize refrigeration components including liquid line solenoid valves, compressor contactors, electronic expansion valves and adjust capacity for troubleshooting or repair. The control shall monitor the compressor during manual operation and shall shut the compressor down if needed to prevent electrical or mechanical damage.

2.32 FLOODED START PROTECTION

A. The control shall isolate each compressor through a dedicated circuit liquid line solenoid valve and/or electronic expansion valve. These devices, combined with a spring-closed discharge check valve and compressor crankcase heater (air-cooled models), shall help ensure refrigerant does not migrate/carry oil out of the compressor case during the off cycle.

2.33 COMPRESSOR DEHUMIDIFICATION

A. The control shall permit the user to specify which compressor is used for dehumidification. The choices shall be 1st compressor, 2nd compressor, 1 or 2, or BOTH.Miscellaneous Options

2.34 LOCKING DISCONNECT SWITCH

A. The manual disconnect switch shall be mounted in the high-voltage section of the electrical panel. The switch shall be accessible from the outside of the unit with the door closed and shall prevent access to the high-voltage electrical components until switched to the Off position.

2.35 SMOKE SENSOR

A. The smoke sensor shall immediately shut down the environmental control system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel with the sensing element in the return air compartment. The smoke sensor is not intended to function as or replace any room smoke detection system that may be required by local or national codes. The smoke sensor shall include a supervision contact closure.

2.36 LOW-VOLTAGE TERMINAL PACKAGE

A. Factory-installed and factory-wired terminals shall be provided for customer connection to lock out the reheat and humidifier upon contact closure. Two extra normally open common alarm contacts shall be provided. Two extra remote shutdown terminals shall be provided.

2.37 MAIN FAN OVERLOAD

A. A pair of normally open contacts shall be factory-installed and wired to indicate Main Fan Overload.

2.38 WIRED SUPPLY SENSORS

A. Each Liebert iCOM shall have 1 supply air sensor connected and used as a controlling sensors or reference. This shall be in addition to the standard factory-supplied supply air sensor. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

2.39 WIRED REMOTE SENSORS

A. Each Liebert iCOM shall have 5 2T rack temperature sensors for control or reference. As part of the U2U network, those sensors shall be shared and used to control the units and provide greater flexibility, visibility and control using that to respond to changes in the data center. When the sensors are used for control, the user may set the control to be based off a maximum or average of a select highest temperature reading.

2.40 REMOTE MONITORING

A. A factory-installed communication card shall be provided for monitoring and/or control. The communication card shall be capable of connecting to Building Management System/Building Automation System using the following protocols:

1. BACnet IP—BACnet over Internet Protocol

2. BACnet MSTP—BACnet Master-Slave/Token-Passing (MSTP) communications protocol over a RS-485 serial network (also known as BACnet MSTP RS-485)

3. Modbus RTU—Modbus Remote Terminal Unit (RTU) communication protocol over a RS-485 serial network (also known as Modbus RTU RS-485)

4. Modbus TCP—Modbus Transmission Control Protocol over Internet Protocol (also known as Modbus TCP/IP)

5. SNMP

6. YDN23 - YD-T-1363 specification protocol (also known as YD/T 1363)

The communications card shall be capable of connecting to two of these protocols at once.

2.41 PRESSURE RATING, 150 PSI

A. The condenser water circuit shall be designed for a pressure of 150 psi

2.42 LIEBERT LIQUI-TECT® SENSORS

A. Provide 2/unit solid state water sensors on the floor.

2.43 FLOOR STAND

A. The floor stand shall be constructed of a welded steel frame. The floor stand shall have adjustable legs with vibration isolation pads. The floor stand shall accommodate unit installation in the existing raised floor.

2.44 RETURN AIR PLENUM FOR DOWNFLOW UNITS

A. The air plenum shall be constructed of 20 gauge steel, powder coated to match unit color. The plenum shall be 36" high. A door shall be included in the front of the plenum to enable front filter access. Air shall enter the plenum from the top.

PART 3 EXECUTION

3.1 INSTALLATION OF THERMAL MANAGEMENT UNITS

A. General: Install Thermal Management units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

C. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

3.2 FIELD QUALITY CONTROL

A. Start Thermal Management units in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. These specifications shall describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature and humidity conditions in the rooms containing electronic equipment.

The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements.

PART 4 BASIS OF DESIGN/APPROVED MANUFACTURERS

4.1 BASIS OF DESIGN

A. Liebert/Emerson.

4.2 APPROVED EQUAL

A. Stulz.

B. Data Aire Is an approved manufacturer, provided that a computational fluid dynamics model is submitted that validates that an equivalent amount of cooling is provided to match the Basis of Design.

C. Approved equal must submit a CFD (computational fluid dynamics) model and detailed report validating their solution will meet the required load. This must be provided to the engineer of record two weeks prior to bid date.

*** END OF SECTION 23 81 23 ***

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-22:

1. Suction Lines for Air-Conditioning Applications: 185 psi.
2. Suction Lines for Heat-Pump Applications: 325 psig.
3. Hot-Gas and Liquid Lines: 325 psig.

B. Line Test Pressure for Refrigerant R-134a:

1. Suction Lines for Air-Conditioning Applications: 115 psig.
2. Suction Lines for Heat-Pump Applications: 225 psig.
3. Hot-Gas and Liquid Lines: 225 psig.

C. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

D. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.

2. Solenoid valves.

3. Hot-gas bypass valves.

4. Filter dryers.

5. Strainers.

6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot .

2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports. Reports shall indicate results of leak test, acid test.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Deliver, store, and protect products under provisions of Basic Mechanical Requirements, General Conditions, and Supplementary General Conditions.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.

4. Pressure Rating: Factory test at minimum 500 psig.

5. Maximum Operating Temperature: 250 degF.

2.2 VALVES AND SPECIALTIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Henry Valve Co.

2. Sporlan Valve Co.

3. Danfoss, Inc.

B. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.

3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 degF.

C. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.

2. Packing: Molded stem, back seating, and replaceable under pressure.

3. Operator: Rising stem.

4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.

5. Seal Cap: Forged-brass or valox hex cap.

6. End Connections: Socket, union, threaded, or flanged.

7. Working Pressure Rating: 500 psig.

8. Maximum Operating Temperature: 275 degF.

D. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.

2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.

3. Piston: Removable polytetrafluoroethylene seat.

4. Closing Spring: Stainless steel.

5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.

6. End Connections: Socket, union, threaded, or flanged.

7. Maximum Opening Pressure: 0.50 psig.

8. Working Pressure Rating: 500 psig.

9. Maximum Operating Temperature: 275 degF.

E. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.

2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Copper spring.

5. Working Pressure Rating: 500 psig.

F. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.

2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.

6. Working Pressure Rating: 400 psig.

7. Maximum Operating Temperature: 240 degF.

8. Manual operator.

G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

2. Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Seat Disc: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Working Pressure Rating: 400 psig.

6. Maximum Operating Temperature: 240 degF.

H. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: 40 degF.

6. Superheat: Adjustable.

7. Reverse-flow option (for heat-pump applications).

8. End Connections: Socket, flare, or threaded union.

9. Working Pressure Rating: 450 psig.

I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

5. Seat: Polytetrafluoroethylene.

6. Equalizer: External.

7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.

8. End Connections: Socket.

9. Throttling Range: Maximum 5 psig.

10. Working Pressure Rating: 500 psig.

11. Maximum Operating Temperature: 240 degF.

J. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.

2. Screen: 100-mesh stainless steel.

3. End Connections: Socket or flare.

4. Working Pressure Rating: 500 psig.

5. Maximum Operating Temperature: 275 degF.

K. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.

2. Drain Plug: Brass hex plug.

3. Screen: 100-mesh monel.

4. End Connections: Socket or flare.

5. Working Pressure Rating: 500 psig.

6. Maximum Operating Temperature: 275 degF.

L. Moisture/Liquid Indicators:

1. Body: Forged brass.

2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

3. Indicator: Color coded to show moisture content in ppm.

4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 240 degF.

8. Indicator shall be line size sweat type for liquid lines 2-1/8 inches O.D. and smaller.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or threaded.

3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 degF.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.

3. Honeywell, Inc.; Genetron Refrigerants.

4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-22: Monochlorodifluoromethane.

C. ASHRAE 34, R-134a: Tetrafluoroethane.

D. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

E. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Lines NPS 7/8 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, annealed-temper tubing and wrought-copper fittings with soldered joints.

B. Lines NPS greater than 7/8 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top. Valves with port size less than 1/4 inch may be direct operated. Valves 1/4 inch and larger shall be pilot operated. All shall have manual lift stems. Valves shall be selected in accordance with Manufacturer's published data. Systems using refrigerant 12 shall be limited to 2 psig drop through valve and 3 psig for those using 22 or 502. Valves shall have sweat connections for lines 1-1/8 inches O.D. and smaller. When lines larger than 1-1/8 inches O.D. are required they shall be flanged.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.

2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.

2. Thermostatic expansion valves.

3. Hot-gas bypass valves.

4. Compressor.

K. Install receivers sized to accommodate pump-down charge.

L. Install flexible connectors at compressors.

M. Install refrigeration specialties in accordance with manufacturer's instructions.

N. Provide non-conducting dielectric connections when joining dissimilar metals.

O. All piping shall be sized in accordance with the equipment (i.e., remote condenser/chiller or split system) manufacturer's recommendations and limitations. These shall include pressure drop, length of run, lift, etc. Equipment manufacturer shall provide field coordination and shop drawings on all units exceeding 25 tons, 75 feet of equivalent length pipe (one way), or exceeding 20 feet lift.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

Q. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

T. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

U. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

V. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

W. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.

b. System shall maintain test pressure at the manifold gage throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.

2. Verify that compressor oil level is correct.

3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

*** END OF SECTION 23 23 00 ***

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and hydronic specialties for the following:

1. Pre-insulated Underground pipe and fittings.
2. Hot-water heating piping.
3. Chilled-water piping.
4. Condenser-water piping.
5. Glycol cooling-water piping.
6. Makeup-water piping.
7. Condensate-drain piping.
8. Blowdown-drain piping.
9. Air-vents and Air-vent piping.
10. Safety-valve-inlet and -outlet piping.
11. Air Separators
12. Strainers.
13. P/T Plugs.
14. Calibrated Balancing Valves.
15. Relief Valves.
16. Suction Diffusers.
17. Thermometers.
18. Pressure Gauges.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

2. Division 23 Section "Hydronic Piping Specialties" equipment and accessories for hydronic piping systems.

3. Division 23 Section "HVAC Water Treatment" flushing, cleaning and chemical water treatment for hydronic piping systems.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

2. Hot-Water Heating Piping: 150 psig at 200 deg F (93 deg C).

3. Chilled-Water Piping: 150 psig at 200 deg F (93 deg C).

4. Condenser-Water Piping: 150 psig at 200 deg F (93 deg C).

5. Glycol Cooling-Water Piping: 150 psig at 200 deg F (93 deg C).

6. Makeup-Water Piping: 150 psig at 200 deg F (93 deg C).

7. Condensate-Drain Piping: 150 psig at 200 deg F (93 deg C).

8. Blowdown-Drain Piping: 200 deg F (93 deg C).

9. Air-Vent Piping: 200 deg F (93 deg C).

10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.

2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

3. Air control devices.

4. Flushing, cleaning and chemical treatment methodology, products, equipment and procedures including begin and end schedule.

5. Hydronic specialties.

6. Pipe, Fittings and Field Insulation Methodology

B. Shop Drawings: Detail, at 1:20 scale (or as appropriate for representation of details), the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Anvil International, Inc.

b. S. P. Fittings; a division of Star Pipe Products.

c. Victaulic Company of America.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.

3. Facings: Raised face.

4. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

D. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150 minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

3. Separate companion flanges and steel bolts and nuts shall have 150 psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Calpico, Inc.

b. Lochinvar Corporation.

G. Dielectric Nipples:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Perfection Corporation; a subsidiary of American Meter Company.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Company, Inc.

d. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong Pumps, Inc.

b. Tour & Andersson; available through Victaulic Company of America.

c. Macon

d. Mepco.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. Furnish and install, as shown on plans and with manufacturer's recommendations, Model CBV-T threaded type circuit balancing valves.

5. Each valve shall have metering ports incorporating Nordel check valves on both sides of the seat.

6. All valves shall be "Y" pattern, equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. All metal parts are bronze copper alloy. Each valve shall provide four functions:

a. precise flow measurement;

b. precision flow balancing;

c. positive shutoff with a no-drip soft seat; and

d. diagnostic point for system analysis.

7. A ¼" NPT tapped drain port shall be provided on each side of valve seat.

8. Valves shall have four (4) full 360 degree adjustment turns of the handwheel (1,440 degrees) with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof, balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may be clearly read without the use of mirrors or any special tools. Metering ports shall be interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.

9. Each threaded CBV-T to be shipped with a pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.

   b. Tour & Andersson; available through Victaulic Company of America.

   c. Macon

   d. Mepco.

2. CWP Rating: Minimum 125 psig.

3. Maximum Operating Temperature: 250 deg F.

4. CBV-G 2½" through 12" Flanged:

5. Furnish and install, as shown on plans and with manufacturer's recommendations, Circuit Balancing Valves.

6. The valve body shall be ductile iron with grooved ends or with Armgrip(tm) non-rotating ductile iron flange adapters. Valves shall be suitable for the working pressures and temperatures as shown on drawings.

7. Each valve shall have metering ports incorporating Nordel check valves, on both sides of the seat.

8. All valves shall be "Y" pattern, modified equal percentage, globe style, designed either for presetting with a balance schedule or for proportional balancing. Each valve shall perform four functions:

   a. precise flow measurement

   b. precision flow balancing

   c. positive shutoff with a no-drip soft seat; and

   d. diagnostic point for system analysis.

9. Valves shall have five, (2½" and 3") six, (4" through 6") twelve, (8") ten, (10") or fourteen (12") full 360 degree adjustment turns of the handwheel with a micrometer-type indicator and hidden memory feature to program the valve for a precise, tamper-proof balanced setting. When installed, the handwheel and metering ports shall not be located on the bottom of the valve to prevent sediment deposits. Handwheel scale must be able to be positioned so that it may clearly read without the use of mirrors or any special tools.

10. Circuit balancing valves shall be installed at least five pipe diameters downstream from any fitting and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream of the CBV shall be free of any fitting.

11. The valve shall be furnished with pre-formed insulation to meet or exceed ASTM D1784/Class 14253-C, MEA #7-87, ASTM E84, and ASTM E136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less.

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.

2. Armstrong Pumps, Inc.

3. Bell & Gossett Domestic Pump; a division of ITT Industries.

4. Taco.

B. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.

2. Internal Parts: Nonferrous.

3. Operator: Noncorrosive metal float.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/4.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 240 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

2.8 THERMOMETERS

A. Provide thermometers where indicated, specified, and required. They shall be installed so that they can be clearly read from the floor.

B. Industrial stem thermometers shall have a scale not less than 9" long and shall be red-reading mercury type with white background and black etched graduations and numerals. Casing materials shall be aluminum on all products installed outdoors.

C. Thermometers shall be suitable for the service intended and the range shall be selected to span from approximately 10 degrees below through 10 degrees above the operating range of the fluid.

D. Thermometers shall have a guaranteed accuracy of within 1% of the range scale and shall be provided with 1 degree graduations. Thermometers shall be provided with brass separable socket wells.

E. Provide thermometer wells and necessary fittings where specified or indicated. Wells installed in insulated piping shall be provided with lagging extensions of appropriate length to accommodate insulation.

F. Thermometers shall be as manufactured by Marsh Instrument Co., Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.9 PRESSURE GAUGES

A. Pressure and compound pressure gauges shall be installed so that they can be clearly read from the floor and shall be Bronze Bourdon tube type with minimum 6" dials and snubbers. Dials shall be white with black numerals, graduations, and pointers, and shall be set in either iron, steel, or aluminum cases having a baked enamel finish. Cases shall have safety blowout plugs.

B. Pressure gauges shall have a range of approximately twice the operating pressure and all gauges shall have an accuracy of 1/2 of 1% of full scale reading. Gauges shall be provided with brass shutoff cocks.

C. Provide compound pressure gauges in pump suction pipe (30" Hg VAC. to 100 psi).

D. Provide gauges where indicated, specified, or required.

E. Gauges shall be manufactured by Marshalltown Instrument, Weksler Instrumentation, Trerice, Miljoco, or approved equal.

2.10 P/T PLUGS

A. Provide, in locations shown on drawings, a 1/2 inch MPT fitting for pipe line and 1/4 inch for valve body locations to receive either a temperature or pressure probe 1/8 inch OD. Fitting shall be solid brass with two valve cores of Neoprene capable of withstanding a maximum temperature of 200 deg. F at 500 psi, fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig at 140 deg. F.

B. Provide Owner with pressure gauge adapters with 1/8" O.D. probe and 5 inch testing thermometers for chilled water with a 25 - 125 F range.

C. Supply and present to the Owner upon completion of testing, two (2) pressure and temperature test kits. Each shall consist of one dual scale (0-100 psi, 0-230 feet of water) pressure gauge with a No. 500 gauge adapter attached, one 25-125 F pocket testing thermometer, one 0-220 F pocket testing thermometer, one 500 gauge adapter, and one protective carrying case.

D. Acceptable manufacturers shall be Peterson, Sisco, or approved equal.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping and chilled water piping, aboveground, NPS 2 and smaller shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

2. Schedule 40 steel pipe; Class 150 or Class 300 Malleable Iron fittings; and threaded joints.

B. Hot-water heating piping, and chilled water piping aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Domestic makeup-water piping installed aboveground shall be the following:

1. Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Domestic Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

1. Condensate-Drain Piping: Type L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air-Vent Piping:

1. Inlet: Same materials and joining methods as for piping specified for the service in which air-vent is installed.

G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves where indicated on the drawings.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and 3/4 inch hose connection with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Provide strainer blowdown valve with 3/4 inch hose connection with cap.

S. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS ¾ to NPS 1-1/4: Maximum span, 6.5 feet; minimum rod size, 3/8 inch.

2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inc).

3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

4. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.

5. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

6. NPS 4: Maximum span, 10 feet; minimum rod size, 5/8 inch.

7. NPS 6: Maximum span, 10 feet; minimum rod size, 5/8 inch.

8. NPS 8: Maximum span, 14 feet; minimum rod size, 7/8 inch.

9. NPS 100: Maximum span, 14 feet; minimum rod size, 7/8 inch.

10. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.

11. NPS 14: Maximum span, 20 feet; minimum rod size, 1 inch.

12. NPS 16: Maximum span, 20 feet; minimum rod size, 1 inch.

13. NPS 18: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

14. NPS 20: Maximum span, 20 feet; minimum rod size, 1-1/4 inches.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.

2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.

3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger. Install automatic air vents at top of air separator. Refer to detail on drawings for further information..

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position. Install feeder in minimum NPS 3/4insulated bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks on the minimum 4"pad housekeeping. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements. Refer to details.

G. Flow switches, temperature sensors, sensor sockets, wells gage taps, etc. shall be furnished under controls section of these specifications and installed under this Section. Locations of all sensor sockets, flow switches, and taps shall be coordinated with and supervised by the Controls Contractor.

H. Motorized control valves shall be furnished by the Controls Contractor, installed by the Mechanical Contractor.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Provide P/T ports at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

E. Install thermowells and ports for pressure gages and thermometers at equipment as indicated on details and according to Division 23 Section "Meters and Gages for HVAC Piping." Refer to details.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.9 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure (125 psi) . Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

3.11 CLEANING SEQUENCE

A. Hydronic Water Systems: Contractor shall rent a pump with strainer and pipe to new system. Contractor shall circulate for 48 hours, then drain systems as quickly as possible. Refill with clean water, circulate for 24 hours, then drain. Refill with clean water and repeat until system cleaner is removed. After cleaning and flushing, the Contractor shall connect new piping to existing system as shown on drawings. Chemical Water treatment to be provided immediately upon acceptance of the cleaning.

B. The piping shall be thoroughly flushed with cleaned throughout with clean potable water at a rate of 10 feet per second through the largest pipe on the circuit but not exceeding a pressure of 100 psi in the piping system. Provide a temporary bypass on the boiler piping to allow full circulation throughout the existing piping system including as much of the new piping system as possible minus the boilers and pumps. The temporary connection of the supply and return pipe at boiler bypass shall facilitate the flow of water through the piping system during flushing. Flush each heating branch and main system for a minimum of two hours and until the flushing water exiting the piping is clear and free of debris as determined by the owner's chemical treatment company. The source of the water supply to be used for flushing shall be as approved by the authority having jurisdiction. The contractor shall provide the temporary pumping system to be used for flushing the piping system. The new pumps shall not be used as the flushing pumps. The flushing pumps shall be of the capacity (flow rate and dynamic head) as necessary to motivate the water through the largest pipe in the system at a minimum 10 fps velocity. Provide temporary flexible piping and connections to the system as necessary to and from the flushing pumps.

C. Provide all necessary utility connections to the flushing pumps including power, make-up water, drain piping, etc. as necessary for safe operation. If diesel driven flushing pumps are used, these pumps shall be located outdoors in the appropriate open air environment far enough away from the building intake openings such that the diesel exhaust fumes do not pose any threats or perceived threats to the safety of the building environment and building occupants.

D. Prior the flushing and cleaning, this contractor shall remove, clean and reinstall all strainers on the heating system in the building. Upon completion of the flushing and cleaning process, this contractor shall again remove, clean and reinstall all strainers, and fill system with clean water. Adjust the expansion tank for pressure proper operation.

E. Once the system has been flushed, add cleaner to closed systems at concentration as recommended by manufacturer of water contained in the system; of one pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.

F. Each piping system shall be thoroughly cleaned by filling with a solution of commercial cleaning chemicals designed to remove deposits such as pipe dope, oils, loose mill scale, rust and other extraneous materials. The recommended dosages and characteristics of the cleaner shall be such that the water need only be at ambient temperature. After the recommended dosages are added, the water shall be circulated for 36-72 hours. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Systems shall then be drained, filled and flushed with clean water until no foreign matter is observed and total alkalinity of rinse water is equal to that of the make up water.

G. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.

H. Flush systems with clean water for one hour minimum. Drain completely and refill.

I. Remove, clean, and replace strainer screens.

J. Each system shall be properly treated to prevent scaling and corrosion.

K. The water treatment service company currently under contract with the owner shall provide the flushing, cleaning and chemical treatment process.

L. All cost associated with this service and certification shall be paid by the Contractor as a basic part of this project.

*** END OF SECTION 23 21 13 ***

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The General and Supplementary Conditions and General Requirements apply to the work specified in this section—Automatic Temperature Control System (ATCS).

1.2 SCOPE

A. Provide materials, equipment, labor and supervision necessary to expand the existing ALC building management and digital electronic automatic control system. Pneumatic controls are not acceptable.

B. Refer to the equipment schedules, flow diagrams, sequence of operation and input/output summary list as applicable to this project.

C. The system shall consist of a distributed processor direct digital control system utilizing electronic actuation. The system shall be fully integrated with the air handling units, VAV boxes, chillers, pumps, cooling towers and boilers. Every DDC control panel shall be listed by underwriters laboratory under "UL Standard 916 Energy Management Equipment".

D. All electric control and interlock wiring in connection with the controls and instrumentation system shall be furnished by this Contractor. Power wiring to the various control devices shall be provided by the Electrical Contractor, coordinated by this Contractor prior to Bid. Failure of this Contractor to coordinate requirements with other Divisions shall require this Contractor to be responsible for any non-coordinated items. Control power to operate VAV boxes (other than duct heaters or fan power) shall be the responsibility of this Contractor (if applicable). The Electrical Contractor (Division 26) is to provide dedicated 120 VAC power or higher to each control panel.

E. Include the cost of providing a system interface or graphics board (if required) and the required software to Engineering Matrix so that remote connection may be made between the project and the Engineer's office during the course of construction and throughout the warranty period. The intent is to allow the Engineer priority access during system installation, startup and demonstration. The Engineer shall also be able to use the system remotely in order to check/confirm the results of the test and balance reports in a random basis. Sufficient software shall be provided and installed at the office of the Engineer to allow full programming capability; to include: graphics programming language, module libraries, etc.

F. Control Contractor shall complete all installations including electric and electronic components—not the Mechanical Contractor.

G. DDC controllers shall be required to have been BTL (BACNET Testing Laboratory) tested and approved.

1.3 COORDINATION

A. Division 15 Mechanical Contractor shall receive, handle, mount and install automatic temperature control valves, separable wells for immersion elements and couplings for flow and pressure switches.

B. Mechanical Contractor for section 15 or the sheet metal subcontractor shall install all automatic dampers. It shall be the responsibility of the mechanical Contractor or his sheet metal subcontractor to provide and install blank-off plates when the control application requires dampers smaller than duct size.

C. The direct digital portions and automatic temperature control system shall be installed by the Temperature Control Contractor.

D. Coordination of all controls items with other trades shall be the responsibility of the Controls Contractor.

1.4 TEST

A. The Control Contractor shall test the entire system and document point by point operation of all controls. Perform all required continuity testing of conductors prior to final connection to control equipment.

1.5 CALIBRATION AND ADJUSTMENT

A. After completion of the installation, perform calibration and adjustments of the Automatic Temperature Control equipment provided under this contract, and supply services incidental to the proper performance of the temperature control system under the warranty below.

1.6 SYSTEM WARRANTY

A. System Warranty

All temperature control devices provided by this Contractor shall be warranted to be free of defects in workmanship and material for a period of two (2) years from the date of the job acceptance (Final Substantial Completion) by the Owner and/or date of beneficial use. Any equipment found to be defective during this period shall be repaired or replaced without expense to the Owner. This work shall be accomplished by the Contractor during normal working hours (8 am to 5 pm, Monday through Friday, excluding holidays).

The Controls Contractor shall be responsible for all defects or failures throughout the warranty period (parts and labor).

B. Service Organization Qualifications:

The Servicing Contractor shall meet all of the following requirements:

1. Have certified OEM factory-trained technicians experienced on the specific equipment needing repair. Service technicians to be equipped with laptop computers.

2. Provide for two (2) hour response time, 24 hours/day, 7 days/week to inspect down equipment and then repair to make equipment operational.

3. Maintain a complete stock of OEM parts, service, and repair manuals covering types and models of equipment owned by the Owner. It is unacceptable to remove a failed device and return it to the manufacturer for repair. Parts shall be replaced by local stock at the time of service call.

4. Have fully equipped service trucks and other equipment, including that necessary to comply with prudent and regulatory environmental requirements (including CFCs).

5. Maintain software library to support building automation system. Provide and install mandatory upgrades with 30 days of issue. All systems provided shall be the most current version and all units shall be the same version.

6. Provide local training on chillers, air handlers, and automation systems at no cost to Owner as stipulated herein.

1.7 SUBMITTAL REQUIREMENT

A. The following data/information shall be submitted for approval:

1. Complete description of operation. Include an overall system interconnect diagram showing all remote panels and power/surge protection locations.

2. Control system drawings including all pertinent data to provide a functional operating system.

3. Valve, humidifier and damper schedules showing size, configuration, capacity and location of all equipment.

4. Data sheets for all hardware and software control components.

5. A description of the installation materials including conduit, wire, flex, etc.

6. Thermostat/sensor locations.

7. Distributed panel locations.

8. Provide as part of the submittal five copies of all data.

9. Detailed point-to-point diagram of circuitry of all DDC panels, AHUs. Submit on a per distributed panel basis.

10. List of connected data points, including connected control unit and input or output device.

11. System graphics indicating monitored systems, data connected and calculated point addresses, and operator notations, as-built. Graphics shall be demonstrated at the office of the Engineer using live data via modem hook-up to the site. Graphics are to be demonstrated and approved prior to Substantial Completion. Not required at submittal approval time except as listed below.

12. Descriptive data and sequence of operation of operating, user, and application software.

13. Detailed documentation on the specific field equipment to be supplied by the controls Contractor shall be submitted and approved prior to installation; including, but not limited to, actuators, valves, temperature sensors, and damper operators.

14. All schemes and methods proposed to provide lightning protection entering and leaving each building shall be submitted for review and approval.

15. Locations of each control panel, gateway module, override panels on a 24" x 36" drawing or larger floor plan. Submit panel layouts for each.

16. Proposed Graphic Screens shall be submitted for approval with shop drawings. These submittals shall include a schematic of the graphics, all points which will be shown on that screen, whether such points are able to be overridden from the graphics and any such targets or macros to be accessible from that screen.

PART 2 PRODUCTS

2.1 DDC PANELS (MICROPROCESSOR BASED DDC PANELS)

Provide independent, stand alone, microprocessor based control panels in order to provide centralized control of each major piece of HVAC equipment. Provide DDC panels for each air handling unit. These panels shall communicate with the operator via the Communications Network CPU/Graphics Software. Both text and graphics interface shall be provided.

A. The DDC panel shall contain the necessary hardware and firmware to interface the building input/output devices to the CPU over a communications channel.

Each DDC panel shall be a stand alone in a standard assembly packaged in a NEMA 1 enclosure complete with power supplies, card cage, interface cards and termination points. Each remote shall be capable of accepting combinations of input sensors and output controls. Each remote AHU unit shall have its' own timeclock.

As many DDC panels as required shall be furnished to provide the monitoring and control functions and capabilities specified. The panel shall be strategically located in areas of the building that are easily accessible for maintenance and repair.

Any software edit changes in a DDC panel by the Owner shall be available to the Owner. The Owner shall not be tied to the manufacturer for those changes.

If the manufacturer's panel does not have the ability to provide the minimum point requirement, then additional panels shall be provided adjacent to the first unit in order to meet the intent of the spec. No exception to this statement shall be acceptable in order to protect the Owner's interest for future additions.

Provide at each AHU, chillers and boiler (if applicable) a dedicated DDC panel. A key lock shall protect the internal DDC panel components.

Provide sufficient ROM, for operating system and PID algorithms. Protect processor cards and memory with internal grounding. Store setpoints and default parameters in a non-volatile memory (EEPROM). Battery back-up shall not be acceptable for AHU stand-alone DDC panel control. Locate the panel in the AHU room or at the AHU.

B. Input/Output Interface

Each point on each interface card is to be characterized as to its point type, sensor range, status, and scale range in the on-line software data base edit. Revisions or modifications to these parameters shall be entered by the system operator through the PC keyboard.

To gather sensor data and interface with controlled equipment, the DDC panel shall use an internal multiplex design. This design shall allow each panel to accommodate different types of points using any of the following input/output options:

- ❑ Digital Input Options—Monitor the open/closed status of a switch or relay.
- ❑ Analog Input Options—Monitor analog values of voltage, current and resistance from temperature, pressure and humidity sensors, etc.
- ❑ Digital Output Options—Control on/off, start/stop relays.
- ❑ Analog Output Options—Supply voltage or current outputs to controllers.

C. Digital Input (DI)

The digital inputs must be isolated contact closures and can either be normally open (NO) or normally closed (NC).

Points must be transient protected on all points to meet IEEE C37.90a-1974.

Digital input points shall monitor the open/close status of switches or relays. Digital inputs must be isolated contact closures, but normally open or normally closed contacts can be intermixed.

Monitoring voltage is 12 VDC at 12 mA per zone. Two #18 AWG wires are required per point. Points are to be transient protected to meet IEEE 472-1974.

D. Analog Input

The analog inputs can be voltage, current or resistance.

The analog input cards monitor values from temperature, pressure, humidity, and other analog sensors.

Analog inputs can be linear or non-linear. Points shall include a 10-bit A/D converter and an analog power supply. All points shall be wired to the card using #18 AWG twisted, shielded pair cables (Belden 8760 or equivalent) or larger.

E. Digital Output

The digital outputs shall drive control on/off, start/stop relays which have low voltage coils. The control relays must have a minimum contract rating of 120 VAC, 5 amp, and 1/3 HP. Provide manual override switches in order to enable the operator to override the control status of each load.

F. Analog Output

The analog outputs supply voltage or current outputs to devices. The analog outputs shall be a standard 4-20 mA proportional signal. The analog output D/A conversion shall have 10-bit resolution minimum. All output points to valves shall read as a percent open.

G. Packaging And Environment

Distributed DDC panel enclosures shall be locking type, metal cabinet, with common keying. The panels have a metal print pocket suitable for storing wiring, service and log information.

The panel, when required, must functionally operate over the temperature range -30 degrees F to 120 degrees F and the humidity range 10 - 90% non-condensing. Storage temperature shall be -50 degrees F to 150 degrees F.

DDC panels shall come with a minimum of six pre-existing available knockouts for ease of wiring during installation. Panels shall have an on/off switch and shall be fused for power protection. AHU DDC panels shall be provided with the required knock-outs.

The electrical requirements shall be provided by this Contractor. Any 120 VAC requirements are to be coordinated with the Division 16 Contractor prior to bid. Power circuit to each panel shall be provided by Division 16 Contractor.

H. Distributed Control Modules (DCMs)

The Distributed Control Module (referred to as DCMs) shall be distributed standalone controller specifically designed to control the various HVAC equipment as specified herein.

Each DCM shall be capable of communicating with main DDC controller panels over a twisted pair of wires. Provide at each panel an operator interface in the form of a front panel liquid crystal display with keypad. The display and keypad shall allow display and local adjustment of DCMs operating parameters and setpoints.

Each DCM shall have a minimum of 6 programmable/configurable PID loops.

The analog inputs shall be individually selectable for resistance inputs, 4 to 20 mA, 200 ohm input impedance and 0 to 10 VDC.

The binary outputs shall drive dry contact low coil voltage relays with normally open and normally closed (Form C) contacts. The contacts shall be rated at 120 VAC, 5 amps.

The analog outputs shall provide a continuous signal and are individually selectable as either 0-10 VDC or a 0-20 mA or 4-20 mA (both into a 500 ohm impedance).

Provide at each DCM address dip switches for setting the communication link address. In addition, provide at each DCM an RS 232 interface port for connection of a DCM edit software for use with a portable laptop computer.

Damper operators shall be of two (2) types; modulating or two-position depending on the sequence of operation. Two-position operators shall be spring return type and the modulating operators shall be capable of accepting a 0-10 VDC or 4-20 mA signal with a gear de-engagement clutch on the operator cover.

I. Main Direct Digital Controller (MDDC)

The Main Direct Digital Controller shall provide the capability for local loop control. The capability for direct digital control to maintain desired setpoints shall be available. The setpoint values shall be determined manually by the operator's input or by an application program. These values shall be established via the operator input locally or be set via the communications link to another MDDC. The MDDC shall be capable of retrieving data and setting data values from connected DCMs.

The MDDC panel shall have in firmware direct digital control PID loop algorithms for calculations to maintain a setpoint accurately. The algorithm shall utilize this desired setpoint value, mode factors, and feedback to maintain the setpoint. The factors for the mode used in the direct digital control process shall include proportional, integral and derivative value. Each MDDC shall have a minimum of 16 PID loops.

See the point list (I/O summary) for the required number and type of points at each piece of equipment.

2.2 TRANSIENT PROTECTION

A. All communication channels between CPU, MDDC panels, and DCMs whether in conduits or overhead runs, shall have transient suppression networks installed. The transient protection must meet IEEE standard C37.90a-1974. The suppression network shall be automatic, self-restoring and be on duty at all times.

B. Surge suppression shall comply at minimum with manufacturers requirements and is to include suppression on all lines entering/leaving each building.

2.3 SOFTWARE

Provide the following software features for the operation of the system:

A. Password Security

The system security software shall provide the means for ensuring secure operation of the system. In doing so, the system security software shall perform the following:

1. All system editing, control operations, and alarm acknowledgment shall be subject to access authorization prior to allowing such operations to take place.

2. Defining and modifying system password and access assignments shall only be accomplished by the Building Owner, Engineer, or Designee.

3. Associated with each password shall be an access code and level of authorization.

B. Application Software

The application software includes in general the control functions which permit the operator to control the system, and access the associated application parameters. In addition, the interaction between application programs provides the strategy for orderly management of the system as well as the following:

1. Maximum energy conservation

2. Minimum occupant discomfort

3. Unnecessary equipment cycling

All application program editing must be accessible to the Owner and the Owner's personnel who have the proper password authority. All displays necessary to create and edit the system are provided. All editing is done in English by using the menu format and by answering prompted questions. All software programming of sequences shall be done in text and shall be on-line with no intermediate compilations required.

C. Programmed Scheduling

The system shall provide the ability to automatically start up and shut down individual pieces of equipment by zone grouping based on a particular time of day. In addition, the ability to disable alarming and application control for a particular load as a function of the time-of-day is also required. All time programmed control will be done in accordance with the operator specified schedules.

There shall be a minimum of 32 master zone schedules of eight days each.

There shall be at least one schedule for each day of the week. The capability to schedule holidays and special days a minimum of one year in advance shall be included. The priorities of the time program functions relative to the other application programs shall be operator definable. The program shall have the capability of being down-loaded to all programmable remotes.

D. Demand Limiting And Load Shedding

Peak demand control shall be accomplished by monitoring the power consumption of each metered power feed device. The program shall constantly compare the actual peak demand to the operator established limits. Upon reaching limits, configurable priority loads as defined by user shall be shed on a rolling basis.

The program shall use an averaging technique that will offset the effects of demand spikes and the resultant over-shedding of loads.

The operator shall have the ability to define each load to be used for load shedding. In addition, the demand limiting program shall have as a minimum four priority groups. Each load in a particular group shall be rotated with other loads in the same group.

The program shall accommodate time of day demand limits.

There shall be a minimum of 2 time of day intervals with independent, unique limits for weekdays, Saturdays, and Sundays.

The program shall accommodate multiple meters as inputs to the software. It shall be capable of treating each independently. Associated system software shall be capable of treating them as a single sum.

E. Run Time And Maintenance

The system shall provide the ability to accumulate equipment run time for operator specified equipment.

When equipment run time exceeds an operator-specified limit, the system shall alarm the condition and print and sequentially number the maintenance order automatically for the specific piece of equipment. The system shall provide a summary of all points currently assigned to the run time program as well as their current run time values. Run time limits shall be enforceable on either an hourly or calendar date basis.

The operator shall have the ability to define or modify any of the maintenance messages to be used by the run time program.

F. Reports And Logs

The system shall provide management reports and logs detailing certain system performance characteristics.

The system shall have the ability to history trend a minimum of 250 different I/O or internally calculated points. The points shall be operator selectable and shall be a mix/match of the system points as selected by the operator. The operator shall also be able to select the sampling/storage trending time frequency. The minimum sample time frequency must be no greater than 10 minute intervals for 25 of the points and 5 minutes for the remaining points. A minimum of 200 samples for each point shall be trended.

The data or the trend history must be capable of being stored in a spreadsheet compatible file format (EXCEL Version 5.0).

G. Graphics Generation Package

1. Provide an updated version of the dynamic color graphics package to operate in the PC. The graphics package shall work in conjunction with the ATCS as described in Paragraph 2.01 A, B, C. The graphics package shall allow the operator to call up dynamic graphics and to create graphics in the following different methods.

   - ❒ Drawing graphics from scratch with dimensions not exceeding 636 x 360 pixels.
   - ❒ Redrawing an existing graphic (duplication).
   - ❒ Using a library file from the graphics library. The graphics library shall contain as a minimum static pictures of AHUs, fans, chillers, valves, coils, dampers, fan coil units, and ductwork.

   The graphics package shall be setup in SVGA mode with 256 colors and the ability to create/select fonts, text entry dialogue boxes, icons, etc.

2. Dynamic Graphic Software

   Provide as part of this program an adjustable automatic refresh rate for all graphic displays. The automatic refresh rate shall be adjustable down to a minimum of five (5) seconds for all system points being displayed. A graphic mode's pop-up menu shall be provided for accessible selection of all available functions in a tiered top/down structure.

3. Color Graphic Display Linkage Editor

Provide, as part of the graphics generation program, a color graphic display linkage editor which assigns ("links") the appropriate graphic display files to the correct ATCS remotes. The linkage editor shall also provide the operator with the ability to define the display sequence that is followed when the next and previous function keys are utilized.

4. Graphic Requirements

As a part of the requirements of this section, provide a series of logically ordered dynamic graphics as described in paragraph H.1 for each ATCS remote. There shall be as a minimum a dynamic graphic for each of the following:

a. Site Plan Graphic

Provide a site plan of the project indicating location of chiller plant, major mechanical equipment, PCs, and electric power meter(s). The site plan graphics shall also have easily identifiable ICONS and target points.

b. Air Side

1) CRAC Units – Variable Volume

- CRAC status (On/Off)
- Supply air temperature Deg.F.
- VFD position % frequency
- Chilled water valve % open
- Return air temperature Deg.F.
- Supply air temperature setpoint Deg.F.
- Cooling coil discharge temperature Deg.F.

2.4 AUXILIARY CONTROL DEVICES

A. Automatic Control Dampers and Operators

1. Automatic control dampers shall have interlocking blades and frames. Dampers shall be designed and constructed so that the blades, frames and linkage mechanism shall present a rigid assembly with free and easy action. Dampers shall be of galvanized steel blades and welded steel frame. The damper bearings shall be brass or oil impregnated nylon with brass bearing shafts. Where the damper blades are installed in a vertical position, a thrust type ball bearing shall be provided for the lower bearing. All bearings in ducts or casings to the outside shall have the top and bottom edges on both ends trimmed with replaceable neoprene seal fastened in an approved manner, so as to be practically air tight when closed. Closed dampers shall have leakage of not more than one-half percent at 4" of water column (10.2 cm) static pressure and 2,000' per minute velocity.

2. Submit leakage and flow characteristics of dampers to Engineer to specify performance. Test leakage reports shall be in accordance with AMCA standard 500-75.

3. When dampers are located at fan discharge they shall be designed to operate properly without fluttering, at velocities up to 4,000 fpm and against a static pressure differential developed by the fan. Maximum deflection shall be no more than 1/50 of the unsupported span distance. Each automatic damper or section of damper if too large for one motor shall be operated by the required number of modulating motors. The motors shall be of the proper size required to operate the damper with uniform and gradual movement and shall return the damper to the same position for a given signal during an opening or closing movement of the damper. Damper operators shall be of the proportional type capable of accepting 0-10 volts or 4-20 mA control signal and 2-10 VDC feedback signal. The type of operator input signal will be a function of the DDC control panel output.

4. Damper operators shall include spring return, a 0 – 5 VDC feedback signal, and shall be sized a minimum of 125 percent of the highest actual close-off operating pressure of the system (25% safety factor). Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all outside air dampers on 100% outdoor air handling units wherever it applies to this project, for positive feedback of damper position.

5. Approved damper manufacturers are: Safe-Air and Ruskin.

6. The Control Contractor shall furnish all the controlled dampers of the type and sizes indicated on the Drawings for installation by the sheet metal subcontractor.

7. All 2-position control dampers shall be sized for minimum pressure drop, at the specified duct size.

8. All modulating dampers shall be sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal subcontractor for determining the proper duct reductions or baffles used.

9. Damper frames shall not be less than 13 gauge galvanized steel, formed for extra strength, with mounting holes for enclosed duct mounting.

10. All damper blades shall be of not less than 16 gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured 1/2" diameter zinc plated axles by zinc plated bolts and nuts. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade linkage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

11. Dampers shall be suitable for operation between -40 F and 200 F. The Control Manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

12. Dampers shall be of the parallel blade design for 2- position service and opposed blade design for modulating service.

13. Approved damper operator manufacturers are: Belimo.

B. Automatic Control Valves And Operators

1. The Control Contractor shall furnish all the control valves of the type indicated on the drawings for installation by the Mechanical Contractor.

2. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All modulating three-way mixing valves shall be provided with linear V-port plugs or equal percentage flow characterized ball valve type, such that the total flow through the valve shall remain constant regardless of the valve's position. All diverting valves shall have two V-port plugs.

3. Valves 2" and smaller shall have brass or bronze bodies with screwed ends. Valves 2-1/2" and larger shall have iron bodies brass or bronze trimming with flanged ends. Valves shall be factory rated to withstand the pressures encountered. Valves shall have stainless steel stems and spring loaded teflon packing.

4. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs or equal percentage flow characterized ball valve type. Valves and operators shall be capable of close-off pressures equal to or exceeding the dead head pressure of the largest pump within the system or 60 psi, whichever is greater and shall be sized a minimum of 125 percent of the highest actual operating pressure of the system (25% safety factor).

5. All automatic control valves shall be fully modulating type unless specified otherwise in the Sequence of Operations or on the drawings.

6. All control valves shall be designed to fail as follows:

   ❑ Cooling - Fail fully open to coil

   ❑ Heating - Fail fully closed to coil

7. Each valve operator shall be 4-20 mA type Contractor shall provide feedback wiring, terminations, graphics, and control logic connected to DDC input board (analog signal), on all automatic control valves in the chiller plant and/or heating plant (except at air handlers) wherever it applies to this project, for positive feedback of valve position.

8. Operators on all air handlers shall be by Belimo and shall comply with this section.

9. Operators on all automatic control valves in the chiller plant and/or heating plant shall be Belimo SY, NEMA 4X type and shall comply with this section.

C. Differential Pressure Switches

1. Differential pressure switches shall be furnished as indicated by the sequence for status purposes for either air or water applications. Provide single pole double throw switch with fully adjustable differential pressure settings. The switch shall have a snap-acting Form C contact rated for the application. The switch contact shall be rated for 5 amps at 120 volts as a minimum. Units shall be selected for ranges consistent with the application and shall be submitted for the Engineer's approval.

   a. Dwyer and Cleveland products are acceptable manufacturers.

D. Electronic Temperature Sensors

1. Temperature detectors shall be 10K Ohms thermistors or a 2 wire, 4-20 mA DC output 12-35 VDC input, 1,000 or 100 Ohm platinum RTD with a minimum transmitter accuracy of +.1% of span, shall be 100% zero and span field adjustable, polarity protected. Sensors shall be calibrated to less than or equal to a 1/4 degree F resolution for the specific application. Thermistor sensors are approved for VAV zone or room sensing Substitutions must be approved by the Engineer. All sensors to be field calibration verified and if adjustments are necessary, they shall be made at the sensor and not in software. 1,000 or 100 ohm direct panel input sensors are acceptable provided 2 fixed range resistors are installed that will facilitate confirmation of proper A/D conversion.

2. Provide twisted pair lead wires and shield for input circuit.

3. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification sensor length 2.5 m or 5 m as required.

4. Insertion elements for liquids shall be with brass separable socket (thermowell) with minimum insertion length of 2-1/2 inches (60 mm).

5. Supply room sensors with tamper proof cover.

6. Provide outside air sensors with watertight inlet fitting, shielded from direct rays of sun, mounted on the North side of the facility.

7. The transmitter/sensor shall be field calibrated by the Installing Contractor to transmit a 4-20 mA signal at the corresponding temperature ranges. The Installing Contractor shall calibrate transmitter in field with a precision grade substitution resistance box and two (2) decimal place minimum digital ammeter test circuit. Test transmitter at three (3) temperature points minimum. Engineer will spot check verify these calibrations during walk through inspection.

8. Wall mounted sensor shall be mounted at 5'-6" above finished floor in an area which free air current is not constricted or blocked, final location shall be approved by the Owner and Engineer prior to installation.

9. Elements shall be applicable for the medium being sensed; i.e., strap-on elements, room elements, well- mounted elements, duct mounted elements and outdoor mounted elements. Range shall be from 0 to 120 degrees F.

E. Humidity Sensor/Transmitter

Provide relative humidity sensor/transmitter where shown on the control drawings. Sensor and transmitter shall have:

System Accuracy.....+2% RH @ 25ºC from 20-95% RH

Output Signal.....Two wire 4-20 mA linear, proportional to 0-100% RH

The transmitter power shall be compatible with and powered by, the low voltage power supplied by this Contractor.

F. Control Wiring

1. All conductors shall be of stranded copper wire.

2. All EMT/conduit and outlet boxes shall conform to the requirements specified under Division 16, Electrical.

3. All cables run exposed in return air plenums shall be smoke rated for the application. Do not run wire in drywall without conduit.

4. All wiring cables shall have 600 volt insulation.

5. Cables shall be properly identified/tagged as to the control point.

6. All cables from ceilings to wall temperature sensors shall be installed in conduit (EMT).

G. Current Switches

1. Provide a solid state switch which when the current level sensed by the internal current transformer exceeds the adjustable trip point. Internal circuits are to be totally powered by induction from the line being monitored. Provide a zero off-state leakage in the solid-state relay output, while switching both AC and DC circuits. Provide an LED that will show three pieces of information (Rapid Flashing-switch is tripped, Slow Flashing-current is present but below the trip point and no Flashing-current is either off or below the bottom of the range) and permits setting the trip point adjustment prior to system connection.

H. Filter Status Transmitter

1. Provide filter status for all central station air handling units. The transmitter shall have both visual monitoring and electronic control of very low differential pressure. The transmitter shall have 4-20ma output signal to be used by the DDC system. Fan coil units shall not have filter status unless the Engineer recommends it.

2. Transmitter shall be Dwyer series 605.

PART 3 INSTALLATION

3.1 CONTROL WIRING

A. Provide conduit and outlet boxes.

B. Install remote push-button stations and/or control devices interposed in the control wiring.

C. Provide over-current protection for all control and interlock wiring as specified in NFPA (70.1971) Art. 240-5 (a), Exception #4 and Art. 430-72, Exception.

D. Line voltage and exposed low voltage control wiring shall be run in conduit.

E. No splices will be allowed except at junction boxes and control centers.

F. No two wires of the same color shall be run in one conduit unless wires of the same color are properly tagged at both ends and any splice points. Do not change colors at splice points.

3.2 INSTALLATION

A. The control sequences indicated in the specifications herein show the intended sequences of operation of the various control systems and shall be followed completely, deviations are not acceptable.

B. Each control system shall be complete with all necessary thermostats, valves, relays, switches, accessories, etc., and all interconnections, and so arranged that they will provide the proper automatic sequence of operation between the various control devices as required to maintain the desired temperature, conditions and sequences.

C. All control equipment shall be fully modulating unless otherwise noted, and relays or accessories not specifically mentioned but required for proper operation shall be included.

D. The system shall be installed by competent mechanics and electricians regularly employed by the controls Contractor. Installation by mechanical Contractor is not acceptable.

E. Control and instrument wiring and capillaries are to be secured to building structure—not to ductwork.

F. The exact location of instruments, panelboards, accessories, etc., not definitely located shall be approved by the Architect/Engineer.

G. All automatic controls and accessories shall be located in accessible locations.

H. All non-panel, as well as panel mounted instruments, shall be clearly labeled as to use and system served by means of engraved laminated nameplates.

I. Where control instruments or accessories are to be installed on covered casings, ductwork, etc., they shall be mounted on the finished surface of the covering. Care shall be taken that there are no leaks around the stems where they pass through the metal work.

J. All modulating control valves, dampers, etc., shall operate in a slow, gradual manner without any jerking or slamming.

K. All controls shall operate satisfactorily without any cycling or hunting. The manufacturer shall furnish any necessary additional controls, relays or damping devices as required to correct cycling or hunt that occurs in any part of the control system after the system is in operation.

L. Automatic control manufacturer shall provide power to all electric actuators requiring external power source whether they are furnished by him or part of other equipment.

M. Electronic VAV controllers, motors, and sensors shall be provided under this scope of work. The control Contractor shall also include the cost of mounting controllers and motors by the VAV box manufacturer in his price.

N. The Automatic Control Contractor shall furnish all motorized valves and dampers to the Mechanical Contractor for installation.

3.3 CONTROL MANUFACTURER'S FIELD SERVICES AND INSTRUCTIONAL REQUIREMENTS

A. Start-up and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation. On-site training shall not begin until the system has been accepted by the Engineer and field verifications completed.

B. Local Training (Classroom Training): Local training shall be provided for up to 7 of the Owner's representatives (6 staff members and the Engineer of Record). Local training may be held at the Owner's site or at the local distributors offices at the sole discretion of the Engineer. This training shall be customized to address only specific hardware/software used at the site. A working understanding of documentation formats shall be a part of this training. Course outline and schedule shall be submitted to the Engineer no less than 30 days prior to commencement. Training shall consist of both lecture and hands-on format and must address troubleshooting as well as operation of the system and in accordance with the training syllabus described herein.

The training syllabus shall include as a minimum the following:

- ❑ System Architecture and Overview
  - ❍ Menus
  - ❍ Demo disk/workshop
  - ❍ Building control
  - ❍ Scheduling
  - ❍ Zone control
  - ❍ Trend logs
  - ❍ Program priorities
- ❑ Application Troubleshooting
  - ❍ System set-up
  - ❍ Times and dates
  - ❍ Input/output data
  - ❍ Configuration
  - ❍ ICS local programming
  - ❍ Building status/graphics
  - ❍ Maintenance procedures
  - ❍ Troubleshooting procedures

Schedule shall be for no less than four (4) hours of such instruction per individual. Local training shall be completed within 15 days prior to substantial completion, but after field verification. Cost of local training is a part of this contract.

C. On-site Training: On-site training shall be provided for up to 7 of the Owner's representatives (6 staff members and the Engineer of Record). This training shall be completed in groups of no more than 4 persons per group at one time in one 4-hour session for each group. The training shall focus on the specific installation and shall address both hardware and software. This training shall be completed after local training and after substantial completion. Specific as-built documentation for this project shall be used for reference as a part of this training. Pre-submit course outline to Engineer as stated above.

D. For all levels of training, a sign-off sheet shall be submitted to the Engineer certifying that each individual has completed such training to acceptance of individual. Hours of instruction received shall be a part of the sign- off sheet.

E. It shall be the Owner's responsibility to provide adequate time for attendance at all training sessions.

F. Training Aids: Provide an "Owner's Copy" factory prepared DVD describing in layman's terms the complete operation of the system. This DVD shall be professionally made by the manufacturer of the system. DVDs (home made) locally are not acceptable. Provide a copy of this DVD with the submittal package to the Engineer for approval prior to proceeding.

3.4 DEMONSTRATION

A. General: Provide field testing and adjustment of the complete EMCS and on-site, operational acceptance test of the complete operational EMCS. The Owner may witness all tests.

B. Field Test: When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on line. All testing, calibration, adjusting, and final field tests shall be completed by the Controls Manufacturer. Provide a cross check of each control point within the EMCS by making a comparison between the control demand at the Master and field controlled device. Verify that all systems are operable from local controls in the specified failure mode upon EMCS failure or loss of power. Verify that all systems return to EMCS control automatically upon resumption of EMCS operation or return of power. Submit the results of functional, cross and diagnostic tests.

C. The Controls Manufacturer shall, as a part of the base scope, provide two (2) days of operational verification, on-site, with the design Engineer present throughout. The verification shall be completed during two (2) continuous days during building non-occupancy, at the end of the final phase of project construction. This two (2) day period shall be over a weekend unless otherwise agreed upon in writing by the Controls Manufacturer and Engineer at the end of the two (2) day period.

The punchlist items shall be corrected by the Installer to the satisfaction of the Engineer within a two (2) week period directly following the verification period and shall be demonstrated to the Engineer on a weekend day in order to complete the verification process. This process shall continue until all items have been successfully demonstrated and acknowledged to the Engineer in writing. This must be completed prior to substantial completion.

3.5 ACCEPTANCE AND WARRANTY

A. An acceptance test of the completed system in the presence of the Owner's representative and the Engineer shall be performed. When the system performance is deemed satisfactory by these observers and all record (as-built) drawings have been received by the Owner, that part of the system shall be accepted for beneficial use and shall be considered complete.

B. All control hardware, software, and firmware delivered to the Installer by the Controls Manufacturer shall be warranted by the Controls Manufacturer for a period of two (2) years following the date of completion. Defects arising during this warranty period shall be corrected without cost to the Owner.

3.6 CONTRACTOR TRENDING REQUIREMENTS

A. Contractor shall configure the system to provide Excel Spreadsheets showing all points (I/O; virtual points; Setpoints; etc.) referenced in the documents at 5 minute intervals. Coordinate the number of spreadsheets and layout with the Engineer of Record. The spreadsheets shall be electronically submitted weekly to the Engineer throughout the Warranty period. The first such spreadsheet shall be submitted and approved for content and format by the Engineer prior to Substantial Completion. Weekly submittal shall be consistent in layout week to week.

PART 4 SEQUENCE OF OPERATION

REFER TO DRAWINGS

4.1 GENERAL

A. The Control Contractor is responsible to provide/add the required points to correctly perform the specified sequence of operation.

*** END OF SECTION 23 09 00 ***

SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. The purpose of this contract is to provide construction commissioning in accordance with the Florida Building Code – Energy Conservation Requirements (Section C408—System Commissioning).

B. Refer to, and become familiar with the project's Construction Documents, and the following specifications.

1. Section 23 05 93 Testing, Adjusting, And Balancing For HVAC.

C. The following projects are exempt from these specification requirements:

1. Where total mechanical systems capacity in the project is less than 40 tons.

2. Systems that serve dwelling units and sleeping units such as hotels, motels, boarding houses, or similar units.

1.2 DEFINITIONS

A. Acceptance Phase: The phase of commissioning (typically commencing upon Substantial Completion) in which all uncompleted functional testing, training, and project documentation is finalized, and building performance is fine-tuned. Also known as "Occupancy and Operations Phase."

B. Balancer: The specialty subcontractor engaged by the Contractor to perform Testing, Adjusting and Balancing (TAB), of air and hydronic equipment and related control devices, to ensure the HVAC system operates within specified design parameters.

C. Commissioning Plan: A document, prepared by the CxA, which outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. Plan shall include the following:

1. Narrative of commissioning activities to be completed.

2. List of equipment and systems to be tested.

3. Functions to be tested.

4. Conditions under which tests will be performed.

5. Measurable criteria for performance.

D. Commissioning Team: Collectively, the group of Contractor-appointed and Owner-appointed representatives explicitly organized to implement the commissioning process through coordinated action. Individual team members each have authority to act on behalf of the entity they represent.

1. Contractor-Appointed Members:

a. Contractor, including Project superintendent

b. Subcontractors, including installers, suppliers, and any specialists deemed appropriate by the CxA.

c. CxA.

2. Owner-Appointed Members:

a. Engineer of Record.

b. Facility/Site Administrator, Operation & Maintenance Personnel.

E. Construction Phase: The phase of commissioning (typically concurrent with construction), in which the Commissioning Team works to ensure equipment, systems, and assemblies are properly installed, integrated, and operating in a manner compliant with the Construction Documents.

F. CxA: Certified Commissioning Authority. The designated person(s), company, or entity that plans, schedules, and coordinates the commissioning process. Contractor will engage the CxA as part of this contract.

G. Design Phase: The phase of commissioning (typically prior to construction) in which the Design Professional's Construction Documents (plans and specifications), etc., are reviewed for consistency with one another and with the OPR.

H. O&M: Operation and Maintenance – Can refer to either personnel or manuals

I. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and related supporting information.

J. Post-Acceptance Phase: The phase of commissioning (typically commencing upon Final Acceptance) in which follow-up checks are conducted to ensure equipment, systems, and assemblies continue to operate in a manner compliant with the OPR. Any deficiencies discovered during this phase are identified as warranty claims.

K. Pre-Design Phase: The phase of commissioning (typically prior to preparation of Construction Documents) in which the Commissioning Team is assembled, and the OPR is developed. Decisions made in subsequent commissioning phases should comply with the OPR.

L. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 OWNER'S RESPONSIBILITIES

A. Assign O&M personnel and schedule them to participate in Commissioning Team activities.

B. Provide the Construction Documents, prepared by Design Professional and approved by Owner, to the CxA and the Contractor for use in developing the commissioning plan, systems manual, and O&M training plan.

1.4 CXA QUALIFICATIONS

A. The CxA shall be a member in good standing with the National Environmental Balancing Bureau's Building Systems Commissioning group [BSC], the Associated Air Balance Council's Associated Commissioning Group [ACG] or the Building Commissioning Association (BCA).

B. The CxA shall have and maintain at least one of the following certifications:

1. Certified Commissioning Authority, awarded by the ACG Commissioning Group

2. Commissioning Process Management Professional, awarded by ASHRAE

3. Certified Commissioning Professional, awarded by the Building Commissioning Association (BCA)

C. The CxA shall have a fully staffed office and shall be regularly engaged in the testing and commissioning of building systems, including but not limited to HVAC, lighting, and domestic hot water systems.

D. All instruments used shall have been accurately calibrated no more than six months prior to use, and shall be maintained in good working order. Upon request, tests shall be conducted in the Owner's presence.

E. Contractor may engage the Engineer of Record for these services.

PART 2 GENERAL

(NOT USED)

PART 3 EXECUTION

3.1 CONSTRUCTION PHASE ACTIVITIES—DURING THIS COMMISSIONING PHASE, THE CXA SHALL:

A. Identify all the Commissioning Team members.

B. Schedule and conduct a "kick-off" meeting to bring all Commissioning Team members together, distribute the Commissioning Plan, identify roles for each team member; discuss the commissioning process, and review the schedule.

C. Schedule and conduct all commissioning meetings, providing minutes and task tracking.

D. Review shop drawings, equipment submittals, TAB procedures and report formats for conformance with the OPR & Construction Documents.

E. Update the Commissioning Plan to reflect equipment and controls submittal.

F. Integrate the commissioning schedule into the Contractor's schedule.

G. Provide System Verification Checklists (SVCs) for the pre-startup report.

H. Develop and provide start-up reports and include any manufacturer's start-up requirements for the contractor's equipment start-up.

I. Provide on-site inspections of the general installation as it progresses.

J. Review or witness duct and hydronic leak testing.

K. Review completed SVCs completed by the Contractor and sign off to release for start-up when completed.

L. Witness controls operations, including point-to-point check out of all components.

M. Review or witness TAB testing and report. During the commissioning efforts, the CxA shall expect to receive no more than 8 hours of onsite assistance from the TAB agency. This 8 hours is in addition to the time required to perform all TAB efforts as described in section 23 05 93.

N. Merge all TAB deficiencies into report format for tracking.

O. Incorporate all changes and Design Professional's responses to Contractor's requests for information.

P. Notify Owner in writing when the systems are ready for the acceptance phase.

Q. At a minimum, the following systems shall be commissioned:

1. Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls.

2. Lighting controls (by others).

R. Based on operational system availability, conduct and document as early as possible (i.e., prior to any recommendation for Substantial Completion) functional testing of 100% of all major system components including point-by-point controls verification.

3.2 ACCEPTANCE PHASE ACTIVITIES—DURING THIS COMMISSIONING PHASE, THE CXA SHALL:

A. Verify (in writing) the report test data of the Balancer's previously tested equipment.

B. Check controls for proper calibrations, and list all controls requiring adjustment by control installers. A software functional performance point-by-point check-out and test, along with verification forms, shall be included in the Commissioning Report.

C. Conduct Functional Tests and include the results in the Commissioning Report. If design/operating deviations beyond published allowable tolerances are identified, Owner reserves the right to require additional system testing. Owner will establish the scope in writing and approve proposed costs for additional services prior to commencement of any such additional testing. Functional Test shall include the following:

1. HVAC Controls: Test and document control temperature or pressure readout of the device and compare to actual measured condition.

2. Sequence of Operations: Include all major systems such as AHU's, Chillers, DX equipment, and so on; and subsystems such as VAV's, Fans, Fan Coil Unit's, and so on; to verify proper operation. All interlocks shall be field verified. Include a description of operation in the Commissioning Report.

D. Visit site to review progress on a regular basis. Note the progress and all deficiencies in a field report submitted to the Owner each visit. Deficiencies must be uniquely numbered and tracked, with the responsible party clearly identified. A consolidated deficiency list is to be included with the Commissioning Report. Indicate the status of each deficiency as either "Not Resolved" or "Resolved." All parties involved in the contract, including Engineer, CM (or GC), mechanical contractor, controls contractor, Test and Balance Agency, etc., shall sign each field report.

E. Communicate with the installer that upon correction of the deficiencies, the installer shall notify the CxA in writing that the problem is resolved. If the deficiency is not corrected, the Contractor and Balancer will be responsible for the cost of additional re-testing.

F. Verify and confirm in writing that HVAC systems (air, water, electrical, and capacities) have been adjusted and balanced within tolerances published in the Construction Documents.

G. Organize and direct the Contractor/Vendor training of O&M personnel.

H. Verify all required documentation has been furnished to Owner, including any information presented during training sessions.

I. Review the operation of all commissioned systems with O&M staff and building occupants no more than ten (10) months following the date of Substantial Completion. Develop and submit to Owner a written plan for resolving any outstanding commissioning-related issues.

3.4 CxA SUBMITTALS

A. Construction Phase Reports: Submit first report to all members of the Commissioning Team within 30 days of the start of construction. Unless directed otherwise, submit weekly reports thereafter. Reports shall include all documentation required in Part 3.3 – Construction Phase Activities, above.

B. Preliminary Commissioning Report: A preliminary report shall be issued to the Owner and shall identify:

1. Itemization of deficiencies.

2. Deferred test due to climatic conditions.

3. Climatic conditions required for deferred test.

Final mechanical inspection shall not occur until code official has received a letter from the building owner acknowledging that the Building Owner has received the preliminary Commissioning Report.

C. Final Commissioning Report: A Final Report shall be issued to the Owner and shall include the following.

1. Results of functional tests.

2. Resolution of deficiencies.

3. Functional performance test procedures.

D. Manuals: An operation and maintenance manual shall be provided that includes the following:

1. Equipment submittal data.

2. Manufacturer's operation and maintenance manuals.

3. Name and address of at least one service agency capable of providing maintenance services.

4. HVAC controls system maintenance and calibration information.

5. A narrative of how each system is intended to be operated, including setpoints.

E. After the CxA's receipt of equipment submittal data from the installer, equipment start-up forms will be transmitted from the CxA to the installer for use in equipment start-up. The completed forms will be returned to the CxA prior to the beginning of the test and commissioning phase.

F. The final commissioning report shall be submitted within 90 days of the date of Certificate of Occupancy. The report shall document the function of all systems at the time of Substantial Completion of the project. All outstanding deficiencies shall be documented in the report. When all commissioning activities are complete, a final commissioning report will be submitted including all documentation and testing results.

3.5 CXA MEETINGS, OBSERVATIONS, AND TESTING

A. Inspections: Conduct observations regularly during construction. Test systems for proper installation of balancing devices, for generally accepted construction practices related to each system.

Verify installed work conforms with the Construction Documents.

B. Perform Commissioning activities associated with the HVAC System as described herein.

3.6 CxA REPORTS

A. Provide two (2) copies of tabulated report and one electronic copy in .pdf format, in neatly organized typed form. Report will include start-up reports and drawings to coincide with the commissioning report. In addition, all reports shall incorporate a summary page(s) which shall include:

1. General description of project (building type, system type, equipment description, etc.)

2. HVAC Equipment approved submittals (shop drawings).

3. Functional Performance Test Reports

4. Start-up reports.

5. Observation reports with consolidated deficiency list.

6. Point by Point control verification.

7. Systems' balance verification.

8. The final Test and Balance report with the engineer's letter of acceptance.

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SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Cellular glass.

b. Flexible elastomeric.

c. Mineral fiber.

2. Insulating cements.

3. Adhesives.

4. Mastics.

5. Lagging adhesives.

6. Sealants.

7. Field-applied fabric-reinforcing mesh.

8. Field-applied cloths.

9. Field-applied jackets.

10. Tapes.

11. Securements.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at pipe expansion joints for each type of insulation.

3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

4. Detail removable insulation at piping specialties, equipment connections, and access panels.

5. Detail application of field-applied jackets.

6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in piping insulation application with three (3) years minimum experience.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation prior to operating to operating system. Do not use wet insulation materials or apply insulation to wet surfaces.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Block Insulation: ASTM C 552, Type I.

2. Special-Shaped Insulation: ASTM C 552, Type III.

3. Board Insulation: ASTM C 552, Type IV.

4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

H. Type A Piping Insulation:

1. Impermeable, noncombustible, closed cellular glass insulation, conforming to ASTM C 552-79, "Specification for Cellular Glass Block and Pipe Thermal Insulation."

2. Conductivity (k) equals approximately 0.29 (BTU-IN/HR, SF, degrees F) at 75 degrees F.

3. Joint sealants and coatings shall be as approved by the insulation manufacturer for the intended application and service temperature range.

4. Jacketing shall be approximately 125 mils thick, consisting of a bituminous resin reinforced with a woven, glass fabric, an integral aluminum foil layer, and a protective plastic film coating.

5. Approved Manufacturers and trade names:

   a. Pittsburgh Corning Corp. "*Foamglass Super K*" with Pittseal, Pittcote, and Pittwrap.

   b. Approved Equal.

I. Type B Piping Insulation:

1. Closed cell, flexible foamed plastic conforming to ASTM C177 or ASTM C518, "Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form."

2. Conductivity (k) equals approximately 0.27 (BTU-IN/HR, SF, Degree F) at 75 degrees F.

3. Approved Manufacturers and trade names:

   a. Armstrong "*AP Armaflex*"

   b. Rubetex Corp. "*Rubetex*"

J. Type C Piping Insulation:

1. Glass fiber, rigid molded sectional pipe covering conforming to ASTM C547, Class II, Mineral Fiber Preformed Pipe Insulation.

2. Conductivity (k) equals approximately 0.23 (BTU-IN/HR, SF, Degree F) at 75 degrees F.

3. Approved Manufacturers and Trade Names:

   a. Manville Corp. "*Micro-Lok 650-AP-T*."

   b. Owens-Corning Fiberglass Corp. "*One Piece 25 ASJ/SSL-II*"

   c. Certain-Teed "*500 Degree Snap-On*."

   d. Knauf Fiberglass "*Knauf Pipe Insulation, 850°F*."

K. Type A-D Duct Insulation:

1. Flexible glass fiber; ANSI/ASTM C553; commercial grade; 6.0 installed 'R' value (minimum) at 75 degrees F, 0.002 foil scrim facing for air conditioning ducts (nominally 2" thick).

L. Type B-D Insulation:

1. Glass fiber; UL Class 1; 'k' value of 0.24 at 75 degrees F 3 lb/cu ft minimum density; black pigmented, fire resistant coated air side for maximum 6,000 ft/min air velocity. Insulation shall be Owens-Corning Fiberglas Aeroflex Duct Liner.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; FlameChek.

b. Johns Manville; Firetemp Wrap.

c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.

d. Thermal Ceramics; FireMaster Duct Wrap.

e. 3M; Fire Barrier Wrap Products.

f. Unifrax Corporation; FyreWrap.

g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; Triple I.

b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-fiber, hydraulic-setting cement is suitable for temperatures from 100 to 1200 deg F (38 to 649 deg C) and for a smooth surface.

D. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Insulco, Division of MFS, Inc.; SmoothKote.

b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.

c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-96. (-20 to 180)

b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide the following:

a. Aeroflex USA Inc.; Aeroseal.

b. Armacell LCC; 520 Adhesive.

c. Foster Products Corporation, H. B. Fuller Company; 85-75.

d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Products Corporation, H. B. Fuller Company; 30-65.

b. ITW TACC, Division of Illinois Tool Works; CB-50.

c. Marathon Industries, Inc.; 590.

d. Mon-Eco Industries, Inc.; 55-40.

e. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-9.

b. ITW TACC, Division of Illinois Tool Works; CB-05/15.

c. Marathon Industries, Inc.; 550.

d. Mon-Eco Industries, Inc.; 55-50.

e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.

4. Solids Content: 63 percent by volume and 73 percent by weight.

5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-52.

b. Foster Products Corporation, H. B. Fuller Company; 81-42.

c. Marathon Industries, Inc.; 130.

d. Mon-Eco Industries, Inc.; 11-30.

e. Vimasco Corporation; 136.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

4. Service Temperature Range: Minus 50 to plus 180 deg F.

5. Color: White.

2.7 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76.

a. Foster Products Corporation, H. B. Fuller Company; 30-45.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Pittsburgh Corning Corporation; Pittseal 444.

e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Permanently flexible, elastomeric sealant.

5. Service Temperature Range: Minus 100 to plus 300 deg F.

6. Color: White or gray.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; CP-76-8.

a. Foster Products Corporation, H. B. Fuller Company; 95-44.

b. Marathon Industries, Inc.; 405.

c. Mon-Eco Industries, Inc.; 44-05.

d. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.

4. Fire- and water-resistant, flexible, elastomeric sealant.

5. Service Temperature Range: Minus 40 to plus 250 deg F.

6. Color: Aluminum.

7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.

5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 3 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 3 oz./sq. yd. with a thread count of 6 strands by 5.5 meshes per inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

2. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.

a. Vimasco Corporation; Elastafab 894.

b. Childers Products, Division of ITW; Chil-Glas No. 10.

c. Pittsburgh Corning, PC Fabric 79.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system..

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

2.10 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.

3. Thickness: 6.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

b. Compac Corp.; 120.

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Aluminum: ASTM B 209 Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. AGM Industries, Inc.; CWP-1.

   b. GEMCO; CD.

   c. Midwest Fasteners, Inc.; CD.

   d. Nelson Stud Welding; TPA, TPC, and TPS.

3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; CWP-1.

      2) GEMCO; Cupped Head Weld Pin.

      3) Midwest Fasteners, Inc.; Cupped Head.

      4) Nelson Stud Welding; CHP.

4. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

      2) GEMCO; Perforated Base.

      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

      2) GEMCO; Press and Peel.

      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

   c. Spindle: Copper- or zinc-coated, low carbon steel fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; RC-150.

      2) GEMCO; R-150.

      3) Midwest Fasteners, Inc.; WA-150.

      4) Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) GEMCO.

      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

2. C & F Wire.

3. Childers Products.

4. PABCO Metals Corporation.

5. RPR Products, Inc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 0 and 200 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. Provide self adhesive aluminum tape continuous along staples seams.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. Overlap wrapped insulation 12 inches beyond point of lined duct connections.

Q. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

E. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Refer to drawings for details

2. Fabricate boxes from aluminum, at least 0.060 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

F. Interior Piping

1. Butter joints of Foamglass insulation with adhesive. Apply insulation to pipe and fittings with all joints tightly fitted. Secure with stainless steel wire so that each length of insulation shall be secured with two wires. Insulation shall be applied with all joints fitted to eliminate voids. Voids shall be eliminated by refitting or replacing insulation. Do not fill voids with joint sealer.

2. Finish with metalized polyester/scrim/bleached white Kraft or approved foil/scrim/bleached white Kraft, all service jacket (ASJ). Finish elbows and fittings with mastic reinforced with white open weave membrane with maximum mesh opening of 10 x 10 per inch.

G. Exterior and Mechanical Equipment/Storage Rooms Piping

1. Apply insulation as noted above and apply vapor barrier reinforced with white open weave membrane with maximum mesh opening of 10 x 10 per inch. Then apply a second coat of vapor barrier and finish with 0.016 inch thick aluminum jacket. Elbows and tees shall be finished with preformed 0.024 inch thick aluminum fitting covers.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Interior Piping

1. Type B insulation shall be slipped on the pipe prior to connection, and the butt joints shall be sealed. Where the slip-on techniques is not possible, the insulation shall be carefully slit and applied to the pipe.

2. All joints shall be sealed with the Manufacturer's recommended adhesives.

3. Do not apply Type B insulation in multiple layers.

4. Type B insulation shall not be used in plenums nor fire wall penetrations.

5. This Contractor shall paint Type B insulation exterior to the building with two (2) coats of a vinyl lacquer paint recommended by the Insulation Manufacturer.

F. Exterior and Mechanical Equipment/Storage Rooms Piping

1. Type B insulation shall be installed as described for interior except the pipe and fitting shall be covered with .016 inch thick aluminum jacket.

2. Elbows and tees shall be finished with preformed 0.024 inch thick aluminum fitting covers.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use tape along lap seal to secure joint.

2. Repair holes or tears in jacket by placing tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 MINERAL FIBER PIPE INSULATION INSTALLATION

A. Interior—Type C Pipe Insulation

1. Tightly butt together sections of insulation on pipe runs sealing longitudinal seams of jacket with vapor barrier adhesive. Seal end joints with four inch (4") wide straps of vapor barrier tape. Seal off ends of insulation with vapor seal mastic at valves, fittings, and flanges. No further finish required.

B. Exterior and Mechanical Equipment/Storage Rooms—Type C Pipe Insulation

1. PVC fitting jackets shall be used for the particular application.

3.10 DUCT INSTALLATION

A. Type A-D Installation

1. Apply insulation tightly and smoothly to duct.

2. Secure insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag.

3. Install all materials in accordance with Manufacturer's installation instructions.

4. Butt all insulation joints firmly.

5. Install duct wrap to obtain specified 'R' value using a maximum of 25% compression.

6. All penetrations and damage to the facing shall be repaired with tape and mastic prior to system start-up.

7. Provide 3" wide (minimum) pressure sensitive tape applied with moving pressure using an appropriate sealing tool at all seams and joints. Apply vapor seal mastic over all taped seams and joints.

8. Longitudinal seam of the vapor retarder shall be overlapped a minimum of 2 inches. A 2 inch tab shall be provided for the circumferential seam.

9. Closure systems shall have a 25/50 flame spread/smoke developed rating per UL 723.

10. For rectangular ducts over 18 inches wide, the duct wrap shall be secured to the bottom side of the duct with mechanical fasteners spaced on 18 inch centers to reduce sag. Fasteners shall be installed in a manner to avoid over compressing the insulation with the retaining washer.

11. Impale insulation on the bottom of ducts and plenums and on the sides of plenums and other places where the insulation will sag.

12. Cut off protruding pin after clips are secured and seal with aluminum backed pressure sensitive tape.

13. Apply insulation with joints tightly butted.

14. Seal all ductwork joints, punctures, and fittings with a mastic type sealant containing a vapor barrier.

15. Cover all breaks, joints, punctures, and voids with a vapor seal mastic and cover with a vapor barrier material identical to vapor barrier on the insulation.

16. Bevel insulation around nameplates, access plates, and doors.

17. Insulation shall be continuous through walls and floors except at fire dampers.

B. Type B-D Installation

1. All portions of duct designated to receive duct liner shall be completely covered with Duct Liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. Board shall be cut to assure tight, overlapped corner joints. Top pieces shall be supported by the side pieces.

2. The black coated surface of Duct Liner shall face the air stream.

3. Duct Liner shall be adhered to the sheet metal duct with 100% coverage of adhesive, all exposed leading edges and transverse joints shall also be coated with adhesive. In addition to the above, mechanical fasteners shall be used to secure the Duct Liner to the duct. All edges of duct liner shall be coated with adhesive during the fabrication of ductwork and all exposed edges shall be coated with adhesive prior to field installation of sections.

4. For horizontal runs when the duct width exceeds 12" or the duct height exceeds 16", the Duct Liner Board shall be additionally secured with mechanical fasteners starting within 3" of upstream transverse edges of the Liner and spaced at a maximum of 15" o.c. and 15" from longitudinal joints. On vertical runs, the fasteners shall be used when either dimension exceeds 12".

C. Install all materials in accordance with Manufacturer's installation.

D. Continue insulation with vapor barrier through penetrations.

3.11 FIRE-RATED PENETRATIONS

A. Install firestopping at penetrations through fire-rated assemblies.

3.12 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Owner. Vary first and second coats to allow visual inspection of the completed Work. Refer to Mechanical Identification specification.

D. Do not field paint aluminum or stainless-steel jackets.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Chiller Cold Surfaces—Type 'B'—1" thick (add insulation to all surfaces which exhibit condensation).

B. Air Separators, Strainers, Valve Bodies etc.—Type 'A'—2" thick.

C. All Equipment Operating Below Ambient Dew Point—Type 'A'—2" thick.

3.14 INDOOR PIPING INSULATION SCHEDULE

A.

SERVICE	PIPE SIZE	INSULATION TYPE AND THICKNESS
Exterior Chilled Water (including unconditioned spaces and mechanical equipment rooms)	All	2-1/2" Type A
Interior Chilled Water (Including Domestic)	2" or Less	1-1/2" Type A
Interior Chilled Water	2-1/2" to 12"	2" Type A
Interior Chilled Water	14" and Larger	2-1/2" Type A
Refrigerant Suction Pipes (except in plenums or fire wall penetrations)	All	3/4" Type B
Refrigerant Suction Pipes and Coil Condensate Lines (in plenums or fire wall or floor penetrations)	1-1/4" or Less	1-1/2" Type A
Refrigerant Suction Pipes and Coil Condensate Lines (in plenums or fire wall or floor penetrations)	1-1/4" or More	1-1/2" Type A
Condensate and Equipment Drain Water Below 60°F	All	1" Type B

3.15 DUCT INSULATION SCHEDULE

A. Outside Air Intake and Supply and Return Ductwork—Type A-D (nominally 2" thick).

B. Flex Connections at Air Handling Units and Other Transitions—Type A-D (nominally 2" thick).

C. All Equipment and Ductwork Operating Below Ambient Dew Point—Type A-D (nominally 2" thick).

D. Supply and Return Ductwork—Exposed in Occupied Spaces— Type B-D (1" thick) sandwiched inside double wall duct. Refer to Ductwork specification for more information.

E. Exhaust, Relief and Air Transfer Ductwork—Type B-D (1" thick).

F. Tops of All Supply Diffusers—Type A-D (nominally 2" thick).

*** END OF SECTION 23 07 00 ***

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.

b. Variable-flow hydronic systems.

c. Primary-secondary hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

G. The test and balance firm will submit two (2) copies of data for the testing and balancing for the approval of the Project Architect/Engineer and three (3) file copies to the Owner and two (2) copies to this Contractor.

H. All data and information shall be compiled in a neat, orderly format on 8-1/2" x 11" test forms and shall be signed and sealed by the certified individual as previously described.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Contractor on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.

b. The TAB plan.

c. Coordination and cooperation of trades and subcontractors.

d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Owner. Written report submitted to the Engineer a minimum of 15 days prior to Substantial Completion of each project phase. The Owner will then perform a verification TAB. If discrepancies are found, they will be corrected by this Contractor and the contractor will responsible to pay for additional trips for the Owner's TAB representatives to verify.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE111, Section5, "Instrumentation." All instruments used shall be accurately calibrated within six months of testing and balancing and shall be maintained in good working order.

F. The final result of balancing shall be to provide uniform air temperatures within a two (2) degree F spread in the conditioned space at peak load conditions.

G. In the event of dispute, the Owner or Contractor or Project Architect/Engineer may choose to provide verification of test and balance reports, and such verification shall be by a second independent agency selected by the Engineer. Reports found to be inaccurate will be disallowed, and the Contractor's test and balance firm will be required to repeat operations under the supervision of the second independent agency until accurate reports are completed and agreed upon, provided the Contractor's TAB firm is found to be at fault in the judgment of the Engineer. The cost of disputed test and balance work shall be borne by the Owner or Contractor (whichever is found to be at fault).

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 SCOPE

A. Description

1. The Contractor shall, at the Contractor's expense, procure the services of an independent testing and balance firm which specializes in the balancing and testing of heating, ventilating and air conditioning systems. This specialty services firm shall balance, adjust and test water circulation, air moving equipment, air distribution and/or exhaust systems as herein specified.

2. Test and balance work shall not begin until all systems have been completed and are in full working order to the satisfaction of the Project Architect/Engineer and the Owner. This Contractor shall make all preliminary tests and adjustments before advising in writing that test and balance work is ready to begin and shall place all systems and equipment into full operation during each working day of testing and balancing.

3. The Contractor shall perform baseline testing of the 2 existing CRAC units prior to demolition. This shall include airside and waterside testing of the CRAC units. Testing of the chillers and pumps is not required.

4. Upon completion of the installation of the 2 new CRAC units, complete airside and waterside testing shall be completed including operating characteristics of the new roof mounted air cooled condenser.

B. Replacement pulleys (adjustable and non-adjustable), additional balancing dampers, pressure taps, balancing valves, cocks and fittings, etc., required to effect proper air and water balance shall be furnished and installed by this Contractor at no additional cost to the Owner. This Contractor shall do this work as soon as possible so as not to delay the completion of the test and balance work.

C. Air filters shall be replaced and strainers shall be cleaned by this Contractor before proceeding with test and balance and thereafter as required by the test and balance firm.

D. Systems shall be placed into service using approved start up procedures. This (mechanical) contractor shall be responsible for proper initial setting and adjustment of HVAC equipment, air handlers, VAV boxes, exhaust fans, etc. furnished and installed by him.

E. This Contractor shall provide test openings as required; shall operate HVAC equipment and provide trades persons to assist and make adjustments for test and balance during the process.

F. When the Owner's verification test and balance firm is ready to test according to the established schedule, but is prevented from testing and balancing, making adjustments or taking measurements due to incompleteness of the work, all extra charges for test and balance attributable to the delay may be back charged to this Contractor. The Project Architect/Engineer shall be the judge as to whether a delay has occurred and back charges due the Owner, and which, if judged proper, shall be effected through a Change Order reducing the Contract Sum.

G. The Contractor's test and balance firm shall periodically visit the site during construction of the HVAC system. No less than two visits per phase will be made. Should methods, materials or workmanship being used adversely affect balancing and adjusting work, the test and balance agency shall report its findings in writing to the Contractor with recommendations for correction.

H. The Contractor's test and balance firm has agreed or shall agree to carry out the test and balance in accordance with the AABC National Standards for Total Systems Balance or the NEBB Procedural Standards for Testing, Adjusting and Balancing or Environmental Systems, Fourth edition, and in conformance with ASHRAE Handbook, Chapter 34, Testing, Adjusting and Balancing and as outlined in this Specification Section.

I. This Contractor shall furnish to the testing and balancing agency a complete set of plans and specifications, addenda, shop drawings, schedules and change orders as may be required.

J. The TAB Contractor shall be responsible for the following efforts associated with commissioning:

1. Attendance at the commissioning kick-off meeting,

2. An additional 8 hours of onsite testing in support of the CxA agency.

PART 2 PRODUCTS

(NOT APPLICABLE)

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Ductwork" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

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

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke, and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE62.1, Section7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Ductwork."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Owner and Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.

2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow. Close all bypass valves. Set modulating valve to full coil flow.

2. Check liquid level in expansion tank.

3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.

6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

9. Check all strainers and, if required, clean same.

10. Examine water in system and determine if water has been treated and cleaned. If water appears dirty, test and balance work shall stop and this Contractor shall reclean system as specified in the Project Specifications.

11. Check all air vents at high points of water system and determine if all are installed and operating freely. Make sure all air is removed from the system.

12. Set all temperature controls so all coils are calling for full cooling, and determine that this closes all automatic by-pass valves at coils.

13. Check operation of automatic by-pass valves.

14. Check and set operating temperatures of chillers and heat exchangers to design requirements.

15. Complete air balance work must have been accomplished and all work adjusted and corrected before actual water balance is complete.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, turn these dimensions, along with the installed pump curves with the new pump and system curves, for review by the Engineer. Upon approval by the Engineer, the impeller dimensions shall be turned over to the installing contractor for impeller shaving.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.

3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

2. Water flow rate.

3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.

5. Wet-bulb temperature of entering and leaving air for cooling coils.

6. Airflow.

7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.

2. Airflow.

3. Entering- and leaving-air temperature at full load.

4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.

6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.

2. Airflow.

3. Air pressure drop.

4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

4. Air pressure drop.

5. Refrigerant suction pressure and temperature.

3.13 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.

3. Check the refrigerant charge.

4. Check the condition of filters.

5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.

7. Check bearings and other lubricated parts for proper lubrication.

8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.

2. Coils are clean and fins combed.

3. Drain pans are clean.

4. Fans are clean.

5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.14 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

2. Air Outlets and Inlets: Plus or minus 10 percent.

3. Heating-Water Flow Rate: Plus or minus 10 percent.

4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.15 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB contractor.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

a. Indicated versus final performance.

b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.

c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.

e. Fan drive settings including settings and percentage of maximum pitch diameter.

f. Settings for supply-air, static-pressure controller.

g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.

5. Terminal units.

6. Balancing stations.

7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches, and bore.

i. Center-to-center dimensions of sheave, and amount of adjustments in inches.

j. Number, make, and size of belts.

k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat-coil static-pressure differential in inches wg.

g. Cooling-coil static-pressure differential in inches wg.

h. Heating-coil static-pressure differential in inches wg.

i. Outdoor airflow in cfm.

j. Return airflow in cfm.

k. Outdoor-air damper position.

l. Return-air damper position.

m. Vortex damper position.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.

    b. Horsepower and rpm.

    c. Volts, phase, and hertz.

    d. Full-load amperage and service factor.

    e. Sheave make, size in inches, and bore.

    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.

    b. Total system static pressure in inches wg.

    c. Fan rpm.

    d. Discharge static pressure in inches wg.

    e. Suction static pressure in inches wg.

G. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling-unit identification.

    b. Location and zone.

    c. Room or riser served.

    d. Coil make and size.

    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.

    b. Entering-water temperature in degF.

    c. Leaving-water temperature in degF.

    d. Water pressure drop in feet of head or psig.

    e. Entering-air temperature in degF.

f. Leaving-air temperature in degF.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Verify that balancing devices are marked with final balance position.

e. Note deviations from the Contract Documents in the final report.

B. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

*** END OF SECTION 23 05 93 ***

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive. Colors shall comply with ANSI A13.1. Size markers and letters as follows:

OUTSIDE DIAMETER OF INSULATION OR PIPE	LENGTH OF COLOR FIELD	SIZE OF LETTERS
¾" - 2"	1" x 8"	¾"
2½" - 6"	2¼" x 13"	1¾"
8" - 10"	4" x 24"	2½"
Over 10"	4" x 32"	3½"
Ductwork and Equipment	All	3½"

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: 1-1/2 inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.

2. Fasteners: Reinforced grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic equipment markers. Small devices, such as in-line pumps, may be identified with metal tags.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

8. Tags may be used on small diameter piping.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue : For cold-air supply ducts.

2. Yellow : For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels at air handlers, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Identify as to air handling unit number and service (supply air , return air, exhaust, outside air, etc.).

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Provide a valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 EQUIPMENT LOCATOR TACK

A. Equipment Located Above Ceiling (i.e., VAV boxes, fans, air handlers, fire dampers, smoke dampers, etc.): Provide equipment locator tack, located on the ceiling directly below the equipment, to be spot marked and so mark is easily visible from the floor. Use a permanent marker and label each tag with the name of the equipment. Color code equipment by type as follows:

EQUIPMENT ABOVE CEILING	COLOR
Air Handlers/Fan Coil Units	Light Blue
Exhaust Fans	Green
VAV Boxes	Yellow
Duct Heaters	Orange
Fire Dampers	Red
Smoke Dampers	Red

B. Ductwork Volume Dampers Above the Ceiling: Tie an orange tape flag, minimum 18" long, from each volume damper. Let tape hang down vertically.

*** END OF SECTION 23 05 53 ***

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SECTION 23 05 48

VIBRATION AND WIND RESTRAINT CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Elastomeric hangers.
3. Spring hangers.
4. Pipe riser resilient supports.
5. Resilient pipe guides.
6. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: Refer to Structural Drawings.
2. Building Classification Category: Refer to Structural Drawings.
3. Refer to structural drawings for minimum load requirements.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Delegated-Design Submittal: Equipment mounted outdoors shall comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation wind forces required to select wind restraints.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

2. Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

c. Coordinate wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. Isolation Technology, Inc.

3. Kinetics Noise Control.

4. Mason Industries.

5. Vibration Eliminator Co., Inc.

6. AVNEC Incorporated.

7. Kevflex.

B. Isolation Pads—A double deflection pad-type mounting consisting of two layers of 3/8" thick ribbed or waffled Neoprene pads bonded to a 16 gage galvanized steel separator plate. Pads shall be sized for approximately 20 to 40 psi load and a deflection of 0.12" to 0.16".

C. Elastomeric Hangers Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

D. Spring Hangers Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Flanged Pump Piping Isolator, spherical rubber expansion joint constructed of molded neoprene, nylon cord reinforced, with integral steel floating flanges, suitable for pressure up to 225# (4 to 1 safety factor) and temperatures up to 225°F. Connectors shall have minimum movement capability of 1/2" compression, 3/8" extension 1/2" lateral and 15° angular. Where allowable movements will be exceeded or where operating pressures exceed the following, control rods shall be installed at each connector to limit elongation to 3/8".

through 4"..... 200 psi
5" to 10"..... 150 psi
12" to 14"..... 100 psi
16" to 24"..... 50 psi

Control units shall be of the spring isolated design through 8" and neoprene isolated for 10" and larger to limit noise and vibration transmission through the control rods.

F. Pipe Riser Resilient Support All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

G. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.

3. Mason Industries.

4. Vibration Eliminator Co., Inc.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.3 VIBRATION-CONTROL AND WIND-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install wind restraints on outdoor HVAC equipment.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install wind-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported or Suspended Equipment: Install vibration isolators and flexible connectors for the following motor driven equipment.

1. Pumps: Flanged Pump Piping Isolator (mount on suction and discharge side of pump piping).

2. Chillers, Cooling Towers, Air Cooled Condensing Units, and Computer Room A/C Units: Neoprene Isolation Pads.

3. Suspended Split System Air Handling Units and Power Ventilators: Elastomeric or Spring Hangers.

*** END OF SECTION 23 05 48 ***

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SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
5. Division 23 Section(s) “Ductwork" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Fiberglass pipe hangers.

3. Thermal-hanger shield inserts.

4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Fiberglass strut systems. Include Product Data for components.

4. Pipe stands. Include Product Data for components.

5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code—Steel."

2. AWS D1.2, "Structural Welding Code—Aluminum."

3. AWS D1.3, "Structural Welding Code—Sheet Steel."

4. AWS D1.4, "Structural Welding Code—Reinforcing Steel."

5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.

2. Bergen-Power Pipe Supports.

3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.

5. Empire Industries, Inc.

6. ERICO/Michigan Hanger Co.

7. Globe Pipe Hanger Products, Inc.

8. Grinnell Corp.

9. GS Metals Corp.

10. National Pipe Hanger Corporation.

11. PHD Manufacturing, Inc.

12. PHS Industries, Inc.

13. Piping Technology & Products, Inc.

14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.

3. GS Metals Corp.

4. Power-Strut Div.; Tyco International, Ltd.

5. Thomas & Betts Corporation.

6. Tolco Inc.

7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

c. Masterset Fastening Systems, Inc.

d. MKT Fastening, LLC.

e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-Type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.

c. Hilti, Inc.

d. ITW Ramset/Red Head.

e. MKT Fastening, LLC.

f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

C. Low-Type , Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Available Manufacturers:

a. MIRO Industries.

D. High-Type , Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Available Manufacturers:

a. ERICO/Michigan Hanger Co.

b. MIRO Industries.

c. Portable Pipe Hangers.

2. Base: Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type , Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Available Manufacturers:

a. Portable Pipe Hangers.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

B. Sleeves for Pipes through Non-fire Walls or Footings. Form with steel pipe or 18 gage galvanized steel, unless otherwise directed on the drawings with a more stringent requirement.

C. Sleeves through outside walls shall be made with 18 gauge galvanized steel and fitted with chrome escutcheon covers at all finished surfaces.

D. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated sleeves including seals, UL Listed. Contractor shall submit manufacturer's UL approved methods for firesafing all types required for the project as coordinated with the methods of floor and wall construction. Refer to the plans for further requirements.

E. Sleeves for Round Ductwork: Form with galvanized steel.

F. Sleeves for Rectangular Ductwork: Form with galvanized steel.

G. Caulk: Silicone sealant of top quality

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 degF pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-Type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degF piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degF piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-Type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS P-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand types except Curb-Mounting Type : Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

   b. NPS 4: 12 inches long and 0.06 inch thick.

   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

Q. Support horizontal piping as follows:

PIPE SIZE (INCHES)	MAXIMUM HANGER SPACING	HANGER ROD DIAMETER
1/2 to 1-1/4	6'-6"	3/8"
1-1/2 to 2	9'-0"	3/8"
2-1/2 to 3	10'-0"	1/2"
4 to 6	10'-0"	3/4"
8 to 12	14'-0"	7/8"
14 to 18	20'-0"	1"
PVC (All Sizes)	4'-0"	3/8"

R. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

S. Place a hanger within 12 inches of each horizontal elbow.

T. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

U. Support vertical piping at every floor and support from wall midway between ceiling and floor or at 12 feet maximum spacing, whichever is less. Support vertical cast iron pipe at each floor and at each hub.

V. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

W. Support riser piping independently of connected horizontal piping.

X. All auxiliary steel required for pipe supports shall be furnished and installed by this Contractor. Where building structure is not usable for pipe supports, provide steel members, channels, angles, or "UNISTRUT" components for piping support. All auxiliary steel exposed to weather shall be galvanized.

Y. Provide all steel required for support of pipes other than steel shown on structural Engineer's drawings.

Z. Interior Pipe Guides, Expansion Loops, and Anchors: Provide pipe guides, expansion loops, and anchors on hot water heating pipes installed above the ceiling. Expansion loops shall be installed every 50 feet and supported from building structure with pipe guides on 10 feet spacing. Piping shall be anchored to the structure as necessary for directional expansion control.

AA. Located In or Around Cooling Tower Yards: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane or 316 stainless steel.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Brace and fasten with flanges bolted to structure.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide equipment bases and supports of concrete Type under all mechanical equipment and as shown on drawings.

D. Provide lateral bracing, to prevent swaying, for equipment supports. Provide rigid anchors for pipes after vibration isolation components are installed.

E. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.7 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.

C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with Manufacturer's instructions for sound control.

3.8 SLEEVES

A. Set sleeves in position in formwork. Provide reinforcing around sleeves.

B. Extend sleeves through floors one inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

D. Install chrome plated steel escutcheons at finished surfaces.

E. Sleeves installed in exterior walls with exposed ends shall be non-corrosive type sleeves (i.e., stainless steel).

*** END OF SECTION 23 05 29 ***

SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. High-performance butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron, center-guided swing check valves.
8. Iron, plate-type check valves.
9. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handlever: For quarter-turn valves.

3. Handwheel: For valves other than quarter-turn types.

4. Handlever: For quarter-turn valves NPS 6 and smaller.

5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2.5-inch stem extensions and the following features:

1. Butterfly Valves: With extended neck.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Three piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Jenkins Valves.

b. Crane Co.; Crane Valve Group; Stockham Division.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Tyco Valves & Controls; a unit of Tyco Flow Control.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 150 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for ball and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, or butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service except Steam: ball, or butterfly valves.

4. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

b. NPS 2-1/ and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valve, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Copper Pipe NPS 2 and Smaller:

1. Ball Valves: Two or Three piece, full port, brass with stainless-steel trim.

2. Bronze Swing Check Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.

2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.

3. High-Performance Butterfly Valves: Class 150, single flange.

4. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.

5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring or iron.

6. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

7. Iron, Plate-Type Check Valves: Class 150; dual plate; metal seat.

*** END OF SECTION 23 05 23 ***

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 EXECUTION

NOT APPLICABLE

*** END OF SECTION 23 05 13 ***

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. HVAC demolition.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.

2. Mechanical sleeve seals.

B. Welding certificates.

C. Submit Manufacturer's published technical data, catalog cuts, wiring diagrams, shop drawings, samples and testing and balancing logs for all elements of the HVAC work. Submit under provisions of General Conditions and Supplementary General Conditions.

D. No equipment, piping, ductwork or components shall be fabricated, delivered, erected, or connected other than from shop drawings reviewed and approved by the Engineer.

E. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

F. Equipment Supports: Submit detailed shop drawings indicating equipment weight and dimensions, support material, connections, anchoring, and vibration isolation.

G. Submittals shall include, but not be limited to the following:

1. All equipment; cooling, heating, plumbing, electrical motors, starters, controls, etc.

2. Voltage, phase, and amps of each electrical item, such as motors, etc.

3. All auxiliary equipment.

4. Pipe, ductwork, valves, insulation, etc.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.8 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

C. The term "Basis of Design" used throughout this document shall be understood to mean a particular manufacturer's equipment (as scheduled specifically on the drawings or specifications) has been used as the basis by the Design Engineer to establish physical dimensions, quality, and performance required, in addition to providing a basis for interaction with other ancillary components and/or other trades. Therefore, it shall be understood that use of a piece of equipment other than that identified as the Basis of Design may impact performance of an overall engineered system or may require revisions to ancillary interfacing equipment, and thus any manufacturer's equipment other than that listed as Basis of Design shall require written approval via Addendum prior to bid except where the manufacturer's name is specifically listed in these specifications as a pre-approved substitute or an accepted manufacturer. All substitutes, pre-approved substitutes, accepted manufacturers, and/or Basis of Design are subject to all requirements of quality, physical characteristics (i.e., dimension, sound, etc), and performance, etc., as set forth in these specifications and contract documents.

1.9 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Mechanical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed below equipment indicated as "Basis of Design" shall be considered as substitutes. Manufacturers other than the Basis of Design shall submit catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute. The comparative shall list capacities, pressure drops, horse power, electrical requirements, etc., (refer to Submittal requirements).

C. Request for approval of substitutions shall be made in writing no less than ten days (unless otherwise directed in Division 01) prior to bid. Substitutions shall not be considered approved unless the approval appears in an Addendum or unless so named in the specifications as a pre-approved substitute. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

D. All requests for substitutions shall specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution. Differences shall include, but shall not be limited to, data as follows for both the specified and substituted products.

1. Principle of operation;

2. Materials of construction or finishes;

3. Thickness or gauge of materials;

4. Weight of item;

5. Deleted features or items;

6. Added features or items;

7. Changes in other Contractor's work caused by the substitution;

8. Physical dimensions;

9. Electrical requirements.

E. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

F. Where such approved deviation requires quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

1.10 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC or PVC (as required) one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC or PVC (as required) four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Hart Industries, International, Inc.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Central Plastics Company.

c. Epco Sales, Inc.

d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS—COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Select system components with pressure rating equal to or greater than system operating pressure.

H. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Insulated Piping: One-piece, stamped-steel type with spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.

f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.

d. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.

e. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

I. Install piping to allow application of insulation.

J. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION—COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

*** END OF SECTION 23 05 00 ***

DIVISION 26—ELECTRICAL

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SECTION 26 33 53

UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.1 SUMMARY

A. This specification describes a three-phase continuous duty three-phase, solid-state, scalable (field-upgradeable) uninterruptible power system, hereafter referred to as the UPS. The UPS shall provide high-quality AC power for sensitive electronic equipment. The UPS shall operate in conjunction with the building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS system shall consist of, as required by the project, the UPS modules, battery cabinet(s), maintenance bypass, Static Auto Switchboard and other features as described in this specification.

B. Provide remote monitored points for input into Building Management and Automatic Temperature Control System as indicated herein. Provide coordination and start-up/commissioning support for communications of monitored data. Refer also to 23 09 00 Distributed Digital Control System.

1.2 STANDARDS

A. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

1. UL Standard 1778, Fourth Edition
2. CSA 22.2, No. 107.1
3. FCC Part 15, Subclass B, Class A
4. IEC 61000-4-5
5. National Electrical Code (NFPA-70)
6. NEMA PE-1
7. ISTA_1H

B. The UPS shall be UL and cUL listed per UL Standard 1778.

C. The UPS shall be provided with a Short Circuit Withstand Rating (SCWR) label denoting the maximum source fault short circuit current that is applicable to the unit. The withstand rating shall be independently verified by a nationally recognized, third-party lab.

D. The UPS shall withstand input surges to both the rectifier and bypass when configured as a dual-input unit without damage as per the criteria in EN62040-2 (4kV). The manufacturer shall provide evidence of compliance upon request.

E. The UPS shall be compatible with the wiring practices, materials and coding in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling using raceway or conduit for top and bottom access to input, output, bypass and DC connections. Connection cabinets shall provide for wiring gutter and wire bend radius as defined by the NEC and UL.

1.3 SYSTEM DESCRIPTION

A. Design Requirements - UPS Module

1. Voltage. Input/output voltage specifications of the UPS shall be:

a. Rectifier Input: 480 volts, three-phase, 3-wire-plus-ground

b. Bypass Input: 480 volts, three-phase, 3-wire-plus-ground

c. Output: 480 volts, three-phase, 3-wire-plus-ground

2. Output Load Capacity. Specified output load capacity of the UPS shall be 150 kVA at 1.0 unity power factor.

3. The UPS output capacity shall have the option to enable scalability at the time of ordering and shall be upgradeable through the use of removable hardware modules. Each hardware module shall consist of an inverter and rectifier.

4. Models shall be available in the following frame size:

a. 200 kVA frame – Scalable from 50 kVA to 150 kVA (50 kVA hardware increments)

5. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to unity. The UPS shall also work from unity power factor to 0.5 leading power factors subject to derating.

6. Load voltage and bypass line voltage shall be 480VAC, three-phase, three-wire plus ground. Input voltage shall be 480VAC, three-phase, three-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.

7. The battery shall support the UPS at 100% rated kW load for at least twenty (20) minutes at 77°F (25°C) at startup.

8. The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.

9. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module.

B. Design Requirements - Battery

1. Battery Cells: Valve-regulated, lead acid batteries.

2. Reserve Time: 20 minutes at full load, with ambient temperature of 77°F (25°C). Unit shall provide terminal for connection of external batteries.

3. Recharge Time: to 95% capacity within ten (10) times discharge time.

C. Modes of Operation

1. The UPS shall be designed to operate as an on-line, double-conversion, reverse-transfer system with the following operating modes:

a. Normal: The critical AC load shall be continuously powered by the UPS inverter. The rectifier/charger shall derive power from the utility AC source and supply DC power to the DC-DC converter, which in turn shall supply the inverter while simultaneously float charging the battery.

b. ECO Mode: The critical AC load shall be continuously powered by the bypass with the inverter available to power the load if the bypass source voltage or frequency exceeds adjustable parameters of power quality.

c. Battery: Upon failure of utility AC power, the critical load shall be powered by the inverter, which, without any switching, shall obtain its power from the battery plant via the DC-DC converter. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

d. Recharge: Upon restoration of the utility AC source, the rectifier shall supply power to the output inverter and to the DC-DC converter, which shall simultaneously recharge the batteries. This shall be an automatic function and shall cause no interruption to the critical load.

e. Bypass: If the UPS must be taken out of service, the static transfer switch shall transfer the load to the bypass source. The transfer process shall cause no interruption in power to the critical load. An optional external wrap-around maintenance bypass shall be used to ensure full isolation of the unit for the service of internal components while providing safety from arc flash and in compliance with OSHA requirements.

f. Off-Battery: If the battery only is taken out of service, it shall be disconnected from the DC-DC converter by means of an external disconnect circuit breaker (in the case of external batteries). The UPS shall continue to function and meet all of the specified steady-state performance criteria, except for the power outage backup time capability. If multiple battery strings are used, each string shall be capable of being electrically isolated for safety during maintenance.

D. Performance Requirements

1. AC Input to UPS

a. Voltage Configuration for Standard Units: 480V, three-phase, three-wire plus ground

b. Voltage Range: +20%, -15% of at full load, -40% at half load.

c. Frequency: 40-70 Hz

d. Maximum Inrush Current: UPS inrush current not to exceed 1.5 times rated input current

e. Power Factor: Minimum 0.99 at nominal input voltage and full-rated UPS output load.

f. Current Distortion: <3% reflected THD maximum at full load current and less than 5% at full load non-linear input current in double-conversion mode

g. Surge Protection: Sustains input surges of 4kV (line-to-ground) without damage per criteria listed in EN 6100-4-5: 1995

h. Short Circuit Current Rating: Units shall carry as standard 35kA Short Circuit Withstand Rating. All ratings shall be certified and a label shall be applied to the unit clearly identifying this rating as required by the National Electrical Code.

2. AC Output, UPS Inverter

a. Load Rating: 100% of load rating at 104°F (40°C) for any load from 0.5 lagging to 0.9 leading

b. Voltage Regulation:

(1) ±1% RMS average for a balanced, three-phase load

(2) ±2% for 100% unbalanced load for line-to-line imbalances

c. Voltage Adjustment Range: ±5% for line drop compensation adjustable by factory service personnel

d. Frequency Regulation:

(1) Synchronized to bypass: ±2.0Hz default setting, (adjustable by factory service personnel)

e. Phase Imbalance:

(1) Balanced loads: 120° ±0.5°

(2) 100% unbalanced loads: 120° ±1.5°

f. Voltage Transients (average of all three phases):

(1) 0-100% or 100-0%

(2) Response: Meets ITIC and CBEMA Curve Requirements

(3) Complies with IEC/EN 62040-3: 2010 Figure 2 Curve 1, Class 1

(4) Transient Voltage Deviation, RMS: 5%

(5) Recovers within 60ms

g. Overload at Full Output Voltage with ±1% voltage regulation:

(1) 100% continuously

(2) 105% - 110% of full load for 60 minutes at 104°F (40°C) ambient

(3) 110% - 125% of full load for 10 minutes at 104°F (40°C) ambient

(4) 125% - 150% of full load for 60 seconds at 104°F (40°C) ambient

(5) >150% of full load for a minimum of 200 milliseconds at 104°F (40°C) ambient

E. Grounding

1. The UPS chassis shall have an equipment ground terminal.

1.4 ENVIRONMENTAL CONDITIONS

A. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. Operating Ambient Temperature

a. UPS Module: 32°F to 104°F.

b. Battery: 77°F ±9°F.

2. Storage/Transport Ambient Temperature

a. UPS Module: -4°F to 158°F.

b. Battery: -4°F to 92°F.

3. Relative Humidity

a. 0 to 95%, non-condensing

4. Altitude

a. Operating: to 3,300 ft. above mean sea level without derating.

b. Storage/Transport: to 40,000 ft. above mean sea level.

5. Audible Noise:

Unit Size	Noise/Load, dB	
	100% Load	50% Load
50kVA	63.2	60.5
100kVA	66.1	62
150kVA	67.1	62.9
200kVA	68.5	63.4

Measured 4.6 ft. (1.4m) from the surface of the unit.

1.5 WARRANTY

A. All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.

B. One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner.

C. One-year service protection package shall include 7x24 on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with guaranteed response times of 4, or 2 hours in certain major metropolitan areas. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.

D. Manufacturer shall also include Start-up services consisting of: 7x24 Start-up service of UPS and batteries. On-site user training, Site Audit, installation and commissioning of monitoring service, and validation of one-year limited factory warranty will be performed during the start-up.

E. Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits. Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.

1.6 REFERENCES

A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.

B. CSA C22.2 No 107.1 (Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.

C. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.

D. IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.

E. IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.

F. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.

G. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.

H. CISPR 22: FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices (prior to Feb 16, 2006).

I. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment

1.7 SUBMITTALS

A. The UPS shall be supplied with sufficient documentation, including the following manuals:

1. Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:

a. UPS description

b. UPS site planning and unpacking

c. UPS installation

d. Optional accessory installation

e. UPS theory of operation

f. Operating procedures

g. System events

h. UPS maintenance

i. Performance and technical specifications

j. Wiring requirements and recommendations

k. Physical features and requirements

l. Cabinet dimensions

1.8 QUALITY ASSURANCE

A. The UPS manufacturer shall have a minimum of twenty years experience in the design, manufacture and testing of solid-state UPS systems. The system shall be designed and manufactured according to world-class quality standards.

B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.

C. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.

D. Field Engineering Support: The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices must be submitted with the proposal. Third-party maintenance will not be accepted.

E. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.

F. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.

G. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

H. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

1.9 SAFETY

A. The UPS shall be certified by a US recognized NRTL (National Recognized Test Laboratory) in accordance with UL 1778.

B. The UPS shall be certified by a Canadian Recognized Test Laboratory in accordance with CSA C22.2 No.107.3-05.

PART 2 PRODUCTS

2.1 APPROVED MANUFACTURERS:

A. BASIS OF DESIGN—Liebert. (eXM UPS).

B. Eaton (93PM UPS).

C. OTHER SUBSTITUTES—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with specifications. Accepted substitutes will be notified via Addendum.

2.2 FABRICATION

A. All materials of the UPS shall be new, of current manufacture and high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semi-conductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

B. Wiring

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

2. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling, using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with NEC, connection cabinets shall provide for adequate wire bend radius. All copper busbars for customer power connections shall be tin plated for connection integrity.

C. Construction and Mounting - The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling. Maximum cabinet height shall be 78.7 in. (2000mm).

D. Cooling

1. Cooling of the UPS shall be by forced air using a redundant fan configuration. Fan power shall be provided by the UPS.

2. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded. Upon detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause audible alarms to be sounded and visual alarms to be displayed on the UPS control panel. Air filters shall be located at the point of air inlet and shall be changeable. No service clearance or ventilation shall be required in the rear of the system.

2.3 EQUIPMENT

A. UPS System

The UPS system shall consist of an IGBT power factor-corrected rectifier, DC-DC converter and three-phase, transformer-free inverter, bypass static transfer switch, bypass synchronizing circuitry, protective devices and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

B. Output Protection

The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting, current-limiting devices shall be used to protect against cascading failure of solid-state devices. Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off-line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on a graphic display screen on the front of the unit.

2.4 COMPONENTS

A. Rectifier/Charger

1. General:

The term rectifier shall denote the solid-state equipment and controls necessary to convert alternating current to regulated direct current to supply the inverter and charge the battery. The DC output of the rectifier shall meet the input requirements of the inverter without the battery being connected.

2. Input Current Harmonic Distortion:

The rectifier shall actively control and reduce input current distortion over the full operating range of the UPS without the need for an additional passive input filter. Input current THD shall be less than 5% at rated load and nominal voltage in double-conversion mode.

3. Dynamic Current Input Limit Reduction:

The rectifier, in conjunction with the other UPS controls and circuitry, shall adjust the current demanded for battery charging as a function of UPS wattage load and input voltage level.

B. DC-DC Converter

1. General

The term DC-DC converter shall denote the equipment and controls to regulate the output of the rectifier to the levels appropriate for charging the battery and to boost the battery voltage to the level required to operate the inverter. The DC-DC converter shall be solid-state, capable of providing rated output power and, for increased performance, shall be a pulse width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). The DC-DC converter shall control charging of the battery. The AC ripple voltage of the charger DC shall not exceed 1% RMS of the float voltage.

2. Battery Equalize Charge

A manually initiated equalize charge feature shall be provided to apply an equalize voltage to the battery. The duration of equalize charge time shall be adjustable from 8 to 30 hours. A method shall be available to deactivate this feature for valve regulated battery systems.

3. Stop Battery Charging Function

Battery charging may be stopped by a shunt trip of the battery cabinet breaker when overtemperature is sensed in the battery cabinet, on generator or when environmental contact is closed.

4. Overvoltage Protection

There shall be DC overvoltage protection so that if the DC voltage rises to the pre-set limit, the UPS shall shut down automatically and initiate an uninterrupted load transfer to bypass or shall disconnect the battery via the DC breaker(s) in the battery string.

5. Temperature-Compensated Charging

The UPS shall adjust the battery charging voltage based on the battery temperature reported from external battery temperature sensors. When multiple sensors are used, the voltage shall be based on the average temperature measured. Excessive difference in the temperature measurements shall be reported and the charging voltage adjusted to protect the batteries from excessive current.

6. Battery Load Testing

The UPS shall be capable of performing battery load testing under operator supervision. To accomplish this, the rectifier shall reduce charging voltage to force the batteries to carry the load for a short time. If the curve of battery voltage drop indicates diminished battery capacity, the UPS shall display an alarm message. If the voltage drop indicates battery failure, the UPS shall terminate the test immediately and annunciate the appropriate alarms.

C. Inverter

The term inverter shall denote the equipment and controls to convert direct current from the rectifier or battery via the DC-DC converter to precise alternating current to power the load. The inverter shall be solid-state, capable of providing rated output power and, for increased performance, the inverter shall be a pulse-width-modulated design and shall utilize insulated gate bipolar transistors (IGBTs). To further enhance reliable performance and efficiency, the inverter shall not require an inverter output series static switch/isolator for the purposes of overload or fault isolation or transfers to bypass.

1. Overload Capability

The inverter shall be able to withstand an overload across its output terminals while supplying full rated voltage of up to 150% for 60 seconds. The inverter shall be capable of at least 170% current for short-circuit conditions including phase-to-phase, phase-to-ground and three-phase faults. After the fault is removed, the UPS shall return to normal operation without damage. If the short circuit is sustained, the load shall be transferred to the bypass source and the inverter shall disconnect automatically from the critical load bus.

2. Output Frequency

The inverter shall track the bypass continuously, providing the bypass source maintains a frequency of 60Hz ±1% (0.6 Hz).

3. Phase-to-Phase Balance

The inverter shall provide a phase-to-phase voltage displacement of no worse than ±3% with a 100% unbalanced load.

4. Inverter Fault Sensing and Isolation

   The UPS shall be provided with a means to detect a malfunctioning inverter and isolate it from the critical load bus to prevent disturbance of the critical load voltage beyond the specified limits.

5. Battery Protection

   The inverter shall be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Inverter shutdown shall be initiated when the battery voltage has reached the end of discharge voltage. The battery end-of-discharge voltage shall be calculated and automatically adjusted for partial load conditions to allow extended operation without damaging the battery. Automatic shutdown based on discharge time shall not be acceptable.

D. Inverter Bypass Operation

When maintenance is required or when the inverter cannot maintain voltage to the load due to sustained overload or malfunction, a bypass circuit shall be provided to isolate the inverter output from the load and provide a path for power directly from an alternate AC (bypass) source. The UPS control system shall constantly monitor the availability of the inverter bypass circuit to perform a transfer. The inverter bypass circuit shall consist of a continuous duty bypass static switch and an overcurrent protection device to isolate the static bypass switch from the bypass utility source. The bypass static switch shall denote the solid-state device incorporating SCRs (silicon controlled rectifiers) that can automatically and instantaneously connect the alternate AC source to the load.

1. Static Bypass Switch Rating

   The static bypass switch shall be rated for continuous duty operation at full rated load for highest reliability without the use of mechanical devices, such as those used with a momentary rated device.

2. Manual Load Transfers

   A manual load transfer between the inverter output and the alternate AC source shall be initiated from the control panel. Manually initiated transfers shall be make-before-break, utilizing the inverter and the bypass static switch.

3. Automatic Load Transfers

   An automatic load transfer between the inverter output and the alternate AC source shall be initiated if an overload condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads shall initiate an automatic retransfer of the load to the inverter only after the load has returned to a level within the rating of the inverter source and the alarm has been acknowledged.

4. Momentary Overloads

In the event of a load current inrush or branch load circuit fault in excess of the inverter rating, the bypass static switch shall connect the alternate AC source to the load for at least 600 milliseconds, allowing up to 1000% of the normal rated output current to flow. Output voltage shall be sustained to the extent the alternate AC source capacity permits. If the overload condition is removed before the end of the 600-millisecond period, the bypass static switch shall turn Off and the load shall remain on inverter power. If the overload remains, then a transfer to the alternate AC source is to be completed.

5. Back-Feed Protection

As required by UL1778 and CSA, the static transfer switch shall not back-feed UPS power to the bypass distribution system while the UPS is operating on battery during a bypass power outage. The purpose of this requirement is to prevent the risk of electrical shock on the distribution system when the normal source of power is disconnected or has failed. If a shorted SCR is detected, the static transfer switch shall be isolated by automatically tripping the upstream bypass circuit breaker and an alarm message shall be annunciated at the UPS control panel. The load shall remain on conditioned and protected power after detection of a shorted SCR and isolation of the bypass static switch.

6. Active ECO-Mode

When selected, this mode of operation shall transfer the load to the bypass source and maintain it there as long as the bypass source frequency, slew rate and voltage are within the adjusted operating parameters. While in this mode, the inverter shall remain operating to be able to instantaneously assume the load without interrupting the output voltage. Should the bypass source go outside the adjusted limits, the bypass static switch shall turn Off, isolating the load from the bypass while the inverter assumes the full critical load. The load shall be transferred from the bypass source to the inverter while maintaining the output voltage within the ITIC and CBEMA curves.

E. Display and Controls

1. Monitoring and Control - The UPS shall be provided with a microprocessor-based unit status display and controls section designed for convenient and reliable user operation. A graphical liquid crystal display (LCD) shall be used to show a single-line diagram of the UPS and shall be provided as part of the monitoring and controls sections of the UPS. All operator controls and monitors shall be located on the front of the UPS cabinet. Monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD. Additional features of the monitoring system shall include:

a. Menu-driven display with pushbutton navigation

b. Real-time clock (time and date)

c. Alarm history with time and date stamp

d. Memory with battery backup

2. Metering - The following parameters shall be displayed:

    a. Input AC voltage line-to-line

    b. Input AC current for each phase

    c. Input frequency

    d. Battery voltage

    e. Battery charge/discharge current

    f. Output AC voltage line-to-line

    g. Output AC current for each phase

    h. Output frequency

    i. Bypass input voltage, line-to-line

    j. Bypass input frequency

    k. Load Current

    l. Apparent power (kW), total and percentage

    m. Active power (kVA), total and percentage

    n. Battery time left during battery operation

    o. Battery temperature.

3. Alarm Messages

    The following alarm messages shall be displayed:

    a. Mains Voltage Abnormal

    b. Mains Undervoltage

    c. Mains Freq. Abnormal

    d. Charger Fault

    e. Battery Reversed

    f. No Battery

    g. Control Power 1 Fail

    h. Parallel Comm. Fail

    i. Bypass Unable To Track

    j. Bypass Abnormal

k. Inverter Asynchronous

l. Fan Fault

m. Control Power 2 Fail

n. Unit Over Load

o. System Over Load

p. Bypass Phase Reversed

q. Transfer Time-Out

r. Load Sharing Fault

s. Parallel Connect Fault

t. Bypass Over Current

u. Output Ground Fault

4. Status Messages

The following UPS status messages shall be displayed:

a. Rectifier (Off / Soft Start / Main Input On / Battery Input On)

b. Input Supply (Normal Mode / Battery Mode / All Off)

c. Battery Self Test (True / False)

d. Input Disconnect (Open / Closed)

e. EPO (True / False)

f. Charger (On / Off)

g. Output Disconnect (Open / Closed)

h. Maint. Disconnect (Open / Closed)

i. Bypass Disconnect (Open / Closed)

j. Inverter (Off / Soft Start / On)

k. Bypass (Normal / Unable To Trace / Abnormal)

l. Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)

m. Inverter On (Enable / Disable)

5. Controls - UPS startup, shutdown and maintenance bypass operations shall be accomplished through pushbutton controls on the front panel. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD to depict a single-line diagram of the UPS with switch positions and power flow.

6. On-Line Battery Test - The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

F. Battery Cabinet - The battery cabinet shall include ten (10) year design life, valve-regulated, lead-acid battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system lineup. All battery cell inter-connects shall utilize bolted connections, and all batteries shall include copper, inserted terminal posts allowing connector torque of 110 in-lb (12.4 Nm). Battery cells shall be mounted on slide-out trays for ease of maintenance. A battery disconnect circuit breaker shall be included for isolation of the battery pack from the UPS module. Casters and leveling feet shall also be provided with the battery cabinet for ease of installation. When the application calls for the battery cabinet to be bolted to the UPS cabinet, an interconnecting cable kit will be available, precut and pre-lugged.

G. Accessories

1. Network Interface Card - Provide communication outputs to indicate a change of status of the UPS. Outputs as follows:

   a. BACnet IP (confirm with Controls Contractor).

2. Maintenance Bypass and Output Paralleling Panel Board – Provide with a make-before-break maintenance bypass with Solenoid Key Release Unit (SKRU) interlock shall be provided. Installation shall not affect the cooling ability of the UPS. Thermal-magnetic breakers shall be provided for bypass and maintenance isolation.

3. Remote Alarm Panel - The remote alarm panel shall have LED alarm lights. An audible alarm shall sound upon any alarm condition. The surface- or flush-mounted NEMA 1 enclosed panel shall indicate:

   a. Load on UPS LED

   b. Load on Bypass LED

   c. Battery Discharging LED

   d. Low Battery Warning LED

   e. UPS Alarm Condition LED

   f. New Alarm Condition LED (For a Second UPS Alarm Condition)

   g. Audible Alarm with Reset pushbutton

   h. Lamp Test/Reset pushbutton

4. Load Bus Sync - The Load Bus Sync (LBS) shall enable three independent single-module UPS units to stay in sync when operating on battery or unsynchronized input sources. The LBS shall determine the master and slave relationship between UPS units. The LBS shall be installed within each single-module UPS.

5. Relay Contact Card – A relay contact card shall provide output dry contact signals communicating the following UPS states: Summary Alarm, Bypass Active (On Bypass), Low Battery, AC Input Failure (UPS Fault) and On UPS.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. UPS 'A' and 'B' will be installed in separate phases. Multiple visits to the site will be required.

3.2 COMMISSIONING

A. Factory start-up shall be provided on a 7 x 24 basis. Start-up service shall be provided at no extra charge and shall include one visit to perform all procedures and tests specified within UPS Installation and Operation manual. UPS manufacturer shall also offer the following optional services:

1. Pre-energize visit to inspect installation and provide guidance to installers as required.

2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.

B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:

1. Visual Inspection:

a. Visually inspect all equipment for signs of damage or foreign materials.

b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.

c. Inspect equipment for signs of damage.

d. Verify installation per drawings.

e. Inspect cabinets for foreign objects.

f. Verify neutral and ground conductors are properly sized and configured.

g. Inspect battery cases.

h. Inspect battery for proper polarity.

i. Verify all printed circuit boards are configured properly.

2. Mechanical Inspection:

   a. Check all the power connections for tightness.

   b. Check all the control wiring terminations and plugs for tightness or proper seating.

   c. Check all terminal screws, nuts and/or spade lugs for tightness.

3. Electrical Pre-check:

   a. Check all fuses for continuity.

   b. Confirm input voltage and phase rotation is correct.

   c. Assure connection and voltage of the battery string(s)Check the DC bus for a possible short circuit.

   d. Check input and Bypass power for proper voltages and phase rotation.

   e. Check all lamp test functions.

4. Initial UPS Startup:

   a. Verify that all the alarms are in a "go" condition.

   b. Energize the UPS module and verify the proper DC, walkup, and AC phase on.

   c. Check the DC link holding voltage, AC output voltages, and output waveforms.

   d. Check the final DC link voltage and Inverter AC output. Adjust if required.

   e. Check for the proper synchronization.

   f. Check for the voltage difference between the Inverter output and the Bypass source.

   g. Optional on site full-load, step-load, and battery discharge tests using no load banks shall also be offered using a self-commissioning full-load/no-load feature.

5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

3.3 MANUFACTURER'S FIELD SERVICE

A. Service Personnel

1. The UPS manufacturer shall directly employ a nationwide service organization consisting of factory-trained field service personnel dedicated to the startup and maintenance of UPS and power equipment.

2. The manufacturer shall provide a national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours a day, 7 days a week, 365 days a year. If emergency service is required, on-site response time shall be four hours or less within 150 miles of an Emerson Network Power Liebert Services center.

3. Two local customer engineers shall be assigned to the site with a regional office as a backup. Escalation procedures shall be in place to notify Power Technical Support if a site is not functioning within 24 hours.

B. Replacement Parts Stocking

1. Parts shall be available through an extensive network to ensure round-the-clock parts availability throughout the country.

2. Spare parts shall be stocked by local field service personnel with backup available from national parts center and the manufacturing location. A national parts center Customer Support Parts Coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

C. Maintenance Contracts - A complete offering of preventive and full-service maintenance contracts for both the UPS system and battery system shall be available.

D. Automated Site Monitoring – UPS Manufacturer shall include one-year of automated site monitoring. After year one the UPS manufacturer shall provide, as an option, an automated site-monitoring service. This service shall be staffed by a qualified support person 24 hours a day, 7 days a week, 365 days a year. At the detection of an alarm within the UPS, the controls shall initiate communications with the monitoring service. The monitoring service shall be capable of interpreting the communicated alarms to allow dispatch of a service engineer.

3.4 BUILDING MANAGEMENT AND AUTOMATIC TEMPERATURE CONTROL SYSTEM MONITORED POINTS

A. Provide status of Uninterruptible Power Supplies (UPS):

1. Loss of Input Source

2. Input Voltage

3. Output Voltage

4. Output Current

5. Output kW

6. Output Power Factor

7. Output THD
8. Battery Voltage
9. Battery Test Failed
10. System on Bypass
11. General Alarm

B. Provide status of Emergency Power Off (EPO/REPO):

1. EPO Relay Activated at each UPS.

*** END OF SECTION 26 33 53 ***

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 1000 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than fourteen (14) days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Owner's written permission.

4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: One for each size and type.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis of Design—Square D, Schneider Electric.

B. Pre-Approved Substitutes:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

C. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

6. Hookstick Handle: Allows use of a hookstick to operate the handle.

7. Lugs: Mechanical type, suitable for number, size, and conductor material.

8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Basis of Design—Square D, Schneider Electric.

B. Pre-Approved Substitutes:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

C. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 240 or 600-V ac for voltage applied, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 240 or 600-V ac for voltage applied, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open when specified with VFD mounted separately.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 RECEPTACLE SWITCHES

A. Basis of Design—Square D, Schneider Electric.

B. Pre-Approved Substitutes:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

C. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240 or 600-V ac for voltage applied, 30 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

E. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

F. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

1. Receptacle Manufacturer and Catalog Number: NEMA type configuration as shown on drawings.

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.

2. Ferraz Shawmut, Inc.

3. Littelfuse, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power of enough capacity to operate shunt trip, connected pilot, and indicating and control devices. Refer to drawings to ensure separate 120 V source not provided by other means.

E. Accessories:

1. Oiltight key switch for key-to-test function.

2. Oiltight green ON pilot light.

3. Isolated neutral lug; 100 percent rating.

4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.

5. Form C alarm contacts that change state when switch is tripped.

6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Basis of Design—Square D, Schneider Electric.

B. Pre-Approved Substitutes:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

C. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Long- and short-time pickup levels.

2. Long- and short-time time adjustments.

3. Ground-fault pickup level, time delay, and I2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self- powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact when indicated on drawings.

2.6 MOLDED-CASE SWITCHES

A. Basis of Design—Square D, Schneider Electric.

B. Pre-Approved Substitutes:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

C. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

D. Features and Accessories:

1. Standard frame sizes and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.7 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

6. Mechanical Cooling Tower Areas: NEMA 250, Type 4X, stainless steel.

7. Hazardous Areas Indicated on Drawings: NEMA 250, Type 9.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

*** END OF SECTION 26 28 16 ***

SECTION 26 26 00

POWER DISTRIBUTION UNITS (PDUs)

PART 1 GENERAL

1.1 SUMMARY

A. The following technical specification describes the requirements of the power distribution unit for supplying computer grade power to the data processing equipment and other essential loads. The system shall be known as a Power Distribution Unit (PDU). The PDU shall provide isolation, distribution, control and monitoring of AC power. It shall include all equipment to properly interface the AC power source to the intended loads.

B. Provide remote monitored points for input into Building Management and Automatic Temperature Control System as indicated herein. Provide coordination and start-up/commissioning support for communications of monitored data.

1.2 STANDARDS

A. The PDU shall be designed, manufactured, tested and installed in compliance with:

1. American National Standards Institute (ANSI)

2. Canadian Standards Association (CSA)

3. Federal Information Processing Standards Publication 94 (FIPS Pub 94)

4. Institute of Electrical and Electronics Engineers (IEEE)

5. ISO 9001

6. National Electrical Code (NEC - NFPA 70)

7. National Electrical Manufacturers Association (NEMA)

8. National Fire Protection Association (NFPA 75)

9. Underwriters Laboratories (UL)

B. The PDU shall be UL listed as a complete system under UL 60950 Standard for Information Technology Equipment (UL listing applies to 60 Hz units only).

C The specified center shall comply with latest FCC Part 15 EMI emission limits for Class A computing devices and the emission and immunity limits of EN50081-2/EN550022 Class A and EN50082-2.

D. The PDU shall safely withstand without misoperation or damage:

1. Transient voltage surges on the AC power input as defined by ANSI/IEEE C62.41 for Category B3 locations (high surge exposure industrial and commercial facilities),

2. Electrostatic discharges (ESD) up to 10 kV at any point on the exterior of the unit.

3. Electromagnetic fields from portable transmitters within 3 feet of the unit.

1.3 SYSTEM DESCRIPTION

A. Environmental Requirements

1. The PDU shall be designed for operation in the following conditions:

a. Storage temperature range: -55 to +85°C (-67 to +185°F).

b. Operating temperature: 0°C to +40°C

c. Relative humidity: 0% to 95% non-condensing

d. Audible noise: Under normal operation noise level shall not exceed than the ANSI C89 standard for transformers.

e. Storage/transport: Up to 40,000 ft. above Mean Sea Level.

f. Operating altitude: Up to 6,600 ft. above Mean Sea Level. Derated for higher altitude applications

B. Electrical Requirements

1. Refer to drawings for the PDU continuous output capacity requirement.

2. Input voltage shall be 480 volts AC, 60Hz, three-phase, three-wire-plus-ground.

3. The output voltage shall be 120/208 VAC wye, three phase, four-wire plus ground.

1.4 DOCUMENTATION

A. The manufacturer shall furnish an Operation and Maintenance manual detailing installation and start-up instructions. Wiring diagrams and instruction leaflets for major components shall be furnished. Detailed shop drawings for the equipment furnished shall be prepared and submitted for review. Drawings

B. Submittal drawings shall include:

1. One-line wiring diagrams.

2. Outline drawings including weight, dimensions, heat dissipation and recommended service clearances.

3. Location and detailed layout of customer power and control connections.

4. Outline drawings of options if supplied.

5. The manufacturer shall furnish an installation, operation and maintenance manual with installation, startup, operation and maintenance instructions for the specified system.

C. A list of recommended spare parts and an in-service user's list shall be supplied to the customer as part of the close-out documentation.

D. An in-service user's list shall be supplied to the customer upon request.

1.5 WARRANTY

A. The PDU manufacturer warrants that the Product manufactured will conform to Seller's applicable specifications and be free from failure due to defects in workmanship and material for one (1) year from the date of manufacturer start-up of the Product or eighteen (18) months from the date of shipment, whichever occurs first. Repairs or replaced equipment are covered under the period of the original warranty, or ninety (90) days, whichever is longer. Warranty is contingent upon having a factory-authorized representative perform the start-up.

1.6 QUALITY ASSURANCE

A. The PDU shall be factory tested before shipment. Testing shall include, but shall not be limited to: "Hi-Pot" Test at two times rated voltage plus 1000 volts, per UL requirements and Metering Calibration Tests. The manufacturer shall be ISO 9001 certified. The PDU shall be UL listed and labeled as defined in NFPA 70, Article 100.

PART 2 PRODUCT

2.1 APPROVED MANUFACTURERS

A. BASIS OF DESIGN—Liebert. (Precision Power Center).

B. Eaton.

C. OTHER SUBSTITUTES—Submit a written substitution request, prior to bid, to the Architect/Engineer in accordance with specifications. Accepted substitutes will be notified via Addendum.

2.2 COMPONENTS

A. Frame Construction and Enclosure: The frame shall be constructed of galvanized steel and pop riveted to provide a strong substructure. The enclosure shall be mounted on four (4) heavy-duty swivel casters for portability and ease of installation and shall be provided with four permanent leveling jacks for final installation. The unit shall have easily removable output cable trays on the top and bottom to allow matching the size and number of cable/conduit openings to the site requirements. A minimum of 42 cable/conduit openings shall be provided for each output panelboard. All service shall be capable of being performed with access to the front, side and top. A tool shall be required to remove the exterior panels, which access the hazardous voltage area of the unit.

B. The unit shall have lockable, removable, hinged front doors that are 16-gauge perforated sheet metal construction to maximize ventilation. A two-point latch with key lock is provided for security. Doors shall provide access to the main input circuit breaker and to all output circuit breakers. Doors and side panels (if supplied) are finished in powder-coat black.

C. The unit shall be naturally convection-cooled. No fans for forced-air cooling system shall be used. The convection cooling method shall allow continuous full-load operation without activation of over-temperature circuits. The frame shall be configured to accept future field installation of additional bolt-on distribution sections containing additional panelboards. Unit shall be designed as a stand-alone power center or it can be attach to Liebert Foundation racks to form a rack line-up.

D. For 50-225 kVA units, the complete PDU dimensions shall be a maximum of 44 in. Wide by 68 in. High by 33 in. Deep. The distributed floor weight shall be less than 250 lbs/sq.ft.

E. For 300-450 kVA units, the complete PDU dimensions shall be a maximum of 86 in. Wide by 77 in. High by 33 in. Deep. The distributed floor weight shall be less than 250 lbs/sq.ft.

F. Input Power Connections

1. An input voltage junction box shall be provided for input power connections. Power terminal blocks or bus bar for 2 hole lugs shall be provided for connection of the input power conductors and a parity-sized insulated ground conductor. The junction box shall have maximum dimensions of Width, 22 in.; Length, 38 in.; Height, 6 in.

2. A main input conduit with cables shall be provided for connection between the specified unit and the input voltage junction box. Parallel input conduit with cables shall be used on higher ampacity units. The UL/CSA listed liquid-tight, flexible metal conduit shall be 10 feet long and consist of the appropriate number and size of conductors inside.

3. The conductors shall be UL/CSA listed, 90°C minimum insulation, copper conductors, sized in accordance with the NEC, based on the main input circuit breaker rating. Both for reliability and per the NEC, no plug-and-receptacle connectors shall be used for the input power cable(s).

G. Cable Entry: The PDU shall have provisions for top and bottom cable entry and exit.

H. Main Input Circuit Breaker: The specified unit shall be equipped with a main input circuit breaker to provide overcurrent protection and a means for disconnecting all power to the unit. The main input circuit breaker shall be a three-pole molded case circuit breaker sized for 125% of the specified full load input current and rated for 600 VAC. The minimum UL-listed interrupting rating for the main input circuit breaker shall be 35,000 RMS symmetrical amperes at 480 volts AC. The main input circuit breaker shall include a 24 VDC shunt trip mechanism to interface with unit controls, EPO buttons and other remote controls.

I. Isolation Transformer

1. The unit shall contain an electrostatically shielded isolation transformer with a rating as described in specifications. The transformer shall be a dry-type, double-shielded, three-phase, common-core, convection air-cooled transformer. The transformer shall conform to UL1561, with 150°C maximum temperature rise. All transformer windings shall be copper. The transformer shall exhibit the following characteristics: percent impedance 3.0 to 5.5%; common mode noise attenuation 120 dB; harmonic voltage distortion 0.5% maximum additive; full-load efficiency 96.5 to 98%.

2. The isolation transformer shall be provided with six full-capacity compensation taps at 2-1/2% increments to accommodate field adjustment to match the source voltage. These compensation taps shall be easily accessible by removing the front accent panel. Tap changes include: two above nominal voltage (upper range limit of +5%), nominal voltage and four below nominal voltage (lower range limit of -10%).

3. The unit shall be provided with thermal overload protection for the transformer. An alarm shall notify personnel if the transformer temperature reaches 180°C. The unit shall automatically shut down if the transformer temperature reaches 200°C. Temperature sensors shall be located in each coil of the three phase windings.

J. Manual Restart: The specified unit shall be equipped with a manual restart feature to allow for an orderly supervised startup after power failure. The control circuit shall automatically energize the shunt trip mechanism of the main input breaker upon sensing output voltage failure. A field-selectable auto-restart mode shall be provided to deactivate the manual restart if desired.

K. Emergency Power Off (EPO): The local EPO shall include a fully guarded and illuminated "Emergency Power Off" pushbutton. Pressing the EPO switch shall immediately shut down the unit by activating the shunt trip of the main input circuit breaker. As part of the EPO circuit, an interface shall also be provided for connecting one or more normally open or normally closed remote EPO switches to the EPO circuit. For flexibility in meeting shutdown control schemes, the local EPO (unit shutdown) circuit shall be isolated from the remote EPO (room shutdown) circuit. The remote EPO circuit shall be designed to allow direct connection of multiple units with single and multiple shutdown control contacts.

L. Computer Grade Ground: The PDU shall include a single-point ground in accordance with sensitive electronic load manufacturer's recommendations, IEEE Std. 1100 and the requirements of the NEC. The transformer output neutral shall be solidly grounded in accordance with NEC article 250-26. Grounding conductors shall be sized in accordance with IEC 364-HD-384 and applicable national and local codes.

M. Output Distribution Circuit Breakers: The specified system shall contain two section panel with branch circuit breakers and subfeed circuit breakers as indicated on the panel schedules. Square D bolt-in output circuit breakers for distribution to the intended loads.

2.3 POWER MONITORING SYSTEM

A The specified PDU shall be equipped with a microprocessor-based power monitor panel. The monitor panel shall gather and process information from electrical and environmental sensors, relays and switches both internal and external to the unit. The monitored parameters and alarms shall be displayed on the unit monitor panel and shall also be available for communication to a Liebert centralized monitoring system using a two-wire, twisted-pair, low-voltage signal circuit having an RS-422 format for reliable communication up to 1000 meters. Additionally, the monitor panel shall be equipped with an RS-232 service port for adjusting parameters and performing diagnostics and an isolated RS-232 ASCII port for communication to other monitoring systems.

B. Monitored Parameters

1. The monitoring system shall monitor and display all of the following parameters:

a. Input Voltage, Line-To-Line for all three phases

b. Output Voltages, Line-to-Line for all three phases

c. Output Voltages, Line-To-Neutral for all three phases

d. Output Voltage Total Harmonic Distortion (THD) for all three phases

e. Output Current for all three phases

f. Output Current Total Harmonic Distortion (THD) all three phases

g. Output Current Crest Factor (Peak/RMS) for all three phases

h. Output Current Harmonic K-Factor for all three phases

i. Output Neutral Current

j System Ground Current

k. Output Frequency

l. Output kVA/kW

(1) Overall System

(2) Individual Sub-feed circuit(s)

m. Output Power Factor

(1) Overall System

(2) Individual Sub-feed circuit(s)

n. Output kW-Hours

o. Percent Load

p. Date

q. Time

2. All three phases of the three-phase parameters shall be displayed simultaneously. All voltage and current parameters shall be monitored using true RMS measurements for accurate representation of non-sinusoidal waveforms typical of computers and other sensitive loads.

C. Alarm Annunciation

1. The monitoring system shall detect and annunciate by audible alarm and alarm message the following conditions:

a. Output Overvoltage

b. Output Undervoltage

c. Output Overcurrent

d. Neutral Overcurrent

e. Ground Overcurrent

f. Output Voltage Distortion

g. Frequency Deviation

h. Phase Sequence Error

i. Phase Loss

j. Transformer Overtemp

2. All alarm thresholds for monitored parameters shall be adjustable by way of the service port to match site requirements. The factory setpoints for the alarms shall be as follows:

a. Output Overvoltage - output voltage exceeds +6% of nominal

b. Output Undervoltage - output voltage falls below - 13% of nominal

c. Output Overcurrent - output current exceeds 95% of full load amps

d. Neutral Overcurrent - neutral current exceeds 95% of full load amps

e. Ground Overcurrent - ground current exceeds 5 amps

f. Output Voltage Distortion - output voltage THD exceeds 10%

g. Frequency Deviation - output frequency exceeds ±0.5Hz of nominal

D. To facilitate troubleshooting, all alarms shall be stored in battery-backed (non-volatile) memory until reset to protect against erasure by a power outage. Alarms shall be able to be manually reset after the alarm condition has been corrected either at the unit or by way of the central monitoring system.

E. Custom Alarm Annunciation

F. The monitoring system shall be capable of providing alarm annunciation for up to five contact closures (4 N.O. and 1 N.C.). A custom alarm message up to 20 characters shall be provided for each contact. Alarm messages shall be programmable by way of the service port to match site requirements.

G. Summary Alarm Contact

1. A Form C (1 N.O. and 1 N.C.) Summary Alarm Contact shall be provided for remote alarm status. The contacts shall change state upon occurrence of any alarm and shall rest upon alarm silence.

H. Display

1. All monitored parameters and alarm messages shall be displayed on a 4 x 20 character, high visibility liquid crystal display (LCD) located on the unit front door within a decorative bezel. Included in the bezel shall be an Identifying Unit Number, Emergency Power Off (EPO) switch and an Alarm Present/Silence switch.

2. The Alarm Present/Silence switch shall be illuminated upon occurrence of any alarm and remain illuminated until all alarms are reset. The switch shall also be used to silence the audible alarm and reset inactive alarms.

I. Autoscan - for ease of operation, the monitoring system shall include an autoscan mode which provides continuous sequential selection and display of all monitored parameters and active alarm messages. A "Hold/Sequence" switch shall be provided to interrupt the autoscan mode and manually select the displayed parameters when desired.

2.4 ACCESSORIES

A. Low Voltage Control Junction Box

1. A separate low-voltage control junction box shall be provided for connecting all building interface alarms and controls, centralized monitoring and all Remote Emergency Power Off (REPO) switches. The low-voltage junction box shall also contain a 24 VDC, DPDT building interface relay for interfacing with environmental systems, alarm panels, etc. The relay contacts shall be rated for use up to 10 amps at 240 VAC. The low-voltage junction box shall have maximum dimensions of Width, 8 in.; Length, 10 in.; Height, 4 in.

2. A low-voltage control cable shall be provided for connection between the unit and the control junction box. The low-voltage control cable shall utilize UL/CSA listed liquid-tight, flexible metal conduit, measuring 10 feet long.

B. Solid Sheet Metal Doors: The enclosure shall be provided with front and rear lockable, hinged removable solid sheet metal doors.

C. Side Panels: The unit shall be supplied with 18-gauge sheet metal right and left side panel(s). A tool shall be required to remove the exterior panels that access the hazardous voltage area of the unit.

D. Input Lightning/Surge Arrester: The specified unit shall be equipped with a secondary-class surge arrester to divert high-voltage input power surges quickly and safely to ground. The surge arrester shall be mounted ahead of all electrical components to provide maximum protection of the unit insulation and wiring. The surge arrester shall be capable of repeated operations. It shall consist of utility-grade metal-oxide varistors rated for up to 20,000 amps of surge current. The surge arrester shall be rated for maximum FOW sparkover of 3200 volts with maximum discharge voltage of 2.2 kV at 1500 amperes, assuming a standard 8 x 20 microsecond waveform.

E. Output Surge Suppression Module

1. The unit shall be equipped with a surge suppression module to eliminate high-speed, high-energy transients and to filter high frequency noise. The surge suppression module shall be mounted on the output of the unit. The surge suppressor components shall be UL recognized.

2. The surge suppressor shall utilize high-energy metal oxide varistors with less than 1 nanosecond response time. The clipping level shall be 212 volts on a system with a nominal peak line voltage of 170 volts and 354 volts on a system with a nominal peak line voltage of 340 volts. Peak current handling capability shall be at least 13,000 amperes based on an 8 X 20 microsecond waveform. Energy absorption capability shall be at least 200 joules per phase.

3. A passive filter, utilizing metalized polypropylene film capacitors, shall provide normal mode noise attenuation of at least 20 dB from 10 kHz to 1 MHz. The capacitors shall be equipped with an integral pressure-sensitive interrupter to provide short-circuit current interrupting capability of up to 10,000 amperes at 600 VAC.

F. High Energy Output Surge Suppression - the unit shall be equipped with a high energy, UL1449 and UL1283 listed, Transient Voltage Surge Suppression (TVSS) module connected to the unit output with minimal interconnecting wiring for maximum surge suppression. The TVSS shall consist of multiple, gapless Metal Oxide Varistor (MOV) arrays with their clamping voltages matched to within 1%. Each MOV shall be individually fused to protect against MOV failure while still allowing maximum rated surge current to flow without fuse operation. The fuses shall have a 100 kA interrupting capacity. Each array shall be capable of withstanding at least 1250 IEEE C62:41 category C3 surges (20 kV, 10 kA) without failure. The complete TVSS module shall have a total surge current capacity of 80 kA per phase based on a standard 8 x 20 microsecond surge waveform. The UL1449 surge clamping rating shall not exceed 400 volts for a 120/208 volt system. The maximum continuous operating voltage shall be at least 150 VAC for a 120/208 volt system. The TVSS shall also provide electrical noise attenuation of 50 dB from 100 kHz to 100 Mhz (based on MIL220A and 50 OHM impedance). An alarm contact of the TVSS module shall be connected to the unit monitoring system to annunciate any TVSS failure.

G. Subfeed Output Circuit Breaker: Refer to drawing single line electrical diagram for breaker sizes, quantities and spares/space for 240 volts AC rated molded case circuit breaker(s) to be provided to protect subfeed circuit(s) to an expansion, busway, remote distribution cabinet or other loads. The subfeed circuit breaker shall be rated for 25kA amperes symmetrical minimum interrupting capacity at 240 VAC and shall be powered ahead of the panelboard main breakers on the output of the unit. Each subfeed breaker shall include padlock-off provisions to allow circuit lock-out for safety in accordance with OSHA lock-out/tag-out requirements.

H. K-Rated Transformer - unit transformer shall have a K20 rating in accordance with UL 1561 to allow full load operation with highly nonlinear loads. Transformer neutral shall be sized for at least 173% of full load. The transformer shall be designed to operate with 100% single-phase, switch-mode power supplies and associated harmonic phase and neutral currents without derating.

I. Remote Emergency Power Off (EPO) Switches - provisions shall be available for adding multiple EPO switches to meet specific site needs and local codes. The EPO switch shall activate the shunt trip of the main input circuit breaker to shut down the system. Each EPO shall be a fully guarded, normally open, illuminated switch in a wall box. EPO switch shall have 150 feet of 3-conductor cable to connect to the specified system.

J. Phase Rotation Meter - a hand-held phase-rotation meter shall be included to verify rotation of any three-phase circuit rated 600 volts AC or less. It shall indicate "ABC" or "ACB" phase rotation.

K. Transformer High-Temperature Alarm - the transformer high temperature shutdown sensors shall be connected to provide a "Transformer Hightemp" alarm instead of automatically shut down the unit when temperature reaches 200°C. Temperature sensors shall be located in each coil of the three phase windings. The NC contact off the Temperature sensors shall be connected to Power Monitoring Panel Customer Alarm number 5 and shall annunciate a "Transformer Hightemp" alarm.

L. Square D Panelboard

1. The PDU shall be supplied with one vertically mounted panelboard for distribution to the intended loads. The panelboard shall be totally enclosed with an accent cover that provide access to the panelboard without exposing other portions of the unit. Panelboard shall include separate isolated neutral bus bar and safety-ground bus bar for the neutral and safety-ground connections.

2. The output distribution section shall be of dead-front construction, with fillers plates provided for unused circuit breaker positions. The panelboard shall employ copper bus bars and be capable of accepting bolt in type circuit breakers up to 3-pole 225 amps.

3. Panelboard shall have removable output cable landing tray. Circuit breaker ID number shall be provided for each breaker installed.

4. The neutral bus bar and wiring shall be sized for at least 1.73 times the panelboard full load rating to accommodate high harmonic neutral currents associated with nonlinear loads.

5. Conduit landing plates shall be provided on top and in the bottom for output cable exit.

6. Refer to the drawing single line diagram and panel schedules for panelboard quantity and size information. The fault current withstand rating for the circuit breakers shall be 22,000 AIC (minimum).

M. Power Monitoring System

1. The power monitoring system shall have transformer overtemperature and Emergency Power Off (EPO) circuits. All indicators and controls shall be on the front door, along with identifying system number.

2. The transformer overtemperature circuit shall include an audible and visual alarm if any internal transformer winding temperature reaches 180°C. A "SILENCE" switch shall be provided to quiet the audible alarm. The transformer overtemperature circuit shall also trip the main input breaker to remove power automatically when any transformer winding temperature reaches 200°C.

N. Network Interface Card (NIC): The PDU shall have an OpenComms Network card, which enables the PDU to communicate to a network management system (NMS). The Network Interface Card (NIC) will include internal hardware and software to communicate (via SNMP and HTTP) to any I.P.-based Ethernet network through a RJ-45 connector. The NIC shall provide redundant paths for communications that make it possible to connect to a Building Management System (BMS) using BACnet IP while simultaneously communicating to a NMS through SNMP and HTTP. A terminal block shall be provided to connect to BACnet IP.

O. Sub-feed Breaker Monitoring (SBM)

1. The SMB shall monitor the current and voltage of the each sub-feed circuit breaker. These measurements are used for reporting the average RMS current, power and other parameters.

2. The SMB reports alarm and status conditions for each sub-feed circuit breaker.

3. The system shall include individual current transformers to monitor the sub-feed circuit breakers. The SMB shall have the capacity to connect up to 36 individual current transformers.

4. Provide current transformers to monitor sub-feed circuit breaker(s). The system shall monitor the 3 phases, neutral and ground of each sub-feed circuit breaker.

5. The SMB shall monitor and display the following parameters for the sub-feed circuit breaker(s):

    a. Voltage

    b. Line-to-line

    c. Line-to-neutral

    d. Phase Current

    e. Neutral Current

    f. Ground Current

    g. Percent Load

    h. kW

    i. kW-Hours

    j. kVA

    k. Power Factor

    l. Voltage Total Harmonic Distortion (THD)

    m. Current Total Harmonic Distortion (THD)

    n. Crest Factor

6. Circuit identification and status of each breaker shall be displayed. Parameters shall be up dated every 500msec.

7. The SBM shall detect and annunciate by alarm message the following conditions:

    a. Overvoltage - panelboard main breaker

    b. Undervoltage - panelboard main breaker

    c. Neutral Overcurrent - panelboard main breaker (and subfeed breaker(s))

    d. Ground Overcurrent - panelboard main breaker (and subfeed breaker(s))

    e. Phase Overcurrent – panelboard main breaker (subfeed breaker(s)) and branch breakers

f. Phase Overcurrent Warning – panelboard main breaker (subfeed breaker(s)) and branch breakers

g. Summary Alarm

All alarm thresholds for monitored parameters shall be adjustable by way of the service port to match site requirements. The factory set points for the alarms shall be as follows:

8. Sub-feed Breaker:

a. Overvoltage – at least one of the line-to-line voltages exceeds +6% of nominal

b. Undervoltage - at least one of the line-to-line or line-to-neutral voltages falls below -13% of nominal

c. Phase Overcurrent Warning - current exceeds 75% of breaker amps

d. Phase Overcurrent - current exceeds 80% of breaker amps

e. Neutral Current - current exceeds 95% of main breaker amps

f. Ground Current - current exceeds 5 amps

9. Summary Alarm

a. Summary Alarm - shall detect and annunciate upon occurrence of any alarm.

10. To facilitate troubleshooting, all alarms shall be stored in non-volatile memory to protect against erasure by a power outage. Alarms shall be manually reset after the alarm condition has been corrected. Alarms can be reset through Modbus (and the Remote Monitor).

11. Alarms shall be saved in an event log. Event log shall store 128 events using a first in, first out format (FIFO).

P. Output Distribution Cables: The cable supplying each load shall consist of UL/CSA listed liquid-tight flexible metal conduit containing the required THHN copper-insulated power, neutral and parity-sized ground conductors. The flexible conduit shall be liquid-tight, insulated and shielded to minimize electrical or mechanical disturbances to the conductors. The length of each cable and the type of receptacle/termination shall be as specified on the detailed cable schedule. Each output distribution cable shall be permanently labeled at each end of the cable with the assigned circuit number and receptacle type, equipment identification and cable length. Each cable shall be thoroughly factory-checked and factory-tested. Tests shall include continuity, phase rotation and a Hi Pot test at twice rated circuit voltage plus 1000 volts. All output cables can be wound on spools mounted on casters to facilitate handling and installation. Each cable shall be a UL listed assembly.

Q. Transient Suppression Plate - the specified system shall have a transient suppression plate for the input power junction box to reduce effects of transients on the ground. The suppression plate shall measure one square meter.

R. Certified Test Report - a certified copy of the factory test report shall be provided for each unit.

S. Factory Witness Test - the owner and/or the owner's representative shall factory witness test each unit. The factory will perform its standard witness test to demonstrate that the unit meets the STS specification.

T. Export Crating - heavy-duty solid wood crating shall be provided to meet international requirements regarding package strength and special markings for overseas shipments.

PART 3 EXECUTION

3.0 GENERAL

A. Factory start-up, preventative maintenance and full service for the above specified system shall be available and included upon request. The manufacturer shall nationally employ their own internal service organization of factory-trained personnel dedicated to the start-up, maintenance and repair of the manufacturer's power equipment.

B. The manufacturer shall offer, as an option, 7x24 on-site service support with guaranteed response times of 2 hours.

3.1 INSTALLATION, INSPECTION, AND FACTORY AUTHORIZED STARTUP

Installation and start up shall include the following, but not limited to one start up. PDUs will be installed in separate phases:

A. Visual Inspection

1. Visually inspect all equipment for signs of damage and/or foreign materials.

2. Observe type of ventilation, room cleanliness, and the proper application of safety signs.

B. Mechanical Inspection

1. Check all internal power connections for proper tightness (torque).

2. Check all control wiring terminations and plugs for tightness and/or proper connection.

3. Check all PCBA's for proper configuration wiring or jumper settings.

4. Ensure all subassemblies, barriers, and safety guards are installed and secure.

C. Electrical Pre-check

1. Verify modules have been installed in accordance to their installation documentation.

2. Check system for phase to ground shorts internally and externally of the cabinet.

3. Check system for phase to phase shorts internally and externally of the cabinet.

D. Initial Unit Energization

1. Check input power terminations for proper supply voltage and phase rotation.

2. Check all power supply voltages and lamp tests, adjust as necessary.

3. Check all internal and output voltages are within acceptable tolerances.

E. System Monitoring and Control Settings

1. Check front panel control functions (buttons, lamps, displays) are in working order.

2. Check all measured and displayed values are within acceptable tolerances.

3. Check all alarm and operating transition threshold settings.

4. Check all remote monitor operations and displayed parameters.

5. Verify local and remote EPO operation.

F. Waveforms

1. Check all utility input waveforms (voltage and current)

2. Check primary output waveforms (voltage and current)

3. Check logic power supply ripple waveform.

G. System Verification after Critical Loads Have Been Applied

1. Recheck all measured and displayed values (volts, amps, frequency, and power).

2. Recheck all input and output, voltage and current waveforms.

3. Verify output voltage regulation is within acceptable tolerances.

3.2 TRAINING

A. Concurrent with factory authorized system startup the manufacturer's field service engineer shall train the owner's operating personnel in the proper operation of the system. Training shall last a minimum of one hours and shall include:

1. Safety precautions

2. Features and construction of project equipment

3. Voltage adjustment procedures

4. Routine inspection and test procedures, if applicable

5. Routine cleaning

6. Reading and interpretation of statuses and alarms

3.3 BUILDING MANAGEMENT AND AUTOMATIC TEMPERATURE CONTROL SYSTEM MONITORED POINTS

A. Provide status of Power Distribution Units (PDUs):

1. Loss of Input Source
2. Input Voltage
3. Output Voltage
4. Output Current
    a. Overall System
    b. Individual Sub-feed Breaker(s)
5. Output kVA/kW
    a. Overall System
    b. Individual Sub-feed Breaker(s)
6. Output Power Factor
7. Output THD
8. General Alarm

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways, Junction Boxes, and Pullboxes Carrying Circuits at 600 V or Less:

1. Emergency Distribution System: Red.

2. 480 Volt, Single and Three Phase System: Blue.

3. 208 Volt, Single and Three Phase System: Black.

4. Fire Alarm System: Red.

5. Motor and Other Control Systems: Purple.

6. Telephone System: Yellow.

7. Television System: Brown.

8. Security System: White.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

G. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch grommets in corners for mounting.

3. Nominal size, 7 by 10 inches.

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.

5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 10-foot maximum intervals in straight runs, and at 5-foot maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits: Identify with self-adhesive vinyl label, self-adhesive vinyl tape applied in bands, or painted bands. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

2. Power.

3. UPS.

4. Controls.

C. Power-Circuit Conductor Identification, 600 V or Less: For all conductors.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits, specific to the load served and distinguishable from all other in the panel. The directory shall be placed in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

   b. Enclosures and electrical cabinets.

   c. Access doors and panels for concealed electrical items.

   d. Switchgear.

   e. Switchboards.

   f. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

   g. Substations.

   h. Emergency system boxes and enclosures.

   i. Motor-control centers.

   j. Enclosed switches.

   k. Enclosed circuit breakers.

   l. Enclosed controllers.

   m. Variable-speed controllers.

   n. Push-button stations.

   o. Power transfer equipment.

   p. Contactors.

   q. Remote-controlled switches, dimmer modules, and control devices.

   r. Battery-inverter units.

   s. Battery racks.

   t. Power-generating units.

   u. Monitoring and control equipment.

   v. UPS equipment.

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SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.

2. Section 26 05 29 .....Hangers and Supports for Electrical Systems.

3. Section 26 05 53 .....Identification for Electrical Systems.

4. Section 26 27 26 .....Wiring Devices.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: All raceway types, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.

b. Frame and cover design.

c. Grounding details.

d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Alflex Inc.

3. Allied Tube & Conduit; a Tyco International Ltd. Co.

4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. Electri-Flex Co.

6. Manhattan/CDT/Cole-Flex.

7. Maverick Tube Corporation.

8. O-Z Gedney; a unit of General Signal.

9. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1. Zinc coated ¾" minimum.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. EMT: ANSI C80.3. ¾" minimum.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Steel set screw or steel compression. One inch (1") and smaller shall be insulated throats.

2. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

3. Fittings for EMT: Steel, set-screw or compression type.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.

2. Hoffman.

3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways, as required for complete system.

D. Wireway Covers: Hinged type or screw-cover type, as indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect/Engineer.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Thomas & Betts Corporation.

b. Walker Systems, Inc.; Wiremold Company (The).

c. Wiremold Company (The); Electrical Sales Division.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. EGS/Appleton Electric.

3. Erickson Electrical Equipment Company.

4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.

6. O-Z/Gedney; a unit of General Signal.

7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.

9. Scott Fetzer Co.; Adalet Division.

10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.

12. Walker Systems, Inc.; Wiremold Company (The).

13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular. Hubbell B-4236 Series, Walker 880CS Series.

E. Floor Box Covers: Polished solid brass.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Plywood backboard, marine-grade, ¾" thick.

7. Copper Ground Bar with #6 Copper Grounding: Electrode conductor to building steel.

8. Terminal Blocks: ANSI/NEMA ICS 4: UL listed. Channel mounted tubular pressure screw connectors, rated 300 volts.

2.5 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.6 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Concealed in Ceilings and Interior Walls and Partitions: EMT.

3. Damp or Wet Locations: Rigid steel conduit.

4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

B. Minimum Raceway Size: 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use #12 insulated conductor or polypropylene line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.

1. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

N. Install insulated bushing on all conduits. Install grounded metal bushing with lug on all mains, sub-feeders, switchboards, panelboards, transformers, chillers, disconnects, starters, and equipment rated at 100 amps and above.

O. Install boxes to preserve fire resistance rating of partitions and other elements using materials and methods that are UL listed and tested.

P. Existing Walls, Public Areas, Classrooms, Offices, Restrooms, Hallways, etc.: Conduit and boxes shall be concealed. Saw cut walls and floor slab. Make arrangements with General Contractor to patch all areas.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

*** END OF SECTION 26 05 33 ***

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

3. Supports/safety wire and chains for light fixtures and equipment.

B. Related Sections include the following:

1. Division 26 Section "Interior Lighting and Theatrical Lighting."

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Shall not be used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment. After fabrication shall be coated with hot-dipped galvanized with a minimum of 1.50 oz/ft on all sides.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Field cuts shall be zinc coated.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.

4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

5. To Light Steel: Sheet metal screws.

6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that meet seismic-restraint strength and anchorage requirements].

7. Do not drill structural steel members.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

*** END OF SECTION 26 05 29 ***

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding.

2. Common ground bonding with lightning protection system.

1.3 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to metalic water service, concrete encased rebar, building steel, and to supplementary grounding electrodes.

B. Ground each separately-derived system neutral to nearest effectively grounded metallic water pipe, concrete encased rebar, nearest effectively grounded building structural steel member, and separate grounding electrode.

C. Provide communications system grounding conductor at point of service entrance and connect to separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

E. Install lightning surge protection on all service entrances as shown on drawings. Lightning surge protector shall have a minimum withstand rating of a Class "C" test.

F. Bond metallic gas piping with #4 AWG copper conductor.

1.4 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.

2. Ground rods.

3. Ground rings.

4. Grounding arrangements and connections for separately derived systems.

5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Grounding system resistance shall not exceed 10 ohms.

E. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Submit test results to Engineer for review and approval immediately upon completing the test and prior to energizing new utility service. The testing shall include sufficient ground resistant data readings from distances up 100 feet away from the ground triad in order to plot a distinct plateau between two distinctive slopes.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators, length as required for number of terminations plus 25 percent future capacity.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; sectional type, 3/4 inch by 10 feet in diameter, two (2) rods coupled together for overall length of 20 feet.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Ring Conductors: Install bare-copper conductor, No. 4/0 AWG minimum when indicated on the drawings to provide.

1. Bury at least 24 inches below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall, 6 inches above finished floor, unless otherwise indicated.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Clamp connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.

2. Lighting circuits.

3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.

6. Flexible raceway runs.

7. Armored and metal-clad cable runs.

8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Metal and Concrete Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Provide ground rod at each location.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Ground Ring (when identified and called for on the drawings): Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of item indicated.

1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches from building foundation.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Report measured ground resistances that exceed the following values:

1. Main service equipment and distribution gear.

2. Separately derived system (i.e., transformers, uninterruptible power supply, engine generators).

3. Grounding system resistance shall not exceed 10 ohms.

E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

F. Supplement by adding additional ground rods to achieve 10 ohms.

*** END OF SECTION 26 05 26 ***

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

3. Sleeves and sleeve seals for cables.

4. Conductor sizes are based on copper.

B. Related Sections include the following:

1. Section 26 05 33 .....Raceway And Boxes For Electrical Systems.

2. Section 26 05 53 .....Identification For Electrical Systems.

1.3 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. NEMA WC5—Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.4 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70 where wire and cable is not shown.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Determine required separation between cable and other work.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.

2. American Insulated Wire Corp.; a Leviton Company.

3. General Cable Corporation.

4. Senator Wire & Cable Company.

5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

E. Multiconductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

D. No splices shall be permitted in underground locations.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.

2. Calpico, Inc.

3. Metraflex Co.

4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Carbon steel. Include two for each sealing element.

3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN-XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. Class 1 Control Circuits: Type THHN-THWN, in raceway.

M. Class 2 Control Circuits: Type THHN-THWN-TFFN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Concealed Dry Interior Locations: Use only building wire and cable (all types) in raceway.

E. Exposed Dry Interior Locations: For feeders, branch circuits, and class 1 remote control circuits, use only building wire in raceway. For class 2 or 3 control cable and power limited fire protective signaling cables run in raceway.

F. Above Accessible Ceilings: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cables run exposed. For power limited fire protective signaling cables run in raceway.

G. Wet or Damp Interior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire in raceway. For class 2 or 3 remote control cable and power limited fire protective signaling cables run in raceway.

H. Exterior Locations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and fire protective signaling cables run in raceway.

I. Underground Installations: For feeders, branch circuits and class 1 remote control cables use only building wire run in raceway. For class 2 or 3 remote control cables and for power limited fire protective signaling cables run in raceway.

J. Use wiring methods indicated on Drawings.

K. Each branch circuit shall have a dedicated neutral conductor. Shared neutrals on multiwire branch circuits are not acceptable.

L. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

M. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

N. All conductors size #6 and smaller shall be color coded insulation. Equipment grounding conductors #6 and smaller to have green or bare exterior finish per NEC 250-119(A). Grounded conductors (neutral) #6 and smaller to have a white or grey exterior finish per NEC 200-6. Conductors size #4 and larger shall be color code by use of colored plastic tape applied within 6" of each conductor end. All color coding shall be with the same color being used with its respective phase or bus through the entire job as follows:

208/120 VOLTS	277/480 VOLTS
Phase A.....Black	Phase A.....Brown
Phase B.....Red	Phase B.....Orange
Phase C.....Blue	Phase C .....Yellow
Neutral.....White	Neutral.....Gray
Ground .....Green	Ground .....Green

O. Grounding conductors shall be identified with a continuous outer finish that is either green, or green with one or more yellow stripe.

P. Protect exposed cable from damage.

Q. Support cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

R. Neatly train and lace wiring inside boxes, equipment, and panelboards.

S. Clean conductor surfaces before installing lugs and connectors.

T. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

U. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

V. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

W. Terminate spare conductors with electrical tape.

X. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

Y. Splice only in accessible junction boxes. No splices shall be permitted in underground locations.

Z. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both wall surfaces.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

*** END OF SECTION 26 05 19 ***

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SECTION 26 05 10

ELECTRICAL DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical Demolition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as shown on drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to the Architect/Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with utility company and school facility.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service and Distribution System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least one week before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

E. Components indicated on the drawings to be replaced shall be performed by disabling a single component and replacing that component one at a time.

F. Provisions shall be made to minimize outage or no outage at all.

G. Refer to the Sequence for replacing components. This Contractor may evaluate the Sequence and make recommendations to the Schedule of Events.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 and this Section.

B. Prior to any demolition, this Contractor shall survey the building and paint a large red 'R' on the equipment to be removed as coordinated with the architectural and HVAC plans and roofer. If any item(s) is incorrectly tagged, then this Contractor shall clean off the paint so there is no confusion.

C. If any conflicts arise in the field as to which equipment, ductwork, etc., is to be removed, then this Contractor shall notify the Owner/Engineer in writing and shall include a sketch and description of the field conflict for further direction.

D. In areas where demolition is required of this Contractor, then this Contractor shall be responsible for all phases of demolition, including, but not limited to, removal, storage, and reinstallation of items to remain.

E. Remove, relocate, and extend existing installations to accommodate new construction.

F. Remove abandoned wiring to source of supply.

G. Remove exposed, abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors and patch surfaces.

H. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed or remove boxes for wall to be patched.

I. Disconnect and remove abandoned panelboards and distribution equipment.

J. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

K. Repair adjacent construction and finishes damaged during demolition and extension work.

L. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

M. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

N. Coordinate with roofer and assist in removal of all roof mounted electrical conduit devices, equipment, etc., to be removed as indicated on the roofing drawings and HVAC drawings.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1.

*** END OF SECTION 26 05 10 ***

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. Basic electrical requirements specifically applicable to Division 26 Electrical.

1.2 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 01 General Requirements.

1.3 INTENT

A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

B. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.

1.4 SURVEYS AND MEASUREMENTS

A. Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work. All material take-offs for the site shall be field measured prior to bids.

1.5 DRAWINGS

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. Drawings are not to be scaled. The architectural drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. If directed by the Architect or Engineer, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. At the time of each shop drawing submission, the Contractor shall call the Engineer's attention (in writing) to, and plainly mark on shop drawings, any deviations from the Contract Documents.

D. Samples, drawings, specifications, catalogs, submitted for approval, shall be properly labeled indicating specific service for which material or equipment is to be used, location, section and article number of specifications governing, Contractor's name, and name of job. All equipment shall be labeled to match labeling on contract documents.

E. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

F. Approval rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specifications.

G. All shop drawings shall be submitted to the A/E by Contractor no later than 30 days from the day of contract award.

H. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

I. Submit all Division 16 submittals at one (1) time in one (1) integral group. Piece-by-piece submission of individual items will not be acceptable. Engineer may check contents of each submittal set upon initial delivery; if not complete as set forth herein, submittal sets may be returned to Contractor without review and approval and will not be accepted until made complete.

J. At the close of the job, prior to final review, five (5) bound copies of the following shall be submitted by transmittal letter to the Engineer for review and acceptance.

1. Equipment warranties

2. Contractor's warranty

3. Parts list and manuals for all equipment

4. Operating Instructions (in writing)

5. Written instructions on maintenance and care of the system

1.6 REFERENCES

A. ANSI/NFPA 70—National Electrical Code.

B. State Requirements for Educational Facilities (SREF) and Schools, Colleges and Universities, Chapter 4, Section 453 and 468, respectively, of the Florida Building Code.

C. NFPA 101—Life Safety Code.

D. Florida Department of Education Accessibility Guidelines and Requirements.

1.7 SUBMITTALS

A. Submit under provisions of Division 1.

B. Proposed Products List: Include Products specified in the following Sections, but not limited to:

1. Section 26 05 19 .....Low-Voltage Electrical Power Conductors and Cables.

2. Section 26 05 26 .....Grounding and Bonding for Electrical Systems.

3. Section 26 05 29 .....Hangers and Supports for Electrical Systems.

4. Section 26 05 33 .....Raceway and Boxes for Electrical Systems.

5. Section 26 05 53 .....Identification for Electrical Systems.

6. Section 26 26 00 .....Power Distribution Units (PDUs).

7. Section 26 28 16 .....Enclosed Switches and Circuit Breakers.

8. Section 26 33 53 .....Static Uninterruptible Power Supply.

C. It shall be understood that review of shop drawings by the Engineer does not supersede the requirement to provide a complete and functioning system in compliance with the Contract Documents.

1.8 SUBSTITUTIONS

A. Materials and equipment are specified herein by a single or by multiple Manufacturers to indicate quality and performance required. The drawings are based upon equipment scheduled on drawings and specified. If another Manufacturer is considered for substitution during the bidding process, the Electrical Contractor shall be responsible for coordinating all electrical, mechanical, structural, or architectural changes. Comparable equipment Manufacturers which are listed as equals shall be considered as substitutes. Manufacturers other than the basis of design shall submit a catalog information and 1/4" scale plan and section drawings showing proper fit and all clearances for maintenance items.

B. Substitutions of other Manufacturer's will be considered for use if, in the Engineers opinion, the item requested for substitution is equal to that specified. The Contractor shall provide to the Engineer a typed comparative list of the basis of design and the proposed substitute.

Request for approval of substitutions or equals prior to bid must be made in writing. The approval of any substitutions or equals prior to bid shall not be construed as a shop drawing approval. The substitute or equal must be submitted as described in the specifications and meet all the requirements of the specifications and drawings.

C. All requests for substitutions shall be submitted as described in paragraph 1.07, B., and specifically indicate any and all differences or omissions between the product specified as basis of design and the product proposed for substitution.

D. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawing, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical or electrical, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Subcontractor at his own expense and submitted to the Architect/Engineer for approval.

E. Where such approved deviation requires quantity and arrangement of equipment from that specified or indicated on the drawings, any other additional equipment required by the system, at no additional cost to the Owner.

1.9 COOPERATION WITH OTHER TRADES

A. Give full cooperation to other trades and furnish in writing to the General Contractor, with copies to the Architect, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.

B. When work installed under this Division will be in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If so directed by the Engineer/Architect, prepare composite working drawings and sections at a suitable scale not less than 1/4" = 1'0", clearly showing how work is to be installed in relation to the work of other trades. If the work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, make all the necessary changes in work to correct the condition without extra charge.

C. Furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

1.10 ELECTRICAL UTILITY COORDINATION

A. The contractor shall arrange with Utility Company for permanent electric service including payment of Utility Company charges for service.

B. Service shall be underground Service Entrance. System Voltage: 277/480 volts, three phase, four-wire, 60 Hertz.

C. Utility Company: Florida Power and Light Corp.

D. Install service entrance in accordance with Utility Company's rules and regulations.

E. The utility company shall provide the primary utility conduits and the Electrical Contractor shall install the conduits as directed by the utility company. The utility company shall provide and install the primary conductors.

1.11 PROTECTION

A. Protect all work and material provided under this Division from damage. All damaged equipment work or material provided under this Division shall be replaced with new. Rebuilts are not acceptable.

B. Protect all work and equipment until inspected, tested, and accepted. Protect work against theft, injury, or damage; and carefully store material and equipment received on site which are not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.12 SCAFFOLDING, RIGGING, AND HOISTING

A. Provide all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

1.13 REMOVAL OF RUBBISH

A. This Contractor shall at all times keep premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of work he shall remove all his tools, scaffolding, materials, and rubbish from the building and site. He shall leave the premises and his work in a clean, orderly, and acceptable condition.

1.14 SAFETY

A. This Contractor shall comply with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.333), Title 29—Labor, Chapter XIII, Bureau of Standards, Department of Labor, Part 1518—Safety and Health Regulations for Construction; and that his housekeeping and equipment be maintained in such a manner that they comply with the Florida Industrial Commission Safety Code and Regulations of the Federal Williams—Steiger Occupational Safety and Health Act of 1970 (OSHA), wherein it states that the Contractor shall not require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.

1.15 SUPERVISION

A. This Contractor shall provide a competent, experienced, full time superintendent who is acceptable to the Architect/Engineer and Owner, and who is authorized to make decisions on behalf of the Contractor.

1.16 MATERIAL AND WORKMANSHIP

A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished. Refer to substitutions in this Section.

B. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Architect and Engineer in accordance with the recommendations of the Manufacturer. This includes the performance of such tests as the Manufacturer recommends.

1.17 QUIET OPERATION AND VIBRATION

A. All work shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the Engineer and the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer and the Owner shall be corrected in an approved manner at no additional expense to the Owner.

1.18 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS

A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all equipment furnished under this Division, and shall submit drawings to the Architect and Engineer for approval before purchase, fabrication or construction of same.

B. For all floor mounted equipment, provide concrete pads which extend six inches (6") beyond equipment base in all directions with top edge chamfered. Inset six inches (6") steel dowel rods into floors to anchor pads. Shop drawings of all foundations and pads shall be submitted to the Architect and Engineer for approval before same are constructed.

C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be the same materials and same quality of finish as the adjacent and surrounding flooring material.

D. All equipment, unless shown otherwise, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect and the Engineer, not strong enough shall be replaced as directed.

1.19 ACCESS DOORS FOR WALLS AND CEILINGS

A. Provide flush panel access doors with a 16 gauge steel frame and a 14 gauge steel door panel.

B. Finish is to be primed painted steel.

C. Provide concealed hinges which allow the door to open 175 degrees and have a removable pin.

D. Provide access doors with a locked flush mounted vandal proof spanner head operated steel cams.

E. Provide 1-1/2 hour "B" label door for rated chase walls.

F. Furnish masonry anchors for installation in masonry walls and metal lath wings with casing bead for plaster installation.

G. Provide a minimum 2'-0" by 2'-0" access doors unless shown or noted otherwise on the drawings.

H. Access doors for chase walls shall be mounted 16" off the finish floor.

I. Access doors for electrical equipment shall be a minimum of 12" larger than equipment all around.

1.20 REGULATORY REQUIREMENTS

A. Conform to applicable Codes and Standards as follows:

1. Standard:

a. Certain standard materials and installation requirements are described by reference to standard specifications. These standards are as follows:

NEMA..... National Electrical Manufacturers Association.

UL ..... Underwriters Laboratories.

ANSI..... American National Standards Institute.

For additional standards and requirements see other sections of the specifications.

Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition at the time project is bid unless otherwise specified herein.

2. Codes and Rules:

a. All material furnished and all work installed shall comply with the following codes as they apply to this project:

- NFPA 70 and NFPA 101.
- Regulations of the Florida Industrial Commission Concerning Safety.
- Applicable County, State, and Local Building Codes.
- Local and State Fire Marshal Rules and Regulations.
- Chapter 4A-47, Florida Administrative Code - Uniform Fire Safety Standards for Elevators.
- Occupational Safety and Health Agency Standards (OSHA).
- Florida State Board of Health Rules and Regulations.
- Florida Building Code.

Applicable codes shall be those adopted by the authority having jurisdiction at the time project is bid.

3. Permits, Fees and Inspections

a. The Contractor shall give all necessary notices, obtain all permits and pay all government fees, sales taxes and other costs, including utility connections or extensions, in connection with this work; file all necessary approvals of all governmental departments having jurisdiction.

b. Obtain all required certificates of inspection for his work and deliver to the Owner/Engineer the same certificates before request for acceptance and final payment for the work.

c. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations.

d. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

1.21 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

C. The Contractor shall inform the Engineer of any work or materials which conflict with any of the applicable codes, standards, laws and regulations before submitting his bid.

D. The scope of the work included under this Division of the Specifications shall include complete electrical systems as shown on the plans and as specified herein. The General Conditions and Special Conditions of these specifications shall form a part and be included under this Section of the Specifications. Provide all supervision, labor, material, equipment, machinery, factory trained personnel, and any and all other items necessary to complete the electrical systems. All items of equipment are specified in the singular; however, provide and install the number of items of equipment as indicated on the drawings, and as required for complete systems.

1.22 SEQUENCING AND SCHEDULING

A. Construct Work in sequence under provisions of Division 1.

1.23 LICENSE

A. The Subcontracting Firm for the electrical and systems installation shall be licensed by the State of Florida and the local authorities, regularly engaged in the installation of electrical systems and other related equipment. The Subcontracting Firm shall be familiar with all local conditions including interpretations, codes and shall have at least 5 years of successful installation experience on similar projects of the same magnitude and scope.

The Subcontracting Firm shall list at least three projects it has successfully completed over the last five years for proof of experience of this caliber. This list shall be included with submittals for review by Architect/Engineer. The Subcontracting Firm shall hold a Florida State Certified Electrical Contractor license for this project. The Subcontracting firm for the fire alarm system shall be a certified "EF" installer.

1.24 AS-BUILT DRAWINGS

A. This Contractor shall provide AutoCad as-built drawings and copies of each AutoCad file on CD before final payment will be issued.

*** END OF SECTION 26 05 00 ***

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Bid Attachment 3

PLAN SET / DRAWINGS

DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
MCSO - DESOTO DATA CENTER AIR CONDITIONING UNITS: PROJECT # GG01645
MCSO - DESOTO DATA CENTER UPS REPLACEMENT: PROJECT # GG01644
CONSTRUCTION DOCUMENTS - 04-06-2018

SITE LOCATION MAP

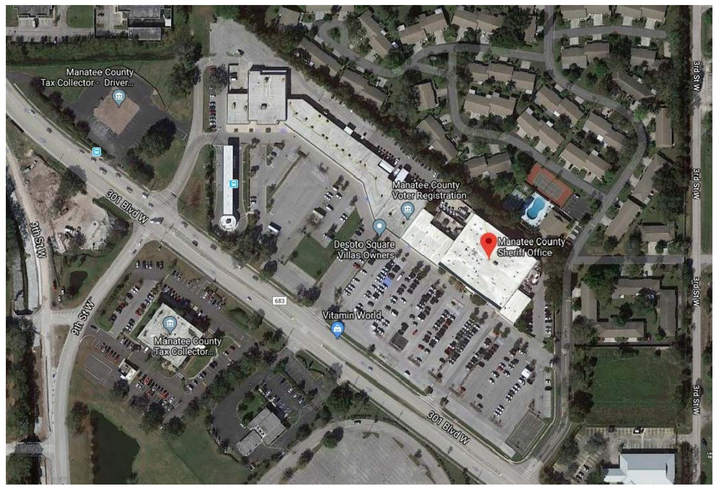

TABLE OF CONTENTS

"TO THE BEST OF MY KNOWLEDGE, THESE DRAWINGS AND THE PROJECT MANUAL ARE COMPLETE AND COMPLY WITH THE 'STATE REQUIREMENTS FOR EDUCATIONAL FACILITIES.'"

SEAL

ENGINEERING MATRIX, INC.
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CERT. OF AUTHORIZATION NO. 4288 EMI JOB NO. 17-0620

CONTROLS SYMBOL LEGEND

SYMBOL	DESCRIPTION
AI	ANALOG INPUT
AO	ANALOG OUTPUT
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
SS	START/STOP SIGNAL
FF	FLOW FEEDBACK/STATUS SIGNAL
WR	CHILLED WATER RESET 4–20 mA SIGNAL
VM	PID VALVE MODULATION
T	TEMPERATURE SENSOR/TRANSMITTER
P	PRESSURE SENSOR/TRANSMITTER
DP	PRESSURE DIFFERENTIAL SWITCH
SP	SETPOINT
M	MOTORIZED DAMPER ACTUATOR
H	HUMIDITY SENSOR/TRANSMITTER
CO2	CARBON DIOXIDE SENSOR/TRANSMITTER
TS	THERMOSTAT
HS	HUMIDISTAT
PF	PROPORTIONAL, LINEARIZED FEEDBACK 4–20mA SIGNAL
TD	TIME DELAY (RELAY OR SOFTWARE LATCH)
CT	CURRENT TRANSDUCER WITH GO/NO GO MONITOR CAPABILITY
O.A.	OUTSIDE AIR
LS	LIMIT SWITCH
VFD	VARIABLE FREQUENCY DRIVE
	"AND" LOGIC GATE
	THREE INPUT "AND" LOGIC GATE
	"OR" LOGIC GATE
	TWO INPUT "OR " LOGIC GATE
DO	SIGNAL OUT OF DIGITAL (EMCS) SOFTWARE INTO HARDWARE
DI	SIGNAL OUT OF HARDWARE INTO DIGITAL (EMCS) SOFTWARE
CI	CONTROL RELAY HOLDING COIL
	NORMALLY OPEN CONTROL RELAY CONTACT
	NORMALLY CLOSED CONTROL RELAY CONTACT
P	THERMOSTAT – CLOSE ON TEMPERATURE RISE
	SINGLE POLE SWITCH
	'NOT' INPUT LOGIC
	SIGNAL TYPE (AI,AO,DI,DO) FUNCTIONAL DESCRIPTION

NOTE:
NOT ALL SYMBOLS SHOWN IN THIS LEGEND NECESSARILY APPEAR IN THESE DOCUMENTS. ADDITIONAL SYMBOLS MAY BE DEFINED ELSEWHERE IN SPECIFIC DRAWINGS.

MECHANICAL SYMBOL LEGEND

SYMBOL	DESCRIPTION
	45 DEGREE OFFSET
	SUCTION DIFFUSER
	PIPE ANCHOR
	PIPE EXPANSION GUIDES
	MANUAL AIR VENT
A	AUTOMATIC AIR VENT
	VIBRATION ISOLATOR
F	FLOAT TRAP
F/T	FLOAT AND THERMOSTATIC TRAP
T	THERMOSTATIC TRAP
D	THERMO–DYNAMIC DISC TRAP
DRYER	DRYER
	FILTER
	EXPANSION VALVE (THERMOSTATIC)
	SIGHT GLASS
	BALL SHUT–OFF VALVE
	LIQUID CHARGING VALVE
	HOT GAS BYPASS VALVE
	HOT GAS TEE
	LIQUID SHUT–OFF VALVE
	THERMOMETER WITH NEEDLE VALVE
	PRESSURE OR VACUUM GAGE WITH NEEDLE VALVE
C	COMPOUND PRESSURE OR VACUUM GAGE WITH NEEDLE VALVE
	LUGGED BUTTERFLY VALVE
	ANGLE GATE VALVE W/ HOSE BIB
	PRESSURE REDUCING VALVE
	3–WAY CONTROL VALVE
FM	FLOW MONITOR
	2–WAY CONTROL VALVE
	GATE VALVE IN RISE
	FLANGED CONNECTION
	LUGGED BUTTERFLY VALVE IN RISE
	NEEDLE VALVE
	CIRCULATING PUMP
	SHOCK ARRESTOR
	SHUT–OFF VALVE
	GLOBE VALVE
	PIPE UNION
	COMBINATION CALIBRATED BALANCING VALVE WITH MEMORY STOP AND SHUT–OFF VALVE
	TRIPLE DUTY VALVE (CALIBRATED BALANCING, SHUT–OFF AND CHECK)
P/T	PRESSURE /TEMPERATURE PLUG
	SWING CHECK VALVE
	GAS PLUG VALVE
	Y–TYPE STRAINER WITH BLOW DOWN AND VALVE
	SHUT–OFF VALVE IN VALVE BOX
	ASME TEMPERATURE AND PRESSURE RELIEF VALVE
	SPRING CHECK VALVE
	COMBINATION MAGNETIC MOTOR STARTER
	FUSIBLE DISCONNECT SWITCH
FS	FLOW SWITCH

MECHANICAL SYMBOL LEGEND

SYMBOL	DESCRIPTION
	EXISTING DEVICES OR EQUIPMENT TO REMAIN
	EXISTING DEVICES OR EQUIPMENT TO BE REMOVED
	NEW OR MODIFIED DEVICES OR EQUIPMENT
	SUPPLY/OUTSIDE AIR FLOW
	RETURN/EXHAUST AIR FLOW
L	LOUVERED DOOR; LOUVERED DOOR SHALL BE MINIMUM 12" X 12" UNLESS OTHERWISE NOTED ON THE DRAWINGS. CONTRACTOR SHALL COORDINATE ALL DOOR LOUVERS WITH DOOR INSTALLATION CONTRACTOR PRIOR TO BID.
U	UNDERCUT DOOR, DOORS SHALL HAVE A ¾ INCH UNDERCUT. CONTRACTOR SHALL COORDINATE ALL DOOR UNDERCUTS WITH DOOR INSTALLATION CONTRACTOR PRIOR TO BID.
R	RISE IN DUCT ELEVATION IN DIRECTION OF AIRFLOW
D	DROP IN DUCT ELEVATION IN DIRECTION OF AIRFLOW
S	SMOKE DETECTOR IN DUCT W/ 6" X 6" ACCESS DOOR
T	THERMOSTAT
T	TEMPERATURE SENSOR
H	HUMIDISTAT
H	HUMIDITY SENSOR
CO_2	CO_2 SENSOR
CRAC X–X	COMPUTER ROOM AIR CONDITIONER
CU X–X	CONDENSING UNIT FOR D/X COMPUTER ROOM AIR CONDITIONER
A 105	INSERT INDICATES AIR DEVICE TYPE (REFER TO MECHANICAL SCHEDULE) INSERT INDICATES DEVICE AIR FLOW RATE
– –	INSERT INDICATES SECTION NUMBER INSERT INDICATES DRAWING NUMBER
– –	INSERT INDICATES DETAIL NUMBER INSERT INDICATES DRAWING NUMBER
	CONNECTION POINT OF NEW TO EXISTING
5	KEYED NOTE
	PIPE DOWN
	PIPE UP
	BRANCH CONNECTION OFF TOP
	BRANCH CONNECTION OFF BOTTOM
	BRANCH CONNECTION OFF SIDE
	CAP ON END OF PIPE
	DIRECTION OF FLOW
	PIPE TRANSITION

MECHANICAL ABBREVIATIONS

ABBREVIATION	DESCRIPTION	ABBREVIATION	DESCRIPTION
S/S	STAINLESS STEEL	F.C.	FAIL CLOSED
DWG	DRAWING	N.T.S.	NOT TO SCALE
AFF	ABOVE FINISHED FLOOR	(E)	EXISTING EQUIPMENT
AFG	ABOVE FINISHED GRADE	Ø	DIAMETER
W/	WITH	O.B.D.	OPPOSED BLADE DAMPER
W/O	WITHOUT	CHWS	CHILLED WATER SUPPLY
AUTO	AUTOMATIC	CHWR	CHILLED WATER RETURN
APPROX.	APPROXIMATE	HWS	HEATING HOT WATER SUPPLY
N.O.	NORMALLY OPEN	HWR	HEATING HOT WATER RETURN
N.C.	NORMALLY CLOSED	CWS	CONDENSER WATER SUPPLY
C.	COMMON (ALWAYS OPEN)	CWR	CONDENSER WATER RETURN
F.O.	FAIL OPEN	CD	CONDENSATE DRAIN

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SEAL:

DRAWING PHASE:
CONSTRUCTION DOCUMENTS

ISSUE DATE:	EMI JOB NO.
4-6-2018	**17-0620**

DRAWING REVISIONS:

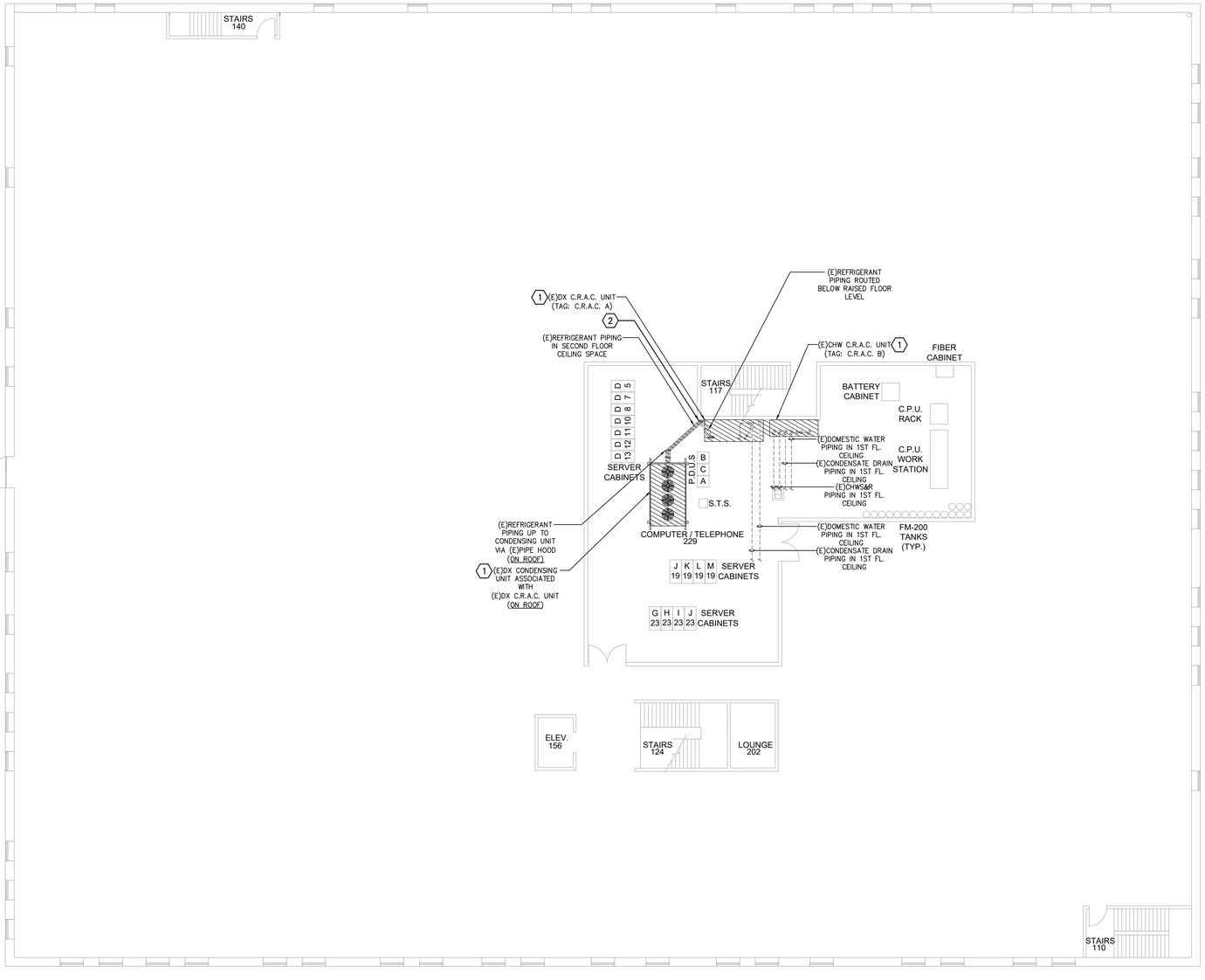
DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: **SMW** CHECKED BY: GFB

DRAWING TITLE:
MECHANICAL SYMBOLS LEGEND

SCALE: **N.T.S.** NORTH:

DRAWING NUMBER:
M0.0



GENERAL NOTES

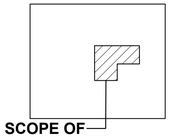
1. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF DEMOLITION WORK WITH OTHER TRADES TO AVOID CONFLICTS.
2. ALL EQUIPMENT SCHEDULED FOR DEMOLITION SHALL BE PRESENTED TO OWNER FOR THE FIRST RIGHT OF REFUSAL. SHOULD THE OWNER REFUSE, ALL EQUIPMENT SHALL BE DISPOSED OF IN A PROPER MANNER.
3. EXISTING EQUIPMENT, LOCATIONS, AND DATA ARE BASED ON EXISTING DRAWING DATA. CONTRACTOR SHALL FIELD VERIFY EXACT LOCATIONS.
4. ANY EXISTING WALL, ROOF, FLOOR, EQUIPMENT, ETC. DAMAGED DURING DEMOLITION SHALL BE REPAIRED OR REPLACED TO MATCH EXISTING. COORDINATE WITH GENERAL CONTRACTOR AND/OR OWNER.

KEYED NOTES

1. CONTRACTOR SHALL DEMOLISH AND REMOVE EXISTING COMPUTER ROOM AIR CONDITIONERS AS WELL AS ASSOCIATED CONDENSING UNIT LOCATED ON ROOF. EXISTING DOMESTIC WATER PIPING, EXISTING CHWS&R PIPING, WHERE APPLICABLE, AND EXISTING CONDENSATE DRAINAGE PIPING SHALL BE DEMOLISHED AND REMOVED FLUSH WITH TOP OF SECOND FLOOR SLAB. EXISTING PIPING SHALL BE CLEANED AND PREPARED FOR RECONNECTION TO NEW COMPUTER ROOM AIR CONDITIONERS. REFER TO MECHANICAL FLOOR PLAN FOR FURTHER INFORMATION.
2. CONTRACTOR SHALL DEMOLISH AND REMOVE ALL REFRIGERANT LINE SETS ASSOCIATED WITH EXISTING DIRECT EXPANSION COMPUTER ROOM AIR CONDITIONER, INCLUDING EXISTING REFRIGERANT PIPING COVER LOCATED WITHIN DATA CENTER. EXISTING PIPE HOOD ON ROOF SHALL BE TEMPORARILY REMOVED TO BE RE-INSTALLED ONCE NEW EQUIPMENT IS INSTALLED.

DEMO SEQUENCE NOTES

1. THIS EXISTING DATA CENTER IS A 24 HOUR PER DAY, 365 DAY PER YEAR OPERATIONAL FACILITY.
2. AIR CONDITIONING AND POWER MUST BE MAINTAINED WITHIN THIS FACILITY AT ALL TIMES DURING THE DEMOLITION AND NEW CONSTRUCTION PROCESS.
3. THE 2 EXISTING CRAC UNITS ARE CONFIGURED SUCH THAT ONLY 1 UNIT IS REQUIRED TO OPERATE IN ORDER TO MEET THE PEAK DEMAND. THE 2ND UNIT IS A 100% REDUNDANT BACKUP.
4. THE DEMOLITION OF THE 2 EXISTING CRAC UNITS MUST BE SCHEDULED SUCH THAT ONE UNIT REMAINS IN OPERATION AT ALL TIMES.
5. BID ALTERNATE #1: THE CONTRACTOR MUST HAVE PROVISIONS WITHIN ITS BID TO BRING IN PORTABLE SELF CONTAINED TEMPORARY AC UNITS DURING PERIODS WHERE THE DATA CENTER IS ONLY BEING SERVED BY A SINGLE OPERATIONAL CRAC UNIT. THE TEMPORARY PORTABLE UNITS MUST BE CAPABLE OF BEING INSTALLED WITHIN IN 1 HOUR OF CATASTROPHIC LOSS OF ALL CRAC UNIT CAPACITY.
6. THE 2 NEW CRAC UNITS ARE ALSO CONFIGURED SUCH THAT ONLY 1 UNIT IS REQUIRED TO OPERATE IN ORDER TO MEET THE PEAK DEMAND. THE 2ND UNIT IS A 100% REDUNDANT BACKUP.



KEYPLAN

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4-6-2018	17-0620

DRAWING REVISIONS:

DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES

600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: SMW CHECKED BY: GFB

DRAWING TITLE: PARTIAL SECOND FLOOR DEMOLITION PLAN - MECHANICAL

SCALE: 3/32" = 1'-0" NORTH:

DRAWING NUMBER: M1.2

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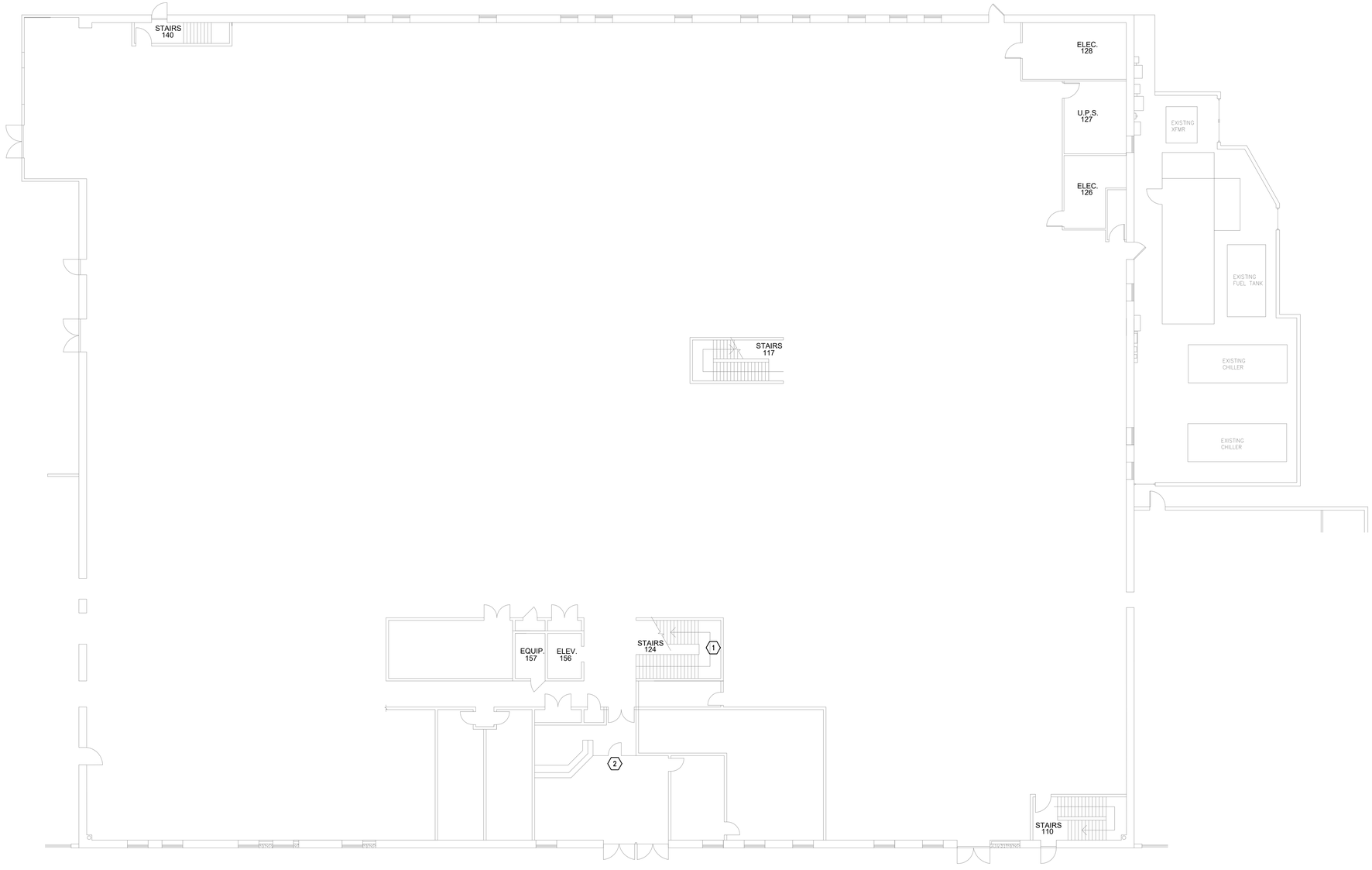


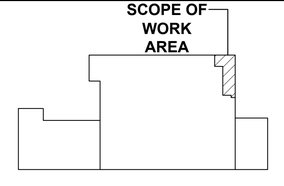
GENERAL NOTES

1. CONTRACTOR SHALL INSTALL MECHANICAL EQUIPMENT IN ACCORDANCE WITH ALL STATE AND LOCAL CODES.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRANSITIONS, FITTINGS, ELBOWS, PIPING, SUPPORTS, ETC. NECESSARY FOR A PROPER INSTALLATION AND OPERATION OF A NEW HVAC SYSTEM.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF INSTALLATION WORK WITH OTHER TRADES TO AVOID CONFLICTS.
4. ANY WALL, ROOF, FLOOR, EQUIPMENT, ETC. DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED TO MATCH EXISTING. COORDINATE WITH GENERAL CONTRACTOR AND/OR OWNER.

KEYED NOTES

(1) THE STAIRWAY SHALL BE USED AS THE PRIMARY ENTRY AND REMOVAL PATH FOR MECHANICAL EQUIPMENT. THE CONTRACTOR SHALL BE REQUIRED TO PROVIDE ALL EQUIPMENT AND LABOR REQUIRED TO REMOVE EXISTING EQUIPMENT AND INSTALL NEW EQUIPMENT THROUGH THE EXISTING STAIRWELL.

(2) THE CONTRACTOR SHALL BE REQUIRED TO REMOVE AND RE-INSTALL THE SECURITY ENTRY PASSAGEWAY SYSTEM AS REQUIRED TO MOVE NEW CRAC UNITS INTO THE BUILDING AND UP TO THE 2ND FLOOR. THE SECURITY ENTRY SYSTEM MAY ONLY BE INOPERABLE FOR A MAXIMUM PERIOD OF 4 HOURS. BOTH CRAC UNITS SHALL BE INSTALLED AT THE SAME TIME SUCH THAT THE SECURITY ENTRY PASSAGEWAY SYSTEM IS ONLY DISTURBED ONE TIME DURING THE COURSE OF THIS PROJECT.



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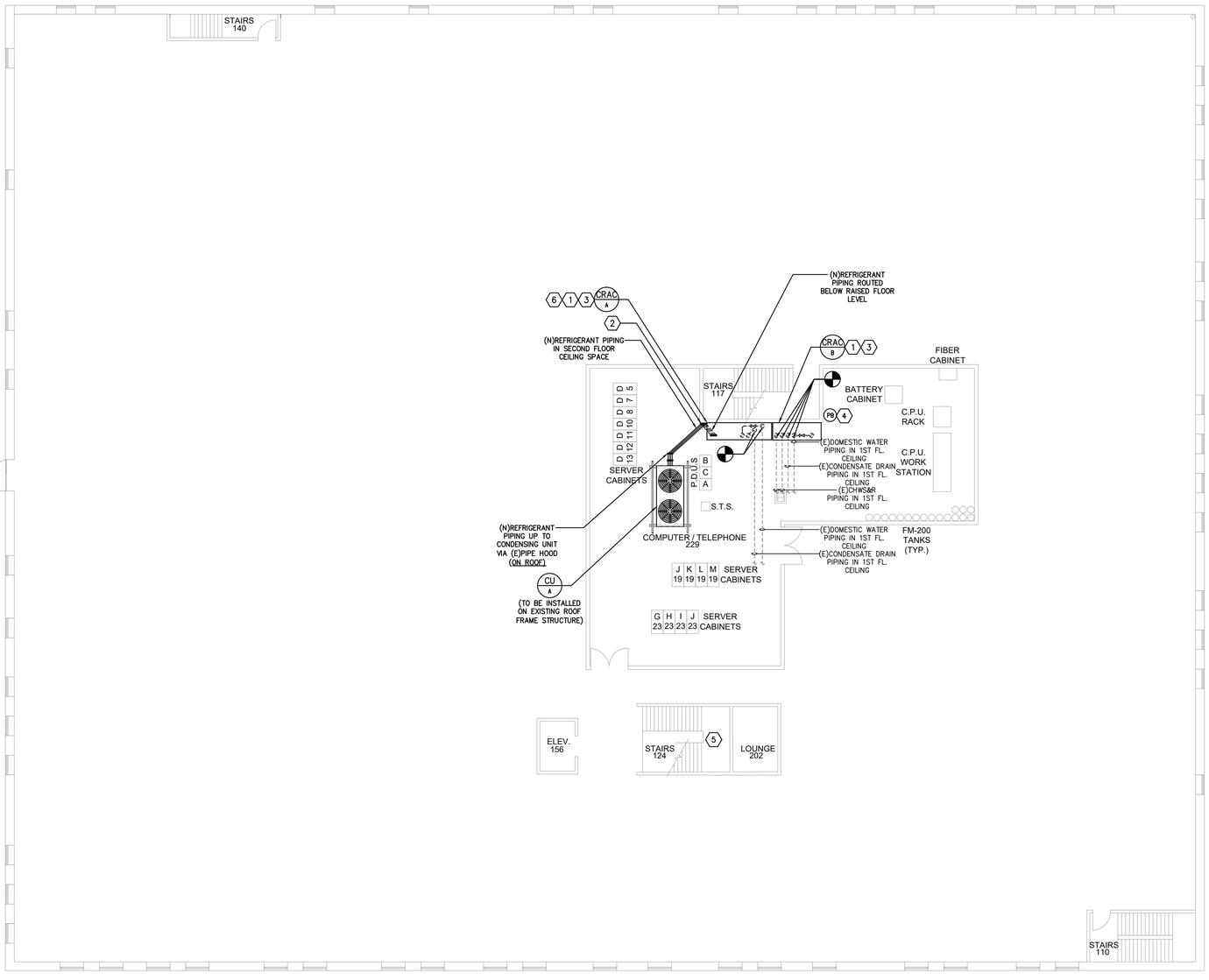
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: XXX CHECKED BY: GFB

DRAWING TITLE:
PARTIAL FIRST FLOOR PLAN - MECHANICAL

SCALE:	NORTH:
3/32" = 1'-0"	

DRAWING NUMBER:
M2.1



GENERAL NOTES

1. CONTRACTOR SHALL INSTALL MECHANICAL EQUIPMENT IN ACCORDANCE WITH ALL STATE AND LOCAL CODES.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRANSITIONS, FITTINGS, ELBOWS, PIPING, SUPPORTS, ETC. NECESSARY FOR A PROPER INSTALLATION AND OPERATION OF A NEW HVAC SYSTEM.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF INSTALLATION WORK WITH OTHER TRADES TO AVOID CONFLICTS.
4. ANY WALL, ROOF, FLOOR, EQUIPMENT, ETC. DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED TO MATCH EXISTING. COORDINATE WITH GENERAL CONTRACTOR AND/OR OWNER.

KEYED NOTES

1. EXISTING DOMESTIC WATER PIPING, EXISTING CHWS&R PIPING, WHERE APPLICABLE, AND EXISTING CONDENSATE DRAINAGE PIPING SHALL BE CAPTURED AND EXTENDED FROM TOP OF SECOND FLOOR SLAB. EXISTING PIPING SHALL TRANSITION AS REQUIRED TO MATE UP WITH NEW UNIT PIPING CONNECTIONS. REFER TO MANUFACTURER'S INSTALLATION GUIDELINES FOR ROUGH-IN SIZES.
2. CONTRACTOR SHALL PROVIDE ALL NEW REFRIGERANT LINE SETS FOR NEW DIRECT EXPANSION COMPUTER ROOM AIR CONDITIONER, INCLUDING NEW REFRIGERANT PIPING COVER LOCATED WITHIN DATA CENTER. SIZE AND NUMBER OF REFRIGERANT LINES SHALL BE PER MANUFACTURER'S INSTALLATION INSTRUCTIONS. EXISTING PIPE HOOD ON ROOF SHALL BE RE-INSTALLED ONCE NEW EQUIPMENT IS INSTALLED AND FLASHED IN BY A LICENSED ROOFING CONTRACTOR TO KEEP BUILDING ENVELOPE SEALED WATER TIGHT.
3. CONTRACTOR SHALL MODIFY EXISTING RAISED FLOOR TILE LAYOUT AS REQUIRED TO ACCOMMODATE FOOTPRINT OF NEW COMPUTER ROOM AIR CONDITIONERS.
4. PROVIDE NEW DIGITAL 3 POSITION SWITCH THAT IS CAPABLE OF INTEGRATING INTO THE BUILDING DDC CONTROL SYSTEM. THE 3 SWITCH POSITIONS SHALL BE:
   A. AUTOMATIC CRAC SELECTION AS PRIMARY UNIT.
   B. CHILLED WATER CRAC OPERATES AS PRIMARY UNIT.
   C. DX CRAC OPERATES AS PRIMARY UNIT.

   THIS 3 POSITION SWITCH SHALL ALSO BE REPRESENTED ON THE DDC GRAPHIC SCREEN TO IDENTITY CURRENT SWITCH POSITION.
5. THE STAIRWAY SHALL BE USED AS THE PRIMARY ENTRY AND REMOVAL PATH FOR MECHANICAL EQUIPMENT. THE CONTRACTOR SHALL BE REQUIRED TO PROVIDE ALL EQUIPMENT AND LABOR REQUIRED TO REMOVE EXISTING EQUIPMENT AND INSTALL NEW EQUIPMENT THROUGH THE EXISTING STAIRWELL.
6. THE NEW DX CRAC UNIT SHALL BE INSTALLED FIRST SUCH THAT IT IS UP AND RUNNING PRIOR TO REMOVAL OF THE EXISTING CHW CRAC UNIT.

SCOPE OF WORK AREA

KEYPLAN

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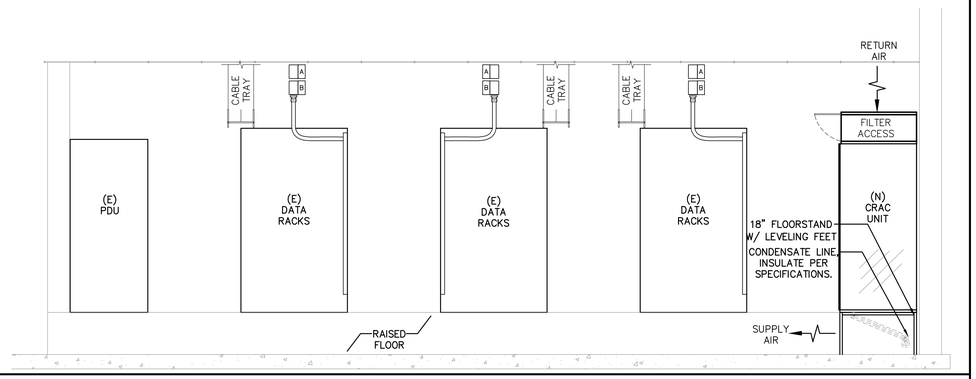
DRAWN BY: SMW CHECKED BY: GFB

DRAWING TITTLE: PARTIAL SECOND FLOOR PLAN - MECHANICAL

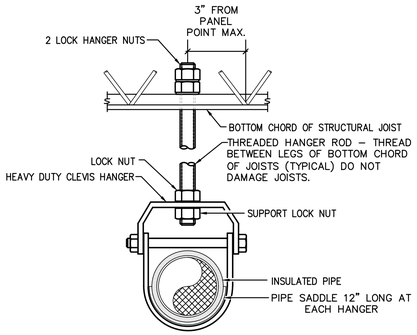
SCALE: 3/32" = 1'-0" NORTH:

DRAWING NUMBER: M2.2



CRAC UNIT CONFIGURATION AND ELEVATION

NO SCALE



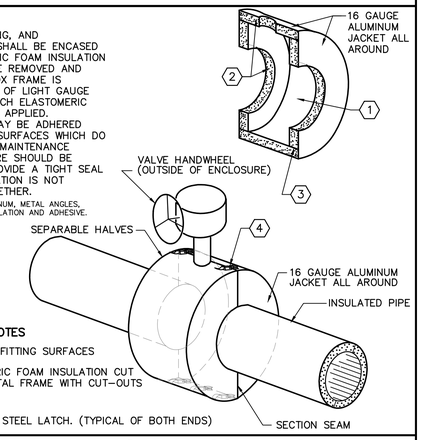
TYPICAL CLEVIS HANGER DETAIL

NO SCALE

NOTES:

VALVES, FITTING, AND FLOWMETERS SHALL BE ENCASED IN ELASTOMERIC FOAM INSULATION WHICH CAN BE REMOVED AND REUSED. A BOX FRAME IS CONSTRUCTED OF LIGHT GAUGE METAL TO WHICH ELASTOMERIC INSULATION IS APPLIED. INSULATION MAY BE ADHERED DIRECTLY TO SURFACES WHICH DO NOT REQUIRE MAINTENANCE REMOVAL. CARE SHOULD BE TAKEN TO PROVIDE A TIGHT SEAL WHERE INSULATION IS NOT ADHERED TOGETHER.

MATERIALS: ALUMINUM, METAL ANGLES, ELASTOMERIC INSULATION AND ADHESIVE.



KEYED NOTES

1. VALVE OR FITTING SURFACES
2. ELASTOMERIC FOAM INSULATION CUT TO FIT METAL FRAME WITH CUT–OUTS
3. ADHESIVE
4. STAINLESS STEEL LATCH. (TYPICAL OF BOTH ENDS)

REMOVABLE / REPLACEABLE COVER FOR VALVES AND FITTINGS

NO SCALE

COMPUTER ROOM AIR CONDITIONER SCHEDULE

AIR HANDLING UNIT DATA			
UNIT CONFIGURATION	–	DIRECT EXPANSION	CHILLED WATER
MARK	–	CRAC–A	CRAC–B
MANUFACTURER	–	LIEBERT	LIEBERT
MODEL	–	DS105AU	CW106D
TOTAL COOLING CAPACITY	MBH	315	234
SENSIBLE CAPACITY	MBH	245	234
SUPPLY AIR QUANTITY	CFM	13,200	17,050
OUTSIDE AIR QUANTITY	CFM	0	0
FAN QUANTITY	–	3	3
ELECTRICAL	V/ø/HZ	480/3/60	480/3/60
M.C.A/M.O.C.P.	AMPS/AMPS	97.4 / 110.0	78.4/80
ENTERING AIR TEMP. DB/WB (COOLING COIL)	°F /°F	72.0/60.0	72.0/60.1
LEAVING AIR TEMP. DB/WB (COOLING COIL)	°F /°F	54.8/51.3	59.3/55.2
EXT. STATIC PRESSURE	IN. W.C.	0.2	0.2
FILTER	–	MERV 8 4" PLEATED	MERV 8 4" PLEATED
WEIGHT	LBS	3,040	1,785
OVERALL DIMENSIONS	L X W X H	35 X 132 X 76	35.5 X 122 X 76
INFRARED HUMIDIFIER CAPACITY	LBS/HR	22	22
CONDENSER COOLING COIL WATER FLOWRATE	GPM	N/A	37.7
CONDENSER COOLING COIL EWT/LWT	F/F	N/A	45.0/59.0
COOLING COIL MAX. H2O PRESS. DROP	FT. H2O	N/A	5.5
NOTES:	–	①②③④ ⑤⑥⑦⑧	①②③④ ⑤⑥⑦
CONDENSING UNIT DATA			
MARK	–	CU–A	N/A
MANUFACTURER	–	LIEBERT	N/A
MODEL NUMBER	–	MCL110	N/A
ELECTRICAL	V/ø/HZ	460/3/60	N/A
M.C.A. / M.O.C.P.	AMPS/AMPS	6.3 / 15.0	N/A

KEYED NOTE:

① PROVIDE WITH NETWORK INTERFACE CARD TO COMMUNICATE WITH MAIN BUILDING MANAGEMENT SYSTEM.

② PROVIDE LOCKING DISCONNECT.

③ PROVIDE UNIT TOP RETURN AIR PLENUM (HEIGHT AS NECESSARY TO ENTER PLENUM).

④ PROVIDE UNIT WITH 18" ADJUSTABLE FLOOR STAND. INSTALL STAND TO MATCH EXISTING RAISED FLOOR HEIGHT.

⑤ LT–410 LEAK DETECTION SENSOR–INTERNAL, LT–410 LEAK DETECTION, HI TEMP SENSOR & SMOKE DETECTORSENSOR–INTERNAL, HUMIDIFIER LOCKOUT, BACNET/IP INTERFACE FOR BMS INTEGRATION, 2 WAY CHILLED WATER VALVE AND ICOM W/SMARTAISLE CONTROL WITH SEPARATE SERVER CABINET TEMP SENSORS.

⑥ PROVIDE START UP BY FACTORY REP.

⑦ FOR ALTERNATES, CFD MODEL REQUIRED TO VALIDATE DESIGN CONDITIONS AND ENSURE CAPACITIES ARE MET AS PER ASHRAE 90.1/2010 PRIOR TO BIDDING

⑧ PROVIDE WITH DIGITAL SCROLL COMPRESSORS, ELECTRIC RE–HEAT, AND AN INFRARED HUMIDIFIER.

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SEAL:

DRAWING PHASE: **CONSTRUCTION DOCUMENTS**

ISSUE DATE: **4-6-2018** | EMI JOB NO. **17-0620**

DRAWING REVISIONS:

DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES

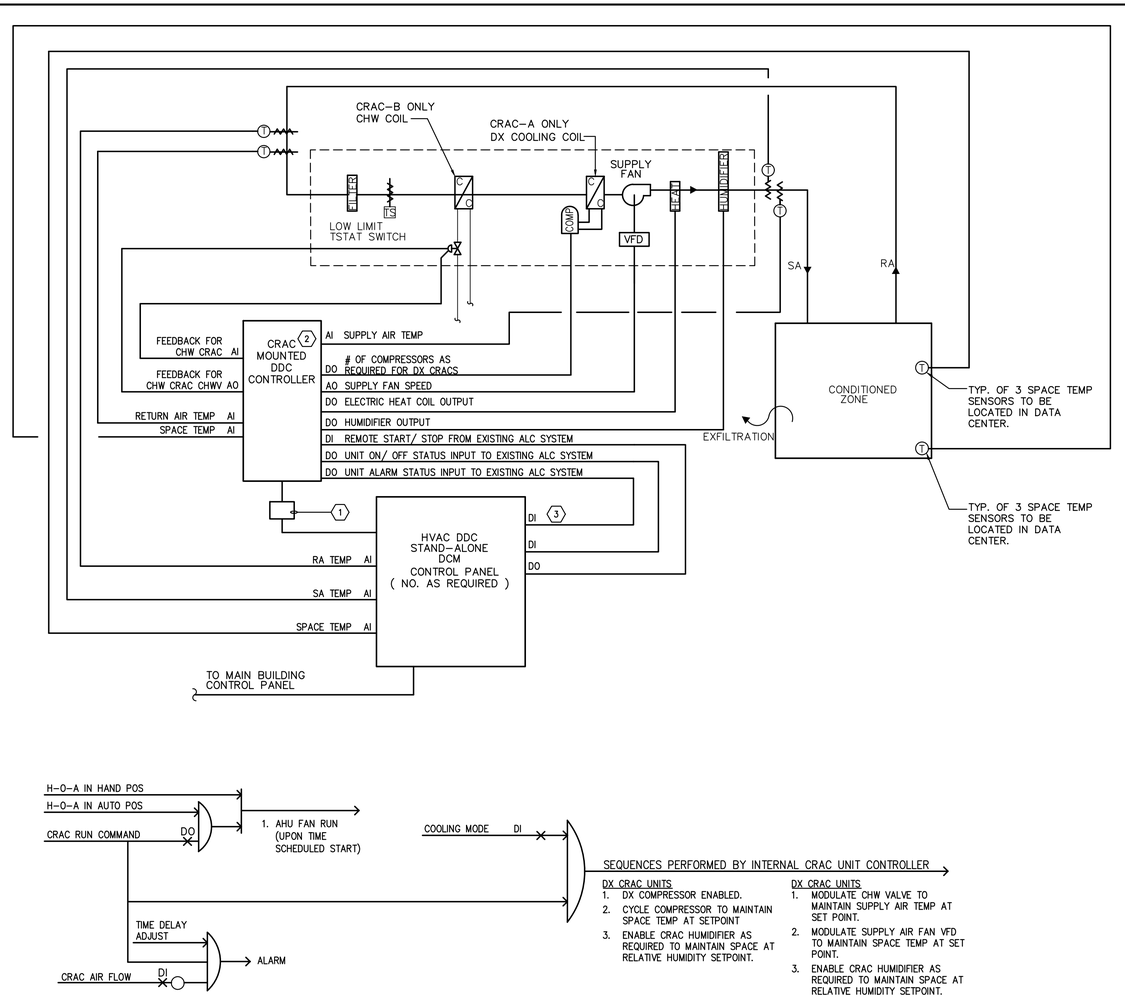
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: **SMW** CHECKED BY: GFB

DRAWING TITLE: **MECHANICAL DETAILS & SCHEDULES**

SCALE: **N.T.S.** | NORTH:

DRAWING NUMBER: **M3.1**



CRAC UNIT CONTROL SCHEMATIC AND LOGIC DIAGRAM

SCALE: NONE TYP. OF ALL CRAC UNITS

KEYED NOTES

1. PROVIDE BACNET COMMUNICATION INTERFACE BETWEEN HVAC AUTOMATIC SYSTEM AND CRAC UNIT CONTROLLER. PROVIDE ALL GATEWAY DEVICES AS NEEDED TO COMMUNICATE ALL CRAC UNIT OPERATING CHARACTERISTICS.
2. CRAC UNIT MANUFACTURER CONTROLLER SHALL PERFORM ALL CRAC UNIT SEQUENCING NECESSARY TO LOAD/ UNLOAD THE UNIT'S CAPACITY AS NEEDED TO MAINTAIN THE ZONE TEMPERATURE SETPOINTS.
3. CRAC UNIT ALARM CONDITION SHALL RESULT IN A GRAPHIC ALARM CONDITION ON THE BUILDING AUTOMATION SYSTEM GRAPHICS SCREEN IN ADDITION TO SENDING A TEXT MESSAGE TO PRE-DETERMINED PHONE NUMBERS (MINIMUM OF 3). THIS CONTRACTOR SHALL BE REQUIRED TO PROVIDE ALL HARDWARE AND SOFTWARE AS REQUIRED TO ACCOMPLISH THE ABOVE FUNCTIONS.

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CERT. OF AUTHORIZATION NO. 4288

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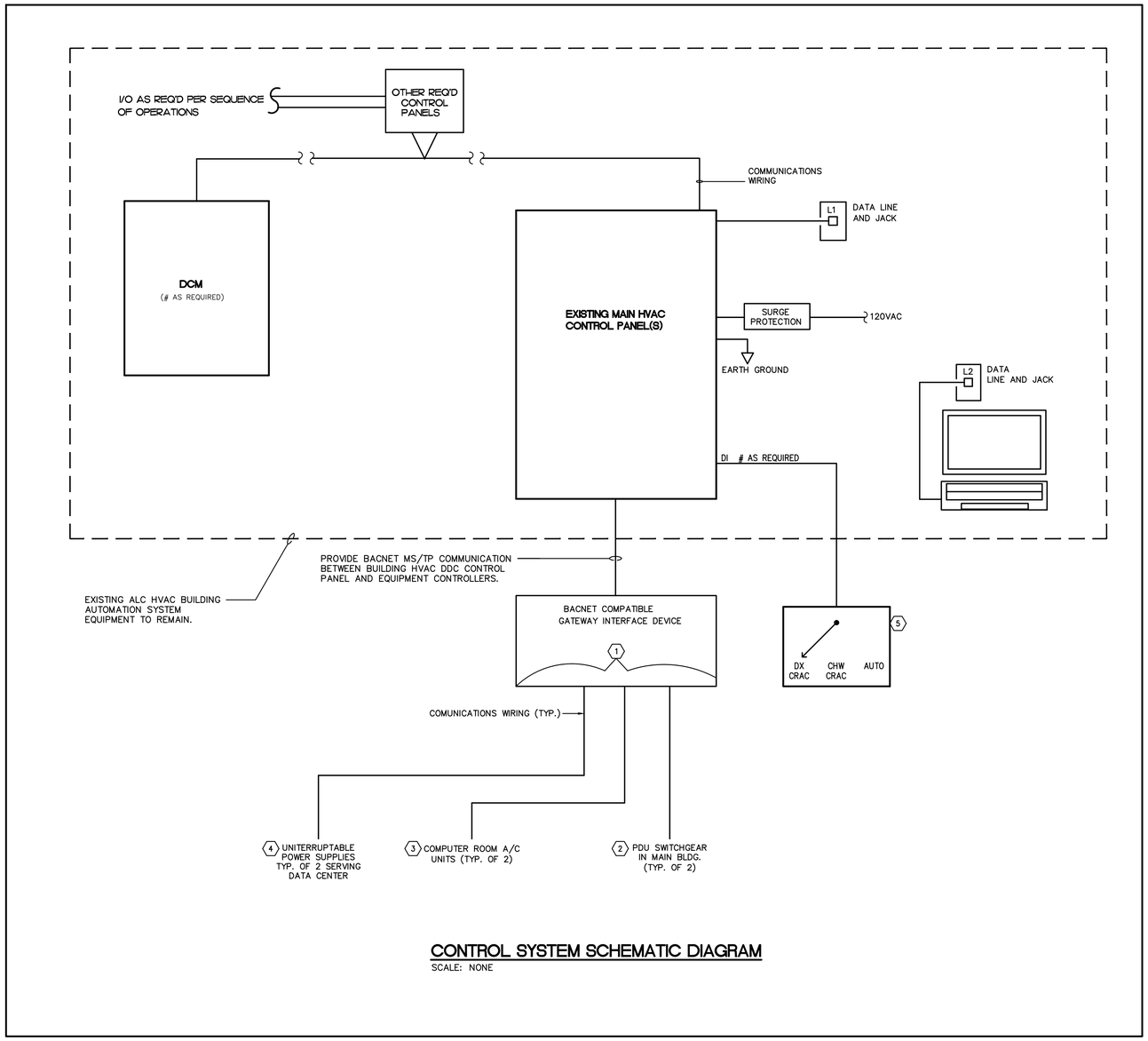
DRAWN BY: CJM CHECKED BY: GFB

DRAWING TITLE:
MECHANICAL CONTROLS

SCALE:	NORTH:
N.T.S.	

DRAWING NUMBER:
M4.1



CONTROL SYSTEM SCHEMATIC DIAGRAM

SCALE: NONE

GENERAL NOTES

1. THE EXISTING ALC CONTROL SYSTEM SHALL BE MODIFIED TO INCLUDE A SCHEDULE TO DETERMINE THE LEAD/LAG OPERATION OF THE NEW CRAC UNITS. ONLY ONE CRAC UNIT IS REQUIRED TO SATISFY THE PEAK DEMAND. THE SECOND CRAC UNIT IS CONSIDERED A 100% REDUNDANT BACKUP. THE ALC SYSTEM SCHEDULE SHALL BE USED TO ENSURE THAT BOTH CRAC UNITS ARE EXERCISED REGULARLY.
2. THE ALC CONTROL SYSTEM SHALL BE REQUIRED TO PROVIDE A REMOTE START/ STOP SIGNAL TO ENERGIZE EACH CRAC UNIT.
3. THE NEW CHILLED WATER CRAC UNIT SHALL BE CONSIDERED THE LEAD UNIT EXCEPT AS NOTED BELOW.
4. THE NEW DX CRAC UNIT SHALL BE CONSIDERED THE LEAD UNIT TWO (2) DAYS A WEEK FROM THE HOURS OF 8 AM TO 2 PM.
5. THE SCHEDULING PARAMETERS DESCRIBED ABOVE SHALL BE REVIEWED AND APPROVED BY THE OWNER PRIOR TO THE SYSTEM BECOMING OPERATIONAL.

KEYED NOTES

1. THE EXISTING ALC BUILDING MANAGEMENT SYSTEM (BMS) SHALL BE REQUIRED TO COMMUNICATE WITH THIS GROUP OF ANCILLARY EQUIPMENT. COMMUNICATION TO EACH EQUIPMENT'S CONTROLLER SHALL BE THROUGH A BACNET MS/TP COMPATIBLE CONTROL DEVICE PROVIDED WITH EACH PIECE OF ANCILLARY EQUIPMENT LISTED BELOW. IT SHALL BE THE RESPONSIBILITY OF THE B.M.S. PROVIDER TO BE THE PRIME COORDINATOR FOR INTEGRATION. B.M.S. PROVIDER TO COORDINATE NEED FOR BACNET INTERFACE FROM OTHER PROVIDERS AND ENSURE ADEQUACY OF INTERFACE PRIOR TO CONSTRUCTION SUBMITTALS.
2. THE BUILDING AUTOMATION SYSTEM MANUFACTURER SHALL PROVIDE A BACNET MS/TP INTERFACE DEVICE TO RECEIVE POWER RELATED INFORMATION AT EACH PDU. INTERFACE SHALL BE CAPABLE OF COMMUNICATING VOLTS, AMPS, POWER FACTOR, KW, AND KWH.
3. THE BMS SHALL PROVIDE ALL NECESSARY CONTROLLERS AND INPUT/OUTPUT DEVICES AS REQUIRED TO PERFORM THE REQUIRED SCHEDULING AND MONITORING FOR COMPUTER ROOM AIR CONDITIONING UNITS. CRAC UNIT INTERNAL SEQUENCING OF FANS, VALVES, HEATERS, HUMIDIFIERS, ETC. SHALL BE PERFORMED BY THE ON BOARD CRAC UNIT INTERANAL CONTROLLERS.
4. THE BUILDING AUTOMATION SYSTEM MANUFACTURER SHALL PROVIDE A BACNET MS/TP INTERFACE DEVICE TO RECEIVE POWER RELATED INFORMATION AT EACH UPS. INTERFACE SHALL BE CAPABLE OF COMMUNICATING VOLTS, AMPS, POWER FACTOR, KW, AND KWH.
5. PROVIDE DIGITAL 3 POSITION SWITCH. SWITCH SHALL BE LOCATED IN DATA CENTER ADJACENT TO CRAC UNITS. THIS SWITCH SHALL PROVIDE INPUTS TO THE EXISTING ALC SYSTEM TO INDICATE THE PREFERRED CRAC OPERATING PROTOCOL. THE POSITION OF THE SWITCH SHALL DETERMINE IF THE DX CRAC OPERATES, THE CHW CRAC OPERATES, OR IF THE CRAC UNIT OPERATION IS DETERMINE BY A PRE-PROGRAMMED LEAD/LAG SCHEDULING SEQUENCE FROM THE ALC SYSTEM.

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DRAWN BY: CJM CHECKED BY: GFB

DRAWING TITLE: MECHANICAL CONTROLS

SCALE: N.T.S. NORTH:

DRAWING NUMBER: M4.2

GENERAL NOTES ELECTRICAL

1. DO NOT SCALE FROM THESE DRAWINGS.
2. ALL WORK SHALL BE DONE IN STRICT ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE AND.
3. ELECTRICAL CONTRACTOR SHALL COORDINATE WORK WITH ALL OTHER TRADES TO ASSURE PROPER CLEARANCES FOR EQUIPMENT AND TO KEEP THE JOB PROGRESSING.
4. ALL EMERGENCY SYSTEMS SHALL BE RUN IN SEPARATE RACEWAY/CONDUIT SYSTEM(S).
5. PROVIDE WALL MOUNTED RED L.E.D. ALARM INDICATOR FOR EACH SMOKE DETECTOR MOUNTED IN PLENUM SPACE(S) OR CONCEALED AREAS.
6. ALL CEILING MOUNTED ITEMS SHALL BE INSTALLED IN ACCORDANCE WITH THE ARCHITECTURAL REFLECTIVE CEILING PLANS. IF LOCATION FOR AN ITEM IS NOT SHOWN ON THE ARCHITECTURAL REFLECTIVE CEILING PLANS, VERIFY THE EXACT LOCATION OF THE ITEM WITH THE ARCHITECT PRIOR TO INSTALLATION. THESE REQUIREMENTS APPLY TO ALL CEILING TYPES IN ALL AREAS.
7. ALL EXTERIOR WIRING DEVICES SHALL BE WEATHERPROOF AND IN NEMA 4X RATED STAINLESS STEEL ENCLOSURES.
8. CONDUIT RUNS SHOWN ARE DIAGRAMMATIC IN NATURE. CONTRACTOR IS RESPONSIBLE FOR SIZING AND LOCATING PULL BOXES PER NEC AND FOR COORDINATION WITH OTHER DISCIPLINES.
9. CONTRACTOR SHALL CONFORM TO APPLICABLE CODES AND STANDARDS. APPLICABLE CODES SHALL BE THOSE ADOPTED BY THE AUTHORITY HAVING JURISDICTION AT THE TIME PROJECT IS BID.
10. ALL MATERIAL FURNISHED AND ALL WORK INSTALLED SHALL COMPLY WITH THE FOLLOWING CODES AS THEY APPLY TO THIS PROJECT:
    a. ANSI/NFPA 70--NATIONAL ELECTRICAL CODE.
    b. NFPA 101--LIFE SAFETY CODE.
    c. REGULATIONS OF THE FLORIDA INDUSTRIAL COMMISSION CONCERNING SAFETY.
    d. APPLICABLE COUNTY, STATE, AND LOCAL BUILDING CODES.
    e. LOCAL AND STATE FIRE MARSHAL RULES AND REGULATIONS.
    f. OCCUPATIONAL SAFETY AND HEALTH AGENCY STANDARDS (OSHA).
    g. FLORIDA BUILDING CODE.
    h. NFPA 72 NATIONAL FIRE ALARM AND SIGNALING CODE.

ELECTRICAL SYMBOL LEGEND

SYMBOL	DESCRIPTION	MOUNTING AND NOTES
	TYPICAL LIGHTING SYMBOL NOTES: 1. UPPER CASE LETTER DENOTES FIXTURE TYPE, SEE FIXTURE SCHEDULE 2. LOWER CASE LETTER DENOTES SWITCHED LEG 3. SHADED FIXTURE SYMBOL INDICATES EMERGENCY FIXTURE 4. 'NL' DENOTES NIGHT LIGHT CIRCUIT	
	CEILING OUTLET FOR FLUORESCENT OR LED DOWNLIGHT FIXTURE.	SEE FIXTURE SCHEDULE
	WALL OUTLET FOR LED, FLUORESCENT, OR HIGH INTENSITY FIXTURE (WALL SCONCE, WALL PACK)	SEE FIXTURE SCHEDULE
	CEILING OUTLET FOR 2'x4' FLUORESCENT FIXTURE.	SEE FIXTURE SCHEDULE
	CEILING OUTLET FOR 2'x2' FLUORESCENT FIXTURE.	SEE FIXTURE SCHEDULE
	CEILING OUTLET FOR 1'x4' FLUORESCENT FIXTURE. (SURFACE, RECESSED, WRAPAROUND, VANDAL-PROOF)	SEE FIXTURE SCHEDULE
	CEILING OUTLET FOR FLUORESCENT FIXTURE. (PENDANT MOUNT, CHANNEL, INDUSTRIAL)	SEE FIXTURE SCHEDULE
	BATTERY POWERED EMERGENCY LIGHTING UNIT, WITH TWO HEADS AND WALL MOUNTING BRACKET	M.H. 7'-6" TO TOP.
	CEILING OUTLET FOR SINGLE FACE EXIT LIGHT FIXTURE. ARROW INDICATES DIRECTION	SEE FIXTURE SCHEDULE
	CEILING OUTLET FOR DOUBLE FACE EXIT LIGHT FIXTURE. ARROW INDICATES DIRECTION	SEE FIXTURE SCHEDULE
S	SINGLE POLE SWITCH	48"AFF U.O.N.
S_3	THREE WAY SWITCH	48"AFF U.O.N.
S_4	FOUR WAY SWITCH	48"AFF U.O.N.
S_H	MOTOR RATED SWITCH WITHOUT THERMAL OVERLOADS FOR FRACTIONAL HORSEPOWER MOTORS.	
S_{SC}	SPEED CONTROL	
S_K	SINGLE POLE SWITCH KEY OPERATED.	48"AFF U.O.N.
S_D	WALL BOX TYPE DIMMER SWITCH. PROVIDE DIMMING BALLAST WHERE REQUIRED.	48"AFF U.O.N.
	TYPICAL RECEPTACLE, OUTLET AND JUNCTION BOX SUFFIX LEGEND: EWC = ELECTRIC WATER COOLER EWH = ELECTRIC WATER HEATER GFI = GROUND FAULT INTERRUPTER EX = EXPLOSION PROOF UP = UP (CONDUIT) DN = DOWN (CONDUIT) E = EXISTING IG = ISOLATED GROUND O = OVEN R = RANGE WP = WEATHERPROOF W = WASHER REF = REFRIGERATOR D = DRYER	
	DUPLEX RECEPTACLE (20A,120V). FLOOR	FLUSH FLOOR OUTLET
	DUPLEX RECEPTACLE (20A, 120V).	M.H. 16" AFF U.O.N.
	DUPLEX RECEPTACLE (20A, 120V). ABOVE COUNTER.	42"AFF, ABOVE COUNTER BACKSLASH U.O.N.
	DUPLEX RECEPTACLE (20A, 120V). FLUSH WITH CEILING.	FLUSH WITH CEILING
	RETRACTABLE CORD REEL. REFER TO DETAIL	CEILING MOUNT
	DOUBLE DUPLEX RECEPTACLE (20A,120V). FLOOR	FLUSH FLOOR OUTLET
	DOUBLE DUPLEX RECEPTACLE (20A, 120V).	16"AFF U.O.N.
R	RANGE RECEPTACLE, 50A, 250V, ONE PHASE, FOUR WIRE.	4" AFF. U.O.N.
D	DRYER RECEPTACLE, 30A, 250V, ONE PHASE, FOUR WIRE.	36" AFF. U.O.N.
	SPECIAL PURPOSE RECEPTACLE, AMPS, VOLTS AND WIRE AS NOTED.	18" AFF, U.O.N.
J	JUNCTION OR OUTLET BOX, 4" SQUARE BOX U.O.N.	AS NOTED
J	FLOOR MOUNTED JUNCTION OR OUTLET BOX, 4" SQUARE BOX U.O.N.	AS NOTED
P	POWER POLE (4-120V RECEPTACLES / 4 DATA OUTLETS)	AS NOTED
	MULTI-OUTLET SURFACE RACEWAY SYSTEM, 20A, 125V,SIMPLEX RECEPTACLES ON 12"CENTERS U.O.N.	MOUNTED ABOVE COUNTER OR AS NOTED
30/3	NON-FUSIBLE DISCONNECT SWITCH, 30A, 3 POLE, U.O.N.	SEE SPECIFICATIONS
60/40/3	FUSIBLE DISCONNECT SWITCH, AMPS/FUSE SIZE/NO. POLES AS NOTED.	SEE SPECIFICATIONS
	COMBINATION MAGNETIC MOTOR STARTER	SEE SPECIFICATIONS
VFD	VARIABLE FREQUENCY DRIVE	BY OTHER DIVISION
3	MOTOR, NUMERAL INDICATES HORSEPOWER	BY OTHER DIVISION
	ELECTRIC DUCT HEATER	BY OTHER DIVISION
	VARIABLE AIR VOLUME CONTROL WITH ELECTRIC HEAT	BY OTHER DIVISION
T	DRY TYPE TRANSFORMER, SIZE AS SHOWN ON RISER	FLOOR OR AS NOTED
	PANELBOARD, 120/208V., 3 PH., 4W	6'-6"AFF MIN. TO TOP
	POWER PANELBOARD, 277/480V, 3PH., 4W.	M.H. 6'-6" MIN. TO TOP
	RACEWAY CONCEALED UNDER FLOOR, IN SLAB OR BELOW GRADE	SEE SPECIFICATIONS
	RACEWAY CONCEALED IN WALL OR CEILING	SEE SPECIFICATIONS
L1B-1,3	HOMERUN TO PANEL, LETTERS INDICATE PANEL, NUMBERS INDICATE CIRCUITS.	SEE SPECIFICATIONS

NOTE: ALL SYMBOLS SHOWN ON LEGEND MY NOT APPEAR ON DRAWINGS. ADDITIONAL SYMBOLS MAY DEFINED ELSEWHERE.

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DRAWN BY: DRJK CHECKED BY: GFB

DRAWING TITTLE:

ELECTRICAL GENERAL

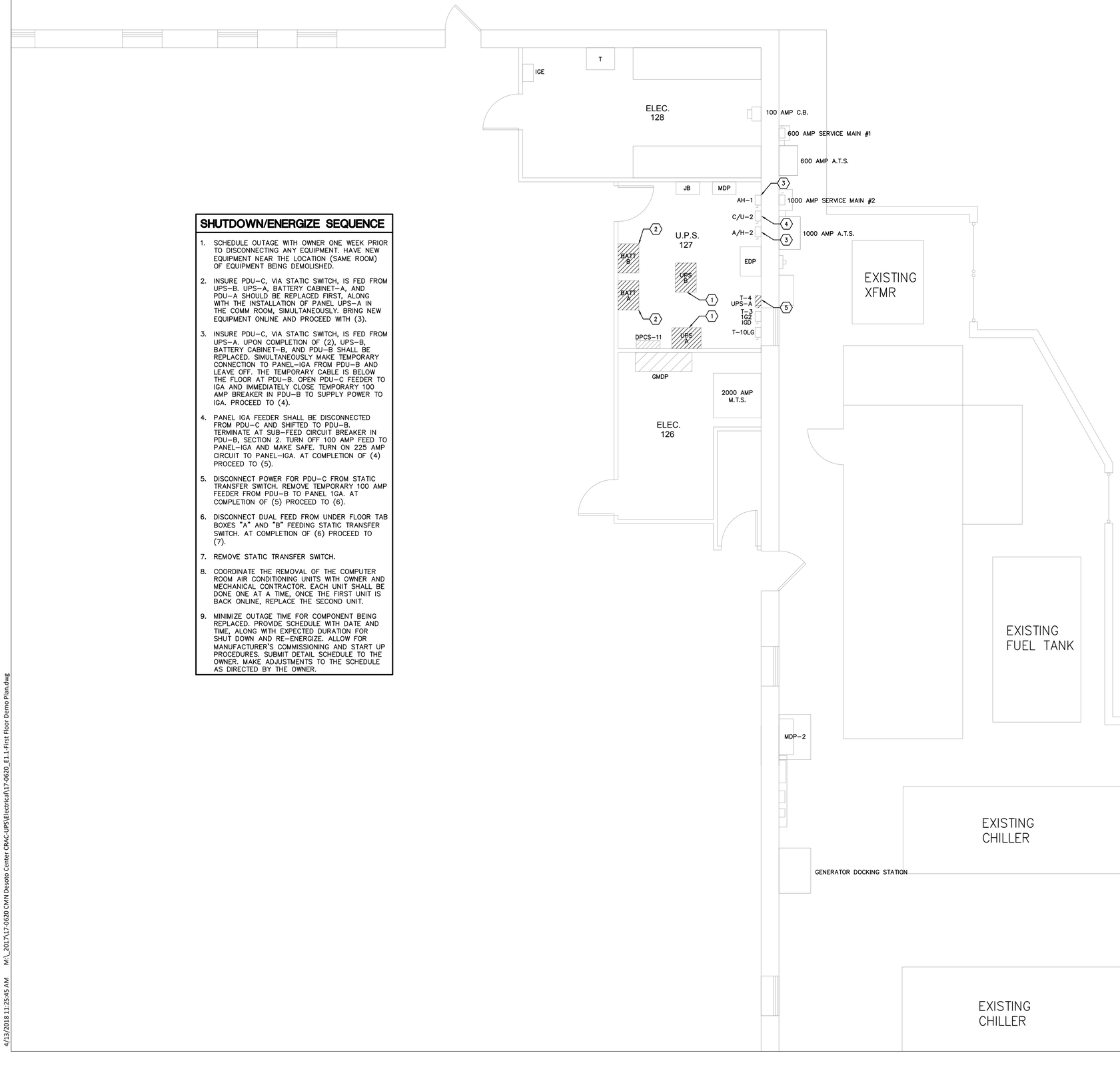
SCALE: **N.T.S.** | NORTH:

DRAWING NUMBER:

E0.0

SHUTDOWN/ENERGIZE SEQUENCE

1. SCHEDULE OUTAGE WITH OWNER ONE WEEK PRIOR TO DISCONNECTING ANY EQUIPMENT. HAVE NEW EQUIPMENT NEAR THE LOCATION (SAME ROOM) OF EQUIPMENT BEING DEMOLISHED.
2. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-B. UPS-A, BATTERY CABINET-A, AND PDU-A SHOULD BE REPLACED FIRST, ALONG WITH THE INSTALLATION OF PANEL UPS-A IN THE COMM ROOM, SIMULTANEOUSLY. BRING NEW EQUIPMENT ONLINE AND PROCEED WITH (3).
3. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-A. UPON COMPLETION OF (2), UPS-B, BATTERY CABINET-B, AND PDU-B SHALL BE REPLACED. SIMULTANEOUSLY MAKE TEMPORARY CONNECTION TO PANEL-IGA FROM PDU-B AND LEAVE OFF. THE TEMPORARY CABLE IS BELOW THE FLOOR AT PDU-B. OPEN PDU-C FEEDER TO IGA AND IMMEDIATELY CLOSE TEMPORARY 100 AMP BREAKER IN PDU-B TO SUPPLY POWER TO IGA. PROCEED TO (4).
4. PANEL IGA FEEDER SHALL BE DISCONNECTED FROM PDU-C AND SHIFTED TO PDU-B. TERMINATE AT SUB-FEED CIRCUIT BREAKER IN PDU-B, SECTION 2. TURN OFF 100 AMP FEED TO PANEL-IGA AND MAKE SAFE. TURN ON 225 AMP CIRCUIT TO PANEL-IGA. AT COMPLETION OF (4) PROCEED TO (5).
5. DISCONNECT POWER FOR PDU-C FROM STATIC TRANSFER SWITCH. REMOVE TEMPORARY 100 AMP FEEDER FROM PDU-B TO PANEL 1GA. AT COMPLETION OF (5) PROCEED TO (6).
6. DISCONNECT DUAL FEED FROM UNDER FLOOR TAB BOXES "A" AND "B" FEEDING STATIC TRANSFER SWITCH. AT COMPLETION OF (6) PROCEED TO (7).
7. REMOVE STATIC TRANSFER SWITCH.
8. COORDINATE THE REMOVAL OF THE COMPUTER ROOM AIR CONDITIONING UNITS WITH OWNER AND MECHANICAL CONTRACTOR. EACH UNIT SHALL BE DONE ONE AT A TIME, ONCE THE FIRST UNIT IS BACK ONLINE, REPLACE THE SECOND UNIT.
9. MINIMIZE OUTAGE TIME FOR COMPONENT BEING REPLACED. PROVIDE SCHEDULE WITH DATE AND TIME, ALONG WITH EXPECTED DURATION FOR SHUT DOWN AND RE-ENERGIZE. ALLOW FOR MANUFACTURER'S COMMISSIONING AND START UP PROCEDURES. SUBMIT DETAIL SCHEDULE TO THE OWNER. MAKE ADJUSTMENTS TO THE SCHEDULE AS DIRECTED BY THE OWNER.

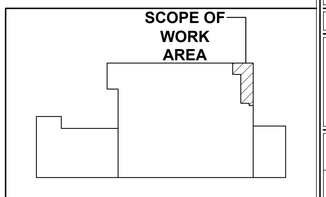


GENERAL NOTES

1. ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF INSTALLATION AND DEMOLITION WORK WITH OTHER TRADES TO AVOID CONFLICTS. ELECTRICAL EQUIPMENT SCHEDULED FOR DEMOLITION SHALL BE PRESENTED TO OWNER FOR FIRST RIGHT OF REFUSAL. SHOULD OWNER REFUSE, ALL EQUIPMENT SHALL BE DISPOSED OF IN SAFE LEGAL MANNER.
2. ALL UNUSED OR ABANDONED ELECTRICAL COMPONENTS ASSOCIATED WITH NEW CONSTRUCTION SHALL BE REMOVED AND DISPOSED OF IN A SAFE AND LEGAL MANNER.
3. ELECTRICAL CONTRACTOR SHALL DISCONNECT AND "MAKE SAFE" FOR REMOVAL ALL EQUIPMENT (HVAC EQUIPMENT, AND ASSOCIATED COMPONENTS) SCHEDULED TO BE REMOVED. REFER TO MECHANICAL DRAWINGS FOR HVAC EQUIPMENT TO BE REMOVED.
4. DEMOLITION DRAWINGS ARE BASED ON FIELD OBSERVATION AND EXISTING RECORD DOCUMENTS. REPORT DISCREPANCIES TO THE ENGINEER BEFORE DISTURBING EXISTING INSTALLATION.
5. REMOVE ALL CONDUIT AND CONDUCTORS SUPPLYING DEMOLISHED EQUIPMENT TO PANEL OF ORIGIN.
6. ALL EXISTING TO REMAIN CIRCUITRY SHALL BE MAINTAINED AFTER THE DEMOLITION OF EQUIPMENT. PROVIDE CONDUIT, JUNCTION BOXES, CONDUCTORS, ETC. TO MAINTAIN CIRCUITS TO EXISTING TO REMAIN DEVICES AND EQUIPMENT.

KEYED NOTES

1. EXISTING UPS SHALL BE REPLACED. DISCONNECT AND MAKE SAFE FOR REMOVAL. MAINTAIN CONDUIT AND CONDUCTORS FOR CONNECTION TO NEW UNIT.
2. EXISTING BATTERIES SHALL BE REPLACED IN SAME LOCATION. DISCONNECT AND MAKE SAFE FOR REMOVAL. MAINTAIN CONDUIT AND REMOVE CONDUCTORS DURING DEMOLITION.
3. CRAC UNIT MANUAL TRANSFER SWITCH TO REMAIN.
4. DX CONDENSER UNIT MANUAL TRANSFER SWITCH TO REMAIN.
5. REMOVE EXISTING DISCONNECT SWITCH ONCE NEW FEEDER IS INSTALLED TO UPS-A.



KEYPLAN

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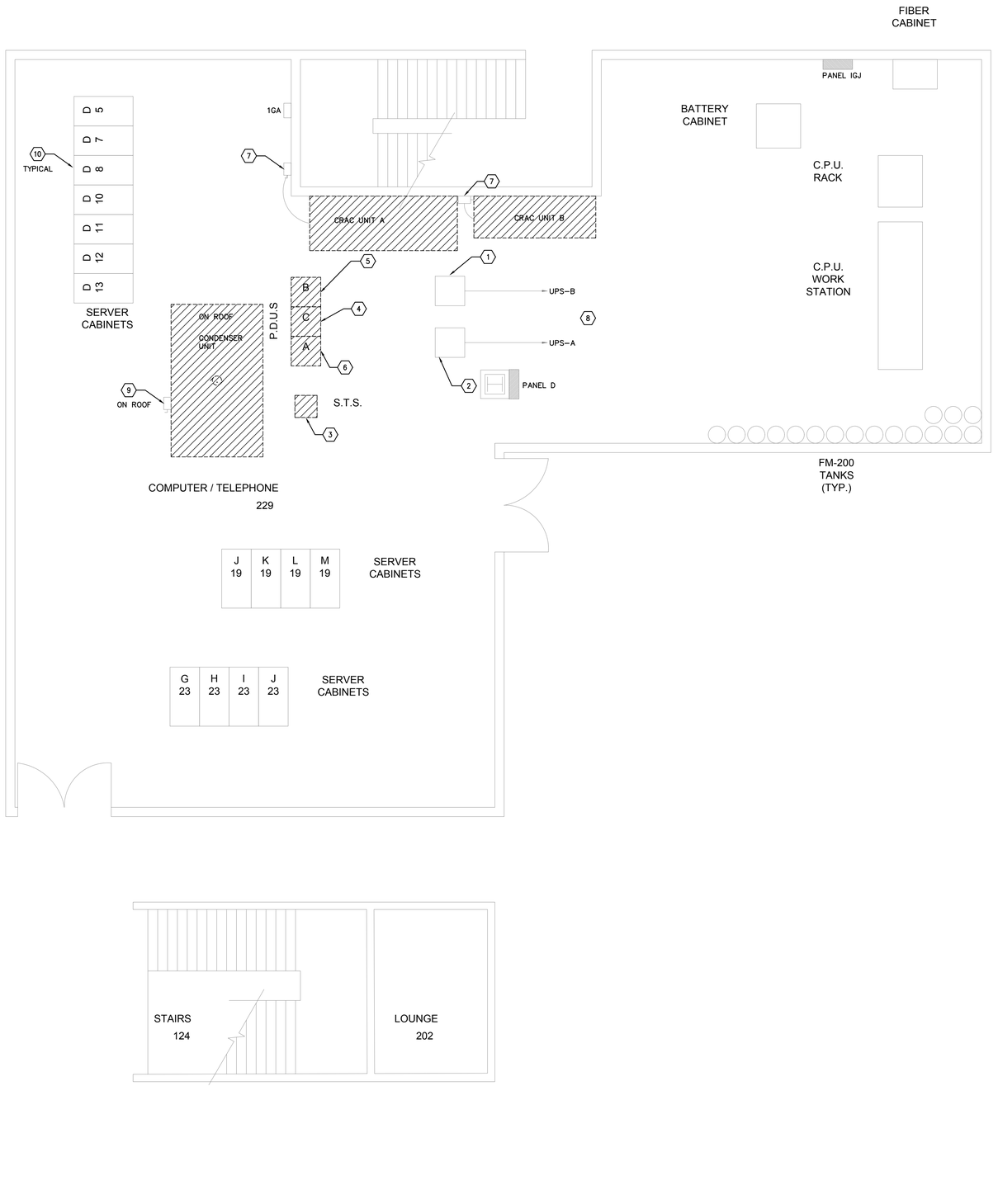
DRAWN BY: KAN CHECKED BY: GFB

DRAWING TITLE: PARTIAL FIRST FLOOR DEMOLITION PLAN - ELECTRICAL

SCALE: 1/4" = 1'-0" NORTH:

DRAWING NUMBER: E1.1



SHUTDOWN/ENERGIZE SEQUENCE

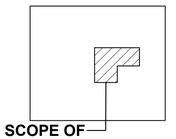
1. SCHEDULE OUTAGE WITH OWNER ONE WEEK PRIOR TO DISCONNECTING ANY EQUIPMENT. HAVE NEW EQUIPMENT NEAR THE LOCATION (SAME ROOM) OF EQUIPMENT BEING DEMOLISHED.
2. INSURE PDU–C, VIA STATIC SWITCH, IS FED FROM UPS–B. UPS–A, BATTERY CABINET–A, AND PDU–A SHOULD BE REPLACED FIRST, ALONG WITH THE INSTALLATION OF PANEL UPS–A IN THE COMM ROOM, SIMULTANEOUSLY. BRING NEW EQUIPMENT ONLINE AND PROCEED WITH (3).
3. INSURE PDU–C, VIA STATIC SWITCH, IS FED FROM UPS–A. UPON COMPLETION OF (2), UPS–B, BATTERY CABINET–B, AND PDU–B SHALL BE REPLACED. SIMULTANEOUSLY MAKE TEMPORARY CONNECTION TO PANEL–IGA FROM PDU–B AND LEAVE OFF. THE TEMPORARY CABLE IS BELOW THE FLOOR AT PDU–B. OPEN PDU–C FEEDER TO IGA AND IMMEDIATELY CLOSE TEMPORARY 100 AMP BREAKER IN PDU–B TO SUPPLY POWER TO IGA. PROCEED TO (4).
4. PANEL IGA FEEDER SHALL BE DISCONNECTED FROM PDU–C AND SHIFTED TO PDU–B. TERMINATE AT SUB–FEED CIRCUIT BREAKER IN PDU–B, SECTION 2. TURN OFF 100 AMP FEED TO PANEL–IGA AND MAKE SAFE. TURN ON 225 AMP CIRCUIT TO PANEL–IGA. AT COMPLETION OF (4) PROCEED TO (5).
5. DISCONNECT POWER FOR PDU–C FROM STATIC TRANSFER SWITCH. REMOVE TEMPORARY 100 AMP FEEDER FROM PDU–B TO PANEL 1GA. AT COMPLETION OF (5) PROCEED TO (6).
6. DISCONNECT DUAL FEED FROM UNDER FLOOR TAB BOXES "A" AND "B" FEEDING STATIC TRANSFER SWITCH. AT COMPLETION OF (6) PROCEED TO (7).
7. REMOVE STATIC TRANSFER SWITCH.
8. COORDINATE THE REMOVAL OF THE COMPUTER ROOM AIR CONDITIONING UNITS WITH OWNER AND MECHANICAL CONTRACTOR. EACH UNIT SHALL BE DONE ONE AT A TIME, ONCE THE FIRST UNIT IS BACK ONLINE, REPLACE THE SECOND UNIT.
9. MINIMIZE OUTAGE TIME FOR COMPONENT BEING REPLACED. PROVIDE SCHEDULE WITH DATE AND TIME, ALONG WITH EXPECTED DURATION FOR SHUT DOWN AND RE–ENERGIZE. ALLOW FOR MANUFACTURER'S COMMISSIONING AND START UP PROCEDURES. SUBMIT DETAIL SCHEDULE TO THE OWNER. MAKE ADJUSTMENTS TO THE SCHEDULE AS DIRECTED BY THE OWNER.

GENERAL NOTES

1. ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF INSTALLATION AND DEMOLITION WORK WITH OTHER TRADES TO AVOID CONFLICTS. ELECTRICAL EQUIPMENT SCHEDULED FOR DEMOLITION SHALL BE PRESENTED TO OWNER FOR FIRST RIGHT OF REFUSAL. SHOULD OWNER REFUSE, ALL EQUIPMENT SHALL BE DISPOSED OF IN SAFE LEGAL MANNER.
2. ALL UNUSED OR ABANDONED ELECTRICAL COMPONENTS ASSOCIATED WITH NEW CONSTRUCTION SHALL BE REMOVED AND DISPOSED OF IN A SAFE AND LEGAL MANNER.
3. ELECTRICAL CONTRACTOR SHALL DISCONNECT AND "MAKE SAFE" FOR REMOVAL ALL EQUIPMENT (HVAC EQUIPMENT, AND ASSOCIATED COMPONENTS) SCHEDULED TO BE REMOVED. REFER TO MECHANICAL DRAWINGS FOR HVAC EQUIPMENT TO BE REMOVED.
4. DEMOLITION DRAWINGS ARE BASED ON FIELD OBSERVATION AND EXISTING RECORD DOCUMENTS. REPORT DISCREPANCIES TO THE ENGINEER BEFORE DISTURBING EXISTING INSTALLATION.
5. REMOVE ALL CONDUIT AND CONDUCTORS SUPPLYING DEMOLISHED EQUIPMENT TO PANEL OF ORIGIN.
6. ALL EXISTING TO REMAIN CIRCUITRY SHALL BE MAINTAINED AFTER THE DEMOLITION OF EQUIPMENT. PROVIDE CONDUIT, JUNCTION BOXES, CONDUCTORS, ETC. TO MAINTAIN CIRCUITS TO EXISTING TO REMAIN DEVICES AND EQUIPMENT.

KEYED NOTES

1. EXISTING TAP BOX BELOW RAISED FLOOR. DISCONNECT PDU–B AND STATIC TRANSFER SWITCH FEEDS. TAP BOX SHALL REMAIN.
2. EXISTING TAP BOX BELOW RAISED FLOOR. DISCONNECT PDU–A AND STATIC TRANSFER SWITCH FEEDS. TAP BOX SHALL REMAIN.
3. DISCONNECT DUAL FEED FROM TAB BOX BELOW FLOOR AND REMOVE STATIC TRANSFER SWITCH. DISCONNECT FEED TO PDU–C
4. DISCONNECT 225 AMP FEED TO PANEL 1GA
5. DISCONNECT ALL CIRCUITS FROM PDU–B AND REMOVE.
6. DISCONNECT ALL CIRCUITS FROM PDU–A AND REMOVE.
7. EXISTING 100 AMP DISCONNECT SWITCH SERVING CRAC UNIT TO REMAIN. DISCONNECT CRAC UNIT TO MAKE SAFE FOR REMOVAL MAINTAIN DISCONNECT SWITCH AND WIRE AND RECONNECT TO NEW REPLACED CRAC UNIT SEE NEW PLANS FOR ADDITIONAL INFORMATION.
8. EXISTING UPS FEED TO TAP BOX SHALL REMAIN.
9. EXISTING 30 AMP DISCONNECT SWITCH SERVING CRAC DX CONDENSING UNIT. DISCONNECT CONDENSING UNIT TO MAKE SAFE FOR REMOVAL. PROTECT EXISTING CIRCUIT CONDUCTORS FOR RECONNECTING TO NEW DX CONDENSING UNIT.
10. EXISTING COUNTY SERVER RACKS ARE SINGLE CORD FEED. MAKE PROVISIONS TO PROIDE DUAL CONNECTION BY ACTIVATING EXISTING CIRCUITS BELOW THE FLOOR FROM PDU–A AND/OR PDU–B AND PROVIDE TEMPORARY CONNECTION.



KEYPLAN

ENGINEERING MATRIX, INC.
CONSULTING ENGINEERS
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PH.(727)573–4656 F.(727)573–2902
EMAIL: ema19@engmtx.com
CERT. OF AUTHORIZATION NO. 4288

SEAL:

DRAWING PHASE: CONSTRUCTION DOCUMENTS

ISSUE DATE:	EMI JOB NO.
4-6-2018	17-0620

DRAWING REVISIONS:

DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

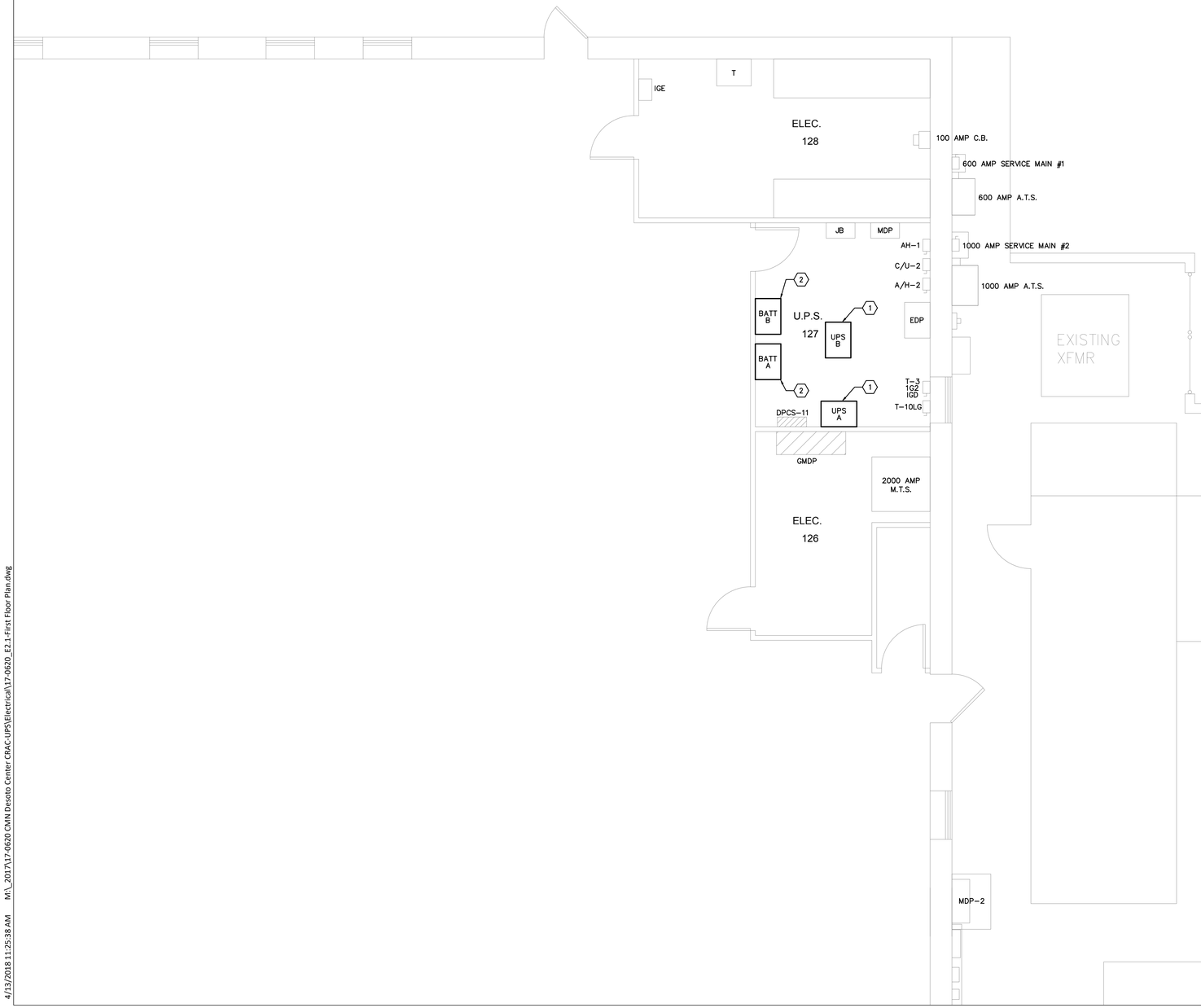
DRAWN BY: KAN CHECKED BY: GFB

DRAWING TITLE: PARTIAL SECOND FLOOR DEMOLITION PLAN - ELECTRICAL

SCALE: 1/4" = 1'-0" NORTH:

DRAWING NUMBER: E1.2

4/13/2018 11:25:41 AM M:_2017\17-0620 CMN Desoto Center CRAC-UPS\Electrical\17-0620_E1.2-Second Floor Demo Plan.dwg



GENERAL NOTES

1. EXISTING CONDITIONS BASED ON AS BUILT DOCUMENTS AND FIELD OBSERVATION. ELECTRICAL CONTRACTOR SHALL FIELD VERIFY EXISTING CONDITIONS AND REPORT DISCREPANCIES TO ENGINEER PRIOR TO DISTURBING EXISTING INSTALLATION.

KEYED NOTES

(1) NEW 150KVA SCALABLE UPS WITH 1-50KVA MODULE. 480V THREE PHASE, THREE WIRE PLUS GROUND INPUT. 480 VOLT, THREE PHASE, THREE WIRE PLUS GROUND OUTPUT.

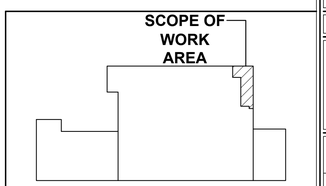
(2) NEW BATTERY CABINET WITH DISCONNECT/BATTERY PROTECTION DEVICE. PROVIDE BATTERIES TO SUPPLY 50KVA BACKUP FOR 20 MINUTES UNDER FULL LOAD.

(3) NEW PANEL UPS-A COMM.

(4) NEW 20 AMP QUAD RECEPTACLES MOUNTED AT EXISTING DATA RACK. (TYPICAL OF 3)

SHUTDOWN/ENERGIZE SEQUENCE

1. SCHEDULE OUTAGE WITH OWNER ONE WEEK PRIOR TO DISCONNECTING ANY EQUIPMENT. HAVE NEW EQUIPMENT NEAR THE LOCATION (SAME ROOM) OF EQUIPMENT BEING DEMOLISHED.
2. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-B. UPS-A, BATTERY CABINET-A, AND PDU-A SHOULD BE REPLACED FIRST, ALONG WITH THE INSTALLATION OF PANEL UPS-A IN THE COMM ROOM, SIMULTANEOUSLY. BRING NEW EQUIPMENT ONLINE AND PROCEED WITH (3).
3. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-A, UPON COMPLETION OF (2), UPS-B, BATTERY CABINET-B, AND PDU-B SHALL BE REPLACED. SIMULTANEOUSLY MAKE TEMPORARY CONNECTION TO PANEL-1GA FROM PDU-B AND LEAVE OFF. THE TEMPORARY CABLE IS BELOW THE FLOOR AT PDU-B. OPEN PDU-C FEEDER TO 1GA AND IMMEDIATELY CLOSE TEMPORARY 100 AMP BREAKER IN PDU-B TO SUPPLY POWER TO 1GA. PROCEED TO (4).
4. PANEL 1GA FEEDER SHALL BE DISCONNECTED FROM PDU-C AND SHIFTED TO PDU-B. TERMINATE AT SUB-FEED CIRCUIT BREAKER IN PDU-B, SECTION 2. TURN OFF 100 AMP FEED TO PANEL-1GA AND MAKE SAFE. TURN ON 225 AMP CIRCUIT TO PANEL-1GA. AT COMPLETION OF (4) PROCEED TO (5).
5. DISCONNECT POWER FOR PDU-C FROM STATIC TRANSFER SWITCH. REMOVE TEMPORARY 100 AMP FEEDER FROM PDU-B TO PANEL 1GA. AT COMPLETION OF (5) PROCEED TO (6).
6. DISCONNECT DUAL FEED FROM UNDER FLOOR TAB BOXES "A" AND "B" FEEDING STATIC TRANSFER SWITCH. AT COMPLETION OF (6) PROCEED TO (7).
7. REMOVE STATIC TRANSFER SWITCH.
8. COORDINATE THE REMOVAL OF THE COMPUTER ROOM AIR CONDITIONING UNITS WITH OWNER AND MECHANICAL CONTRACTOR. EACH UNIT SHALL BE DONE ONE AT A TIME, ONCE THE FIRST UNIT IS BACK ONLINE, REPLACE THE SECOND UNIT.
9. MINIMIZE OUTAGE TIME FOR COMPONENT BEING REPLACED. PROVIDE SCHEDULE WITH DATE AND TIME, ALONG WITH EXPECTED DURATION FOR SHUT DOWN AND RE-ENERGIZE. ALLOW FOR MANUFACTURER'S COMMISSIONING AND START UP PROCEDURES. SUBMIT DETAIL SCHEDULE TO THE OWNER. MAKE ADJUSTMENTS TO THE SCHEDULE AS DIRECTED BY THE OWNER.



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CERT. OF AUTHORIZATION NO. 4288

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4-6-2018	17-0620

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DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES

600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

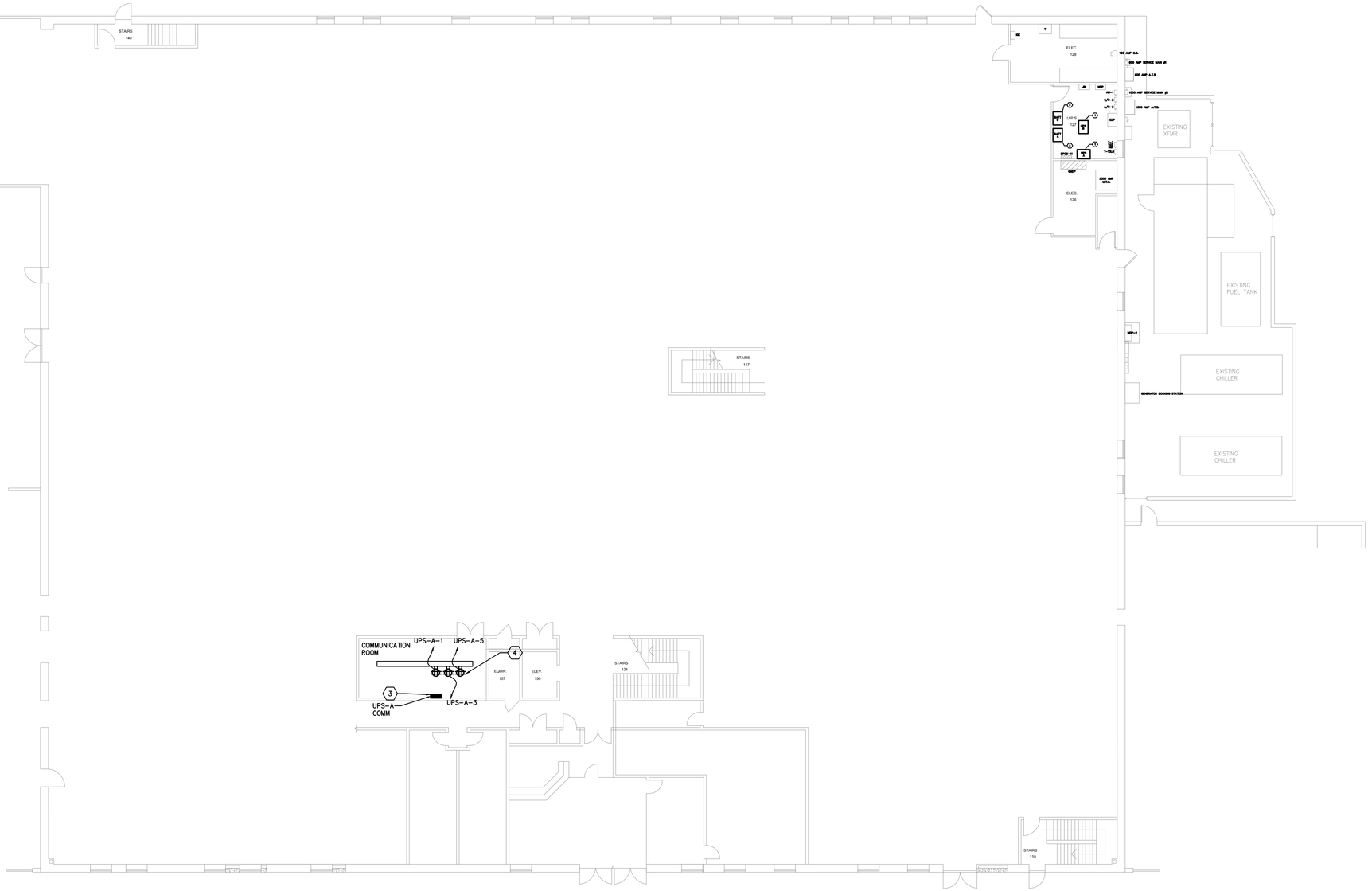
DRAWN BY: KAN CHECKED BY: GFB

DRAWING TITLE: PARTIAL FIRST FLOOR PLAN - POWER

SCALE:	NORTH:
1/4" = 1'-0"	

DRAWING NUMBER: E2.1

4/13/2018 11:25:38 AM M:_2017\17-0620 CMN Desoto Center CRAC-UPS\Electrical\17-0620_E2.1-First Floor Plan.dwg



GENERAL NOTES

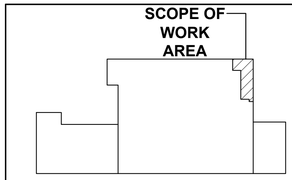
1. EXISTING CONDITIONS BASED ON AS BUILT DOCUMENTS AND FIELD OBSERVATION. ELECTRICAL CONTRACTOR SHALL FIELD VERIFY EXISTING CONDITIONS AND REPORT DISCREPANCIES TO ENGINEER PRIOR TO DISTURBING EXISTING INSTALLATION.

KEYED NOTES

1. NEW 150KVA SCALABLE UPS WITH 1-50KVA MODULE. 480V THREE PHASE, THREE WIRE PLUS GROUND INPUT. 480 VOLT, THREE PHASE, THREE WIRE PLUS GROUND OUTPUT.
2. NEW BATTERY CABINET WITH DISCONNECT/BATTERY PROTECTION DEVICE. PROVIDE BATTERIES TO SUPPLY 50KVA BACKUP FOR 20 MINUTES UNDER FULL LOAD.
3. NEW PANEL UPS-A COMM.
4. NEW 20 AMP QUAD RECEPTACLES MOUNTED AT EXISTING DATA RACK. (TYPICAL OF 3)

SHUTDOWN/ENERGIZE SEQUENCE

1. SCHEDULE OUTAGE WITH OWNER ONE WEEK PRIOR TO DISCONNECTING ANY EQUIPMENT. HAVE NEW EQUIPMENT NEAR THE LOCATION (SAME ROOM) OF EQUIPMENT BEING DEMOLISHED.
2. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-B. UPS-A, BATTERY CABINET-A, AND PDU-A SHOULD BE REPLACED FIRST. ALONG WITH THE INSTALLATION OF PANEL UPS-A IN THE COMM ROOM, SIMULTANEOUSLY. BRING NEW EQUIPMENT ONLINE AND PROCEED WITH (3).
3. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-A, UPON COMPLETION OF (2), UPS-B, BATTERY CABINET-B, AND PDU-B SHALL BE REPLACED. SIMULTANEOUSLY MAKE TEMPORARY CONNECTION TO PANEL-1GA FROM PDU-B AND LEAVE OFF. THE TEMPORARY CABLE IS BELOW THE FLOOR AT PDU-B. OPEN PDU-C FEEDER TO 1GA AND IMMEDIATELY CLOSE TEMPORARY 100 AMP BREAKER IN PDU-B TO SUPPLY POWER TO 1GA. PROCEED TO (4).
4. PANEL 1GA FEEDER SHALL BE DISCONNECTED FROM PDU-C AND SHIFTED TO PDU-B. TERMINATE AT SUB-FEED CIRCUIT BREAKER IN PDU-B, SECTION 2. TURN OFF 100 AMP FEED TO PANEL-1GA AND MAKE SAFE. TURN ON 225 AMP CIRCUIT TO PANEL-1GA. AT COMPLETION OF (4) PROCEED TO (5).
5. DISCONNECT POWER FOR PDU-C FROM STATIC TRANSFER SWITCH. REMOVE TEMPORARY 100 AMP FEEDER FROM PDU-B TO PANEL 1GA. AT COMPLETION OF (5) PROCEED TO (6).
6. DISCONNECT DUAL FEED FROM UNDER FLOOR TAB BOXES "A" AND "B" FEEDING STATIC TRANSFER SWITCH. AT COMPLETION OF (6) PROCEED TO (7).
7. REMOVE STATIC TRANSFER SWITCH.
8. COORDINATE THE REMOVAL OF THE COMPUTER ROOM AIR CONDITIONING UNITS WITH OWNER AND MECHANICAL CONTRACTOR. EACH UNIT SHALL BE DONE ONE AT A TIME, ONCE THE FIRST UNIT IS BACK ONLINE, REPLACE THE SECOND UNIT.
9. MINIMIZE OUTAGE TIME FOR COMPONENT BEING REPLACED. PROVIDE SCHEDULE WITH DATE AND TIME, ALONG WITH EXPECTED DURATION FOR SHUT DOWN AND RE-ENERGIZE. ALLOW FOR MANUFACTURER'S COMMISSIONING AND START UP PROCEDURES. SUBMIT DETAIL SCHEDULE TO THE OWNER. MAKE ADJUSTMENTS TO THE SCHEDULE AS DIRECTED BY THE OWNER.



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ISSUE DATE:	EMI JOB NO.
4-6-2018	17-0620

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DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES

600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

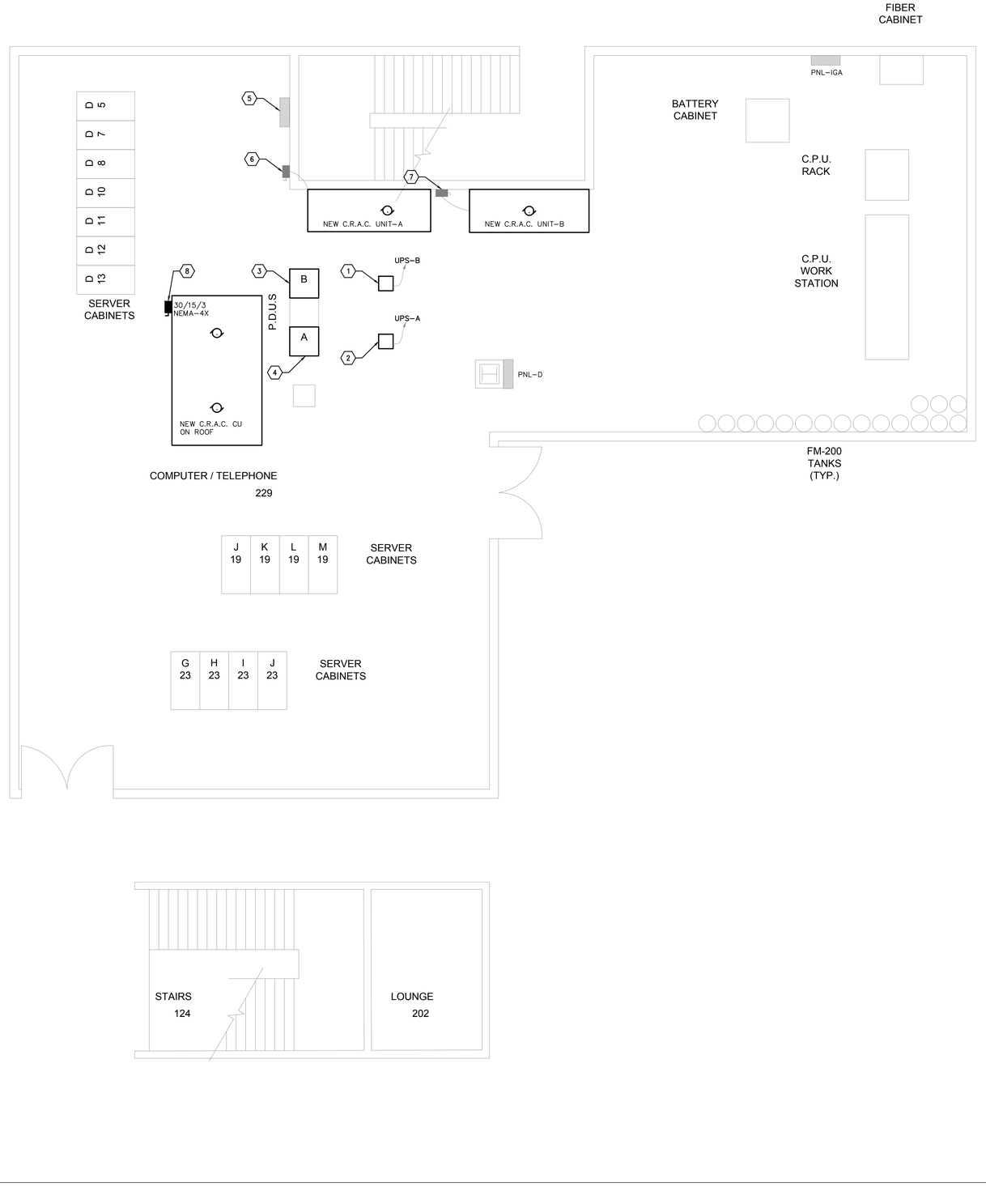
DRAWN BY: KAN CHECKED BY: GFB

DRAWING TITLE: **PARTIAL FIRST FLOOR PLAN - POWER**

SCALE: 3/32" = 1'-0" NORTH:

DRAWING NUMBER:

E2.1A



GENERAL NOTES

1. EXISTING CONDITIONS BASED ON RECORD DOCUMENTS AND FIELD OBSERVATION. ELECTRICAL CONTRACTOR SHALL FIELD VERIFY EXISTING CONDITIONS AND REPORT DISCREPANCIES TO ENGINEER PRIOR TO DISTURBING EXISTING INSTALLATION.

KEYED NOTES

1. EXISTING TAP BOX BELOW RAISED FLOOR. MAKE NEW CONNECTION TO PDU-B.
2. EXISTING TAP BOX BELOW RAISED FLOOR MAKE NEW CONNECTION TO PDU-A.
3. NEW PDU-B. RE-TERMINATE EXISTING CIRCUITS AND NEW FEED TO PANEL 1GA.
4. NEW PDU-A. RE-TERMINATE EXISTING CIRCUITS.
5. EXISTING PANEL 1GA. RECONNECT FEEDER DISCONNECT FROM DELETED PDU-C TO NEW PDU-B 150 AMP 3 POLE SUB MOUNTED CIRCUIT BREAKER.
6. EXISTING 100 AMP FUSED DISCONNECT SWITCH. RECONNECT TO NEW CRAC UNIT A.
7. EXISTING 100 AMP FUSED DISCONNECT SWITCH. RECONNECT TO NEW CRAC UNIT B. COORDINATE LOCATION WITH NEW UNITS, SHIFT AS REQUIRED. PROVIDE ALL COMPONENTS REQUIRED TO EXTEND CIRCUIT. PROVIDE NEW 80 AMP FUSES.
8. NEW DISCONNECT SERVING CONDENSING UNIT. PROVIDE NEW 30 AMP, 3 POLE, FUSIBLE NEMA 4X STAINLESS STEEL DISCONNECT SWITCH AND RECONNECT WIRES. PROVIDE NEW LIQUID TIGHT FLEXIBLE CONNECTION TO CONDENSER UNIT. FUSE DISCONNECT AT 15 AMPS

SHUTDOWN/ENERGIZE SEQUENCE

1. SCHEDULE OUTAGE WITH OWNER ONE WEEK PRIOR TO DISCONNECTING ANY EQUIPMENT. HAVE NEW EQUIPMENT NEAR THE LOCATION (SAME ROOM) OF EQUIPMENT BEING DEMOLISHED.
2. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-B. UPS-A, BATTERY CABINET-A, AND PDU-A SHOULD BE REPLACED FIRST, ALONG WITH THE INSTALLATION OF PANEL UPS-A IN THE COMM ROOM, SIMULTANEOUSLY. BRING NEW EQUIPMENT ONLINE AND PROCEED WITH (3).
3. INSURE PDU-C, VIA STATIC SWITCH, IS FED FROM UPS-A. UPON COMPLETION OF (2), UPS-B, BATTERY CABINET-B, AND PDU-B SHALL BE REPLACED. SIMULTANEOUSLY MAKE TEMPORARY CONNECTION TO PANEL-IGA FROM PDU-B AND LEAVE OFF. THE TEMPORARY CABLE IS BELOW THE FLOOR AT PDU-B. OPEN PDU-C FEEDER TO IGA AND IMMEDIATELY CLOSE TEMPORARY 100 AMP BREAKER IN PDU-B TO SUPPLY POWER TO IGA. PROCEED TO (4).
4. PANEL IGA FEEDER SHALL BE DISCONNECTED FROM PDU-C AND SHIFTED TO PDU-B. TERMINATE AT SUB-FEED CIRCUIT BREAKER IN PDU-B, SECTION 2. TURN OFF 100 AMP FEED TO PANEL-IGA AND MAKE SAFE. TURN ON 225 AMP CIRCUIT TO PANEL-IGA. AT COMPLETION OF (4) PROCEED TO (5).
5. DISCONNECT POWER FOR PDU-C FROM STATIC TRANSFER SWITCH. REMOVE TEMPORARY 100 AMP FEEDER FROM PDU-B TO PANEL 1GA. AT COMPLETION OF (5) PROCEED TO (6).
6. DISCONNECT DUAL FEED FROM UNDER FLOOR TAB BOXES "A" AND "B" FEEDING STATIC TRANSFER SWITCH. AT COMPLETION OF (6) PROCEED TO (7).
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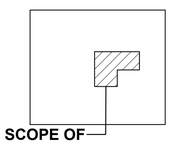
9. MINIMIZE OUTAGE TIME FOR COMPONENT BEING REPLACED. PROVIDE SCHEDULE WITH DATE AND TIME, ALONG WITH EXPECTED DURATION FOR SHUT DOWN AND RE-ENERGIZE. ALLOW FOR MANUFACTURER'S COMMISSIONING AND START UP PROCEDURES. SUBMIT DETAIL SCHEDULE TO THE OWNER. MAKE ADJUSTMENTS TO THE SCHEDULE AS DIRECTED BY THE OWNER.



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SEAL:

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MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES

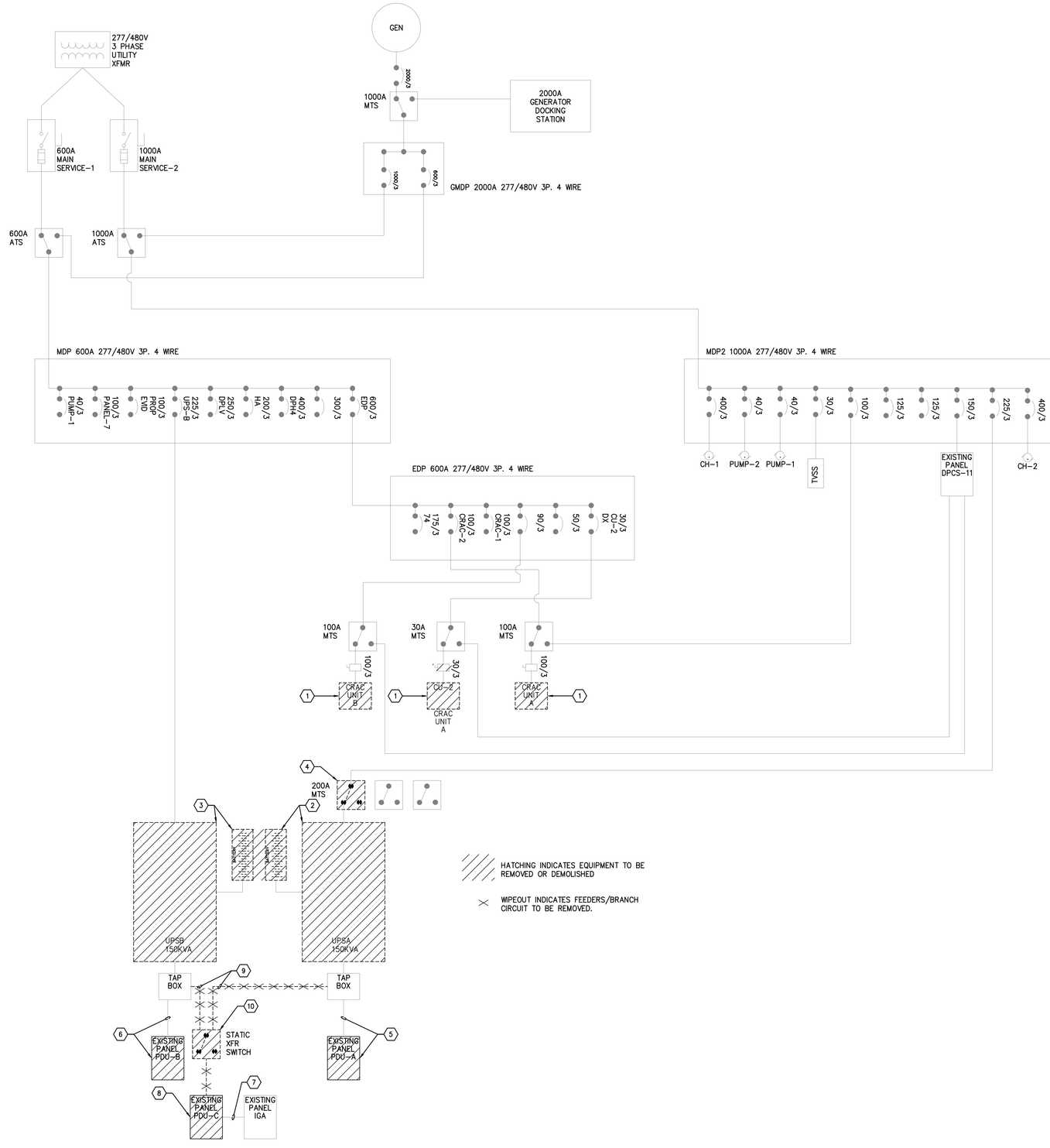
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: DRJK CHECKED BY: GFB

DRAWING TITLE: **PARTIAL SECOND FLOOR PLAN - ELECTRICAL**

SCALE: 1/4" = 1'-0" NORTH:

DRAWING NUMBER: **E2.2**



GENERAL NOTES

1. THIS CONTRACTOR SHALL TRACE OUT ALL CIRCUITS AND PROVIDE NEW LABELS AND TYPE WRITTEN DIRECTORY WITH A DEFINITIVE DESCRIPTION OF EACH CIRCUIT AND FEEDER OF THE LOAD SERVED FOR PANELS MDP, MDP2, EDP, DPCS-11, AND IGA.

KEYED NOTES

1. DISCONNECT COMPUTER ROOM AIR CONDITIONING UNIT AND DX CONDENSING UNITS.
2. DISCONNECT COMPUTER ROOM UPS A AND BATTERY CABINET.
3. DISCONNECT COMPUTER ROOM UPS B AND BATTERY CABINET.
4. DISCONNECT AND REMOVE 200 AMP MANUAL TRANSFER SWITCH A.
5. DISCONNECT POWER DISTRIBUTION UNIT A AND ALL BRANCH CIRCUITS. BRANCH CIRCUITS AND PDU-A POWER FEEDERS SHALL BE PROTECTED FOR RE-TERMINATION TO NEW PDU-A.
6. DISCONNECT POWER DISTRIBUTION UNIT B AND ALL BRANCH CIRCUITS. BRANCH CIRCUITS AND PDU-B POWER FEEDERS SHALL BE PROTECTED FOR RE-TERMINATION TO NEW PDU-B.
7. DISCONNECT AND REMOVE FEEDER FOR PANEL IGA FROM PDU-C. RE-TERMINATE TO PDU-B ONCE NEW PDU-B IS IN OPERATION. REFER TO SUTDOWN/ENERGIZE SEQUENCE ON FLOOR PLANS.
8. DISCONNECT AND AND REMOVE PDU-C.
9. DISCONNECT DUAL FEED FROM UNDER FLOOR TAP BOXES.
10. REMOVE STATIC TRANSFER SWITCH.

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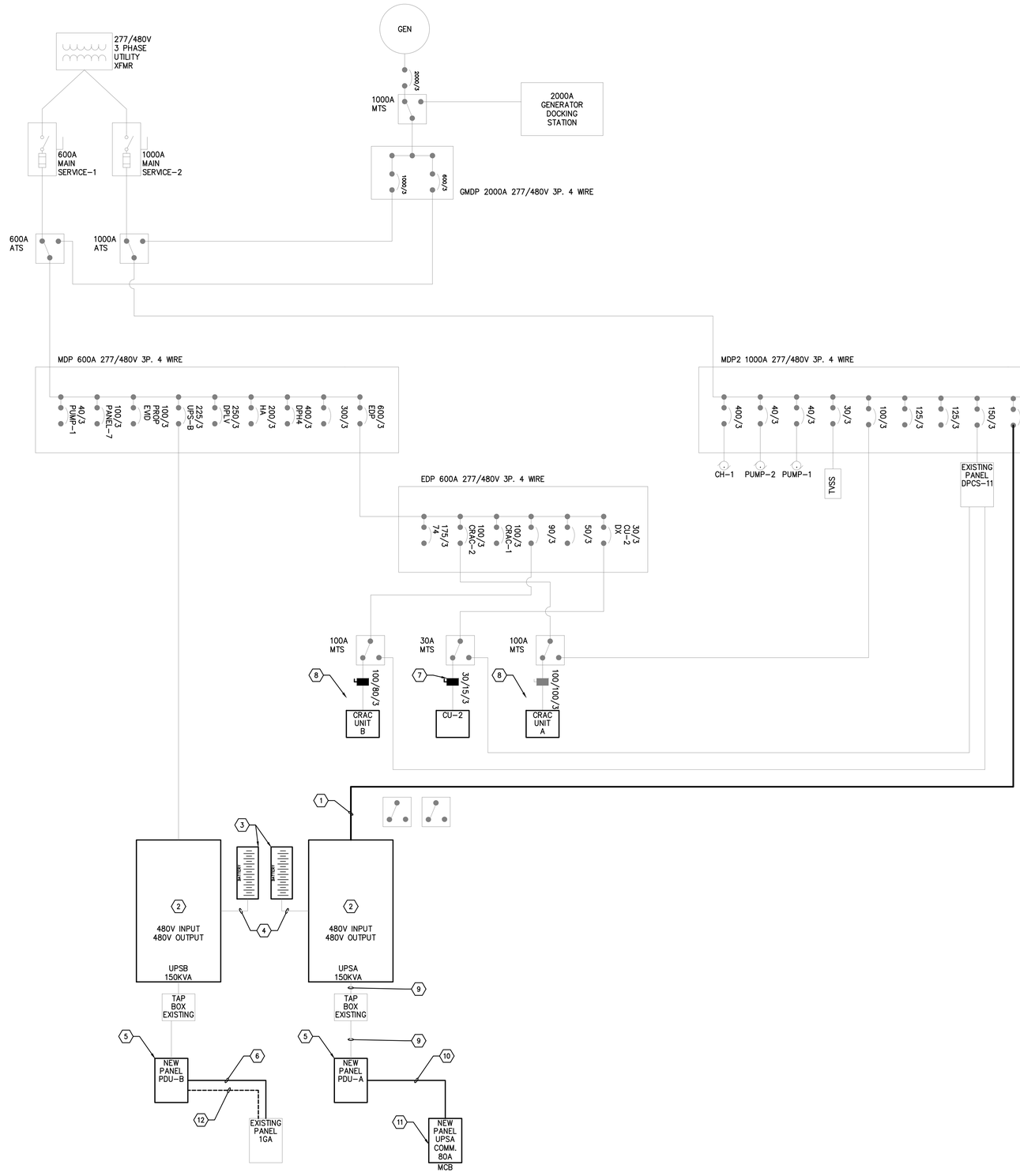
DRAWN BY: DRJK CHECKED BY: GFB

DRAWING TITLE:
ELECTRICAL RISER DIAGRAM DEMOLITION

SCALE: **N.T.S.** | NORTH:

DRAWING NUMBER:
E3.1



GENERAL NOTES

1. THIS CONTRACTOR SHALL TRACE OUT ALL CIRCUITS AND PROVIDE NEW LABELS AND TYPE WRITTEN DIRECTORY WITH A DEFINITIVE DESCRIPTION OF EACH CIRCUIT AND FEEDER OF THE LOAD SERVED FOR PANELS MDP, MDP2, EDP, DPCS-11, AND IGA.

KEYED NOTES

1. CAPTURE EXISTING CONDUIT IN ELECTRICAL ROOM WHERE 200 AMP DISCONNECT IS REMOVED. EXTEND 2 1/2" CONDUIT TO NEW UPS-A. INSTALL NEW 3-4/0 THWN CU AND 1-#4 CU E.G.
2. NEW SCALABLE 150KVA UPS FURNISHED WITH 1-50KVA MODULE. 480V 3 PHASE INPUT, 480 VOLT 3 PHASE OUTPUT PLUS EQUIPMENT GROUND.
3. NEW BATTERY CABINET WITH DISCONNECT SWITH/CIRCUIT BREAKER. BATTERIES SHALL PROVIDE 20 MINUTE RUN TIME AT 100% LOAD. THE BATTERY SHALL BE CAPABLE OF EXPANDING AS ADDITIONAL 50 KVA MODULES ARE ADDED.
4. 2" CONDUIT WITH 2-350 MCM THWN CU AND 1-#3 CU E.G.
5. NEW POWER DISTRIBUTION UNIT WITH 100 KVA TRANSFORMER 480V 3 PHASE INPUT, 120/208V 3 PHASE, 4-WIRE PLUS GROUND OUTPUT. PDU SHALL BE PROVIDED WITH TWO 225 AMP MAIN CIRCUIT BREAKER DISTRIBUTION PANELS. REFER TO PANEL SCHEDULES FOR BRANCH CIRCUITS REQUIRED.
6. EXISTING 2 1/2" FLEXIBLE CONDUIT WITH 4-4/0 THWN CU. AND 1-4/0 CU E.G. RE-TERMINATE TO PDU-B SECTION 2 PANEL SUB-FEED CIRCUIT BREAKER.
7. NEW 30 AMP, 3 POLE, FUSED, 600 VOLT WITH EQUIPMENT GROUND, NEMA 4X, STAINLESS STEEL DISCONNECT SWITCH. MAKE NEW CONNECTION TO ROOFTOP DX CONDENSING UNIT. PROVIDE 15A FUSES.
8. RECONNECT CIRCUIT TO NEW CRAC UNIT. PROVIDE 80A FUSES.
9. EXISTING 2 1/2" CONDUIT, REPLACE EXISTING 4-3/0 CU WITH NEW 4/0 CU. AND 1-#4 CU E.G.
10. NEW 1 1/2" CONDUIT WITH 4-#1 CU AND 1-#6 CU E.G.
11. NEW PANEL UPS-A-COMM IN EXISTING COMMUNICATION ROOM ON FIRST FLOOR.
12. TEMPORARY 100 AMP FEEDER FOR THIS CONTRACTOR TO TERMINATE DISCONNECT AND REMOVE ONCE KEYED NOTE 6 IS READY TO ENERGIZE.

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DRAWN BY: DRJK CHECKED BY: GFB

DRAWING TITTLE:
ELECTRICAL RISER DIAGRAM NEW WORK

SCALE:	NORTH:
N.T.S.	

DRAWING NUMBER:
E3.2

PANEL : PDU A SECT 1

3 PHASE INFO	REMARKS	CKT.	POLES AND	LOAD SERVING VOLT AMPS A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	POLES AND AMPS	CKT.	REMARKS	3 PHASE INFO
SDHD	CABINET D6	1	20/3							12	1	2	12							20/3	2	CABINET D5	SDHD
H.P	–	3	–							12	3	4	12							–	4	–	H.P
HT/KW	–	5	–							12	5	6	12							–	6	–	HT/KW
SDHD	CABINET D4	7	20/3							12	7	8	12							20/3	8	CABINET D3	SDHD
H.P	–	9	–							12	9	10	12							–	10	–	H.P
HT/KW	–	11								12	11	12	12							–	12	–	HT/KW
SDHD	PHONE BOARD	13	15/1							12	13	14								20/3	14	SPARE	SDHD
H.P	RACK D13	15	30/2							10	15	16								–	16	–	H.P
HT/KW		17								10	17	18								–	18	–	HT/KW
SDHD	SPARE	19	30/2								19	20	12							20/3	20	CABINET D8	SDHD
H.P	–	21	–								21	22	12							–	22	–	H.P
HT/KW	SPARE	23	15/1								23	24	12							–	24	–	HT/KW
SDHD	SPARE	25	20/1								25	26								20/3	26	SPARE	SDHD
H.P	SPARE	27	20/2								27	28								–	28	–	H.P
HT/KW		29									29	30								–	30	–	HT/KW
SDHD	SPARE	31	60/3								31	32	12							20/3	32	CABINET D7	SDHD
H.P	–	33	–								33	34	12							–	34	–	H.P
HT/KW	–	35	–								35	36	12							–	36	–	HT/KW
SDHD	RACK J23	37	20/3							12	37	38								20/1	38	SPARE	SDHD
H.P	–	39	–							12	39	40								20/1	40	SPARE	H.P
HT/KW	–	41	–							12	41	42								20/1	42	SPARE	HT/KW
				0	0	0	0	0	0					0	0	0	0	0	0				

CALCULATIONS	CONN. LOAD KVA	CONN. LOAD AMPS	FACTOR	DESIGN LOAD KVA	DESIGN LOAD AMPS
LIGHTING	0.0	0.0	1.25	0.0	0.0
CONV. OUTLETS	0.0	0.0	–	0.0	0.0
MOTORS	0.0	0.0	1	0.0	0.0
MISC	0.0	0.0	1	0.0	0.0
EWH	0.0	0.0	1	0.0	0.0
KITCHEN EQ.	0.0	0.0	0.65	0.0	0.0
SPARE	0.0	0.0	1	0.0	0.0
SPACE ONLY	0.0	0.0	1	0.0	0.0
TOTAL	0.0	0.0		0.0	0.0

PHASE LOADS	
A	0
B	0
C	0

REMARKS:

MOUNTING: SURFACE
VOLTS: 120/208, 3PH, 4W
MAIN SIZE: 225 AMPS
MAIN TYPE: MCB M.D.
BRACING: 22 KAIC 0

EMI JOB 17-0620 0

NOTE: ALL CONDUCTORS ARE #12 AWG UNLESS OTHERVISE NOTED HERE IN DR OR RISER DIAGRAM, OR AS NOTED IN THE SPECIFICATIONS FOR VOLTAGE DROP.
PROVIDE A DEDICATED NEUTRAL FOR EACH FLUORESCENT LIGHTING CIRCUIT. CONDUCTORS SERVING 20 AMP BRANCH CIRCUITS SHALL BE #10 AWG UNLESS OTHERWISE NOTED.
THE CIRCUIT BREAKER FEEDING THE SPD DEVICE SHALL BE INSTALLED AS CLOSE TO THE SPD DEVICES AS POSSIBLE TO MINIMIZE THE LEAD LENGTH. RELOCATE CIRCUIT BREAKERS AS REQUIRED

PANEL : PDU A SECT 2

3 PHASE INFO	REMARKS	CKT.	POLES AND	LOAD SERVING VOLT AMPS A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	POLES AND AMPS	CKT.	REMARKS	3 PHASE INFO
SDHD	CABINET K19	1	20/3							12	1	2									2	SPACE	SDHD
H.P	–	3	–							12	3	4									4	SPACE	H.P
HT/KW	–	5	–							12	5	6									6	SPACE	HT/KW
SDHD	CANET L19	7	20/3							12	7	8									8	SPACE	SDHD
H.P	–	9	–							12	9	10									10	SPACE	H.P
HT/KW	–	11	–							12	11	12									12	SPACE	HT/KW
SDHD	CABINET M19	13	20/3							12	13	14									14	SPACE	SDHD
H.P	–	15	–							12	15	16									16	SPACE	H.P
HT/KW	–	17	–							12	17	18									18	SPACE	HT/KW
SDHD	CABINET I23	19	20/3							12	19	20									20	SPACE	SDHD
H.P	–	21	–							12	21	22									22	SPACE	H.P
HT/KW	–	23	–							12	23	24									24	SPACE	HT/KW
SDHD	CABINET H23	25	20/3							12	25	26	1							125/3	26	UPS-A-COMM	SDHD
H.P	–	27	–							12	27	28	1							–	28	–	H.P
HT/KW	–	29	–							12	29	30	1							–	30	–	HT/KW
SDHD	CABINET G23	31	20/3							12	31	32	12							20/1	32	TELEPHONE EQUIP.	SDHD
H.P	–	33	–							12	33	34	12							20/1	34	TELEPHONE EQUIP.	H.P
HT/KW	–	35	–							12	35	36	12							20/1	36	TELEPHONE EQUIP.	HT/KW
SDHD	AFIS RACK H17	37	20/3							12	37	38	12							20/3	38	AFIS RACK H17	SDHD
H.P	–	39	–							12	39	40	12							–	40	–	H.P
HT/KW	–	41	–							12	41	42	12							–	42	–	HT/KW
				0	0	0	0	0	0					0	0	0	0	0	0				

CALCULATIONS	CONN. LOAD KVA	CONN. LOAD AMPS	FACTOR	DESIGN LOAD KVA	DESIGN LOAD AMPS
LIGHTING	0.0	0.0	1.25	0.0	0.0
CONV. OUTLETS	0.0	0.0	–	0.0	0.0
MOTORS	0.0	0.0	1	0.0	0.0
MISC	0.0	0.0	1	0.0	0.0
EWH	0.0	0.0	1	0.0	0.0
KITCHEN EQ.	0.0	0.0	0.65	0.0	0.0
SPARE	0.0	0.0	1	0.0	0.0
SPACE ONLY	0.0	0.0	1	0.0	0.0
TOTAL	0.0	0.0		0.0	0.0

PHASE LOADS	
A	0
B	0
C	0

REMARKS:

MOUNTING: SURFACE
VOLTS: 120/208, 3PH, 4W
MAIN SIZE: 225 AMPS
MAIN TYPE: MCB M.D.
BRACING: 22 KAIC 0

EMI JOB 17-0620 0

NOTE: ALL CONDUCTORS ARE #12 AWG UNLESS OTHERVISE NOTED HERE IN DR OR RISER DIAGRAM, OR AS NOTED IN THE SPECIFICATIONS FOR VOLTAGE DROP.
PROVIDE A DEDICATED NEUTRAL FOR EACH FLUORESCENT LIGHTING CIRCUIT. CONDUCTORS SERVING 20 AMP BRANCH CIRCUITS SHALL BE #10 AWG UNLESS OTHERWISE NOTED.
THE CIRCUIT BREAKER FEEDING THE SPD DEVICE SHALL BE INSTALLED AS CLOSE TO THE SPD DEVICES AS POSSIBLE TO MINIMIZE THE LEAD LENGTH. RELOCATE CIRCUIT BREAKERS AS REQUIRED

PANEL : PDU B SECT 1

3 PHASE INFO	REMARKS	CKT.	POLES AND	LOAD SERVING VOLT AMPS A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	POLES AND AMPS	CKT.	REMARKS	3 PHASE INFO
SDHD	RACK D6	1	20/3							12	1	2	12							20/3	2	CABINET D5	SDHD
H.P	–	3	–							12	3	4	12							–	4	–	H.P
HT/KW	–	5	–							12	5	6	12							–	6	–	HT/KW
SDHD	RACK D4	7	20/3							12	7	8	12							20/3	8	CABINET D3	SDHD
H.P	–	9	–							12	9	10	12							–	10	–	H.P
HT/KW	–	11	–							12	11	12	12							–	12	–	HT/KW
SDHD	PHONE BOARD	13	15/1							12	13	14								20/3	14	SPARE	SDHD
H.P	RACK D13	15	30/2							10	15	16								–	16	–	H.P
HT/KW	–	17								10	17	18								–	18	–	HT/KW
SDHD	SPARE	19	30/2								19	20	12							20/3	20	CABINET D8	SDHD
H.P	–	21									21	22	12							–	22	–	H.P
HT/KW	SPARE	23	30/3								23	24	12							–	24	–	HT/KW
SDHD	–	25	–								25	26								20/3	26	SPARE	SDHD
H.P	–	27									27	28								–	28	–	H.P
HT/KW	SPARE	29	60/3								29	30								–	30	–	HT/KW
SDHD	–	31	–								31	32	12							20/3	32	CABINET D7	SDHD
H.P	–	33									33	34	12							–	34	–	H.P
HT/KW	SPARE	35	30/2								35	36	12							–	36	–	HT/KW
SDHD	–	37	–								37	38	12							20/3	38	RAK J23	SDHD
H.P	SPARE	39	20/2								39	40	12							–	40	–	H.P
HT/KW	–	41	–								41	42	12							–	42	–	HT/KW
				0	0	0	0	0	0					0	0	0	0	0	0				

CALCULATIONS	CONN. LOAD KVA	CONN. LOAD AMPS	FACTOR	DESIGN LOAD KVA	DESIGN LOAD AMPS
LIGHTING	0.0	0.0	1.25	0.0	0.0
CONV. OUTLETS	0.0	0.0	–	0.0	0.0
MOTORS	0.0	0.0	1	0.0	0.0
MISC	0.0	0.0	1	0.0	0.0
EWH	0.0	0.0	1	0.0	0.0
KITCHEN EQ.	0.0	0.0	0.65	0.0	0.0
SPARE	0.0	0.0	1	0.0	0.0
SPACE ONLY	0.0	0.0	1	0.0	0.0
TOTAL	0.0	0.0		0.0	0.0

PHASE LOADS	
A	0
B	0
C	0

REMARKS:

MOUNTING: SURFACE
VOLTS: 120/208, 3PH, 4W
MAIN SIZE: 225 AMPS
MAIN TYPE: MCB M.D.
BRACING: 22 KAIC 0

EMI JOB 17-0620 0

NOTE: ALL CONDUCTORS ARE #12 AWG UNLESS OTHERVISE NOTED HERE IN DR OR RISER DIAGRAM, OR AS NOTED IN THE SPECIFICATIONS FOR VOLTAGE DROP.
PROVIDE A DEDICATED NEUTRAL FOR EACH FLUORESCENT LIGHTING CIRCUIT. CONDUCTORS SERVING 20 AMP BRANCH CIRCUITS SHALL BE #10 AWG UNLESS OTHERWISE NOTED.
THE CIRCUIT BREAKER FEEDING THE SPD DEVICE SHALL BE INSTALLED AS CLOSE TO THE SPD DEVICES AS POSSIBLE TO MINIMIZE THE LEAD LENGTH. RELOCATE CIRCUIT BREAKERS AS REQUIRED

PANEL : PDU B SECT 2

3 PHASE INFO	REMARKS	CKT.	POLES AND	LOAD SERVING VOLT AMPS A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	POLES AND AMPS	CKT.	REMARKS	3 PHASE INFO
SDHD	CABINET K19	1	20/3							12	1	2	4/0								225/3	PANEL 10A	SDHD
H.P	–	3	–							12	3	4	4/0								–	–	H.P
HT/KW	–	5	–							12	5	6	4/0								–	–	HT/KW
SDHD	CANET L19	7	20/3							12	7	8									8	SPACE	SDHD
H.P	–	9	–							12	9	10									10	SPACE	H.P
HT/KW	–	11	–							12	11	12									12	SPACE	HT/KW
SDHD	CABINET M19	13	20/3							12	13	14									14	SPACE	SDHD
H.P	–	15	–							12	15	16									16	SPACE	H.P
HT/KW	–	17	–							12	17	18									18	SPACE	HT/KW
SDHD	CABINET I23	19	20/3							12	19	20									20	SPACE	SDHD
H.P	–	21	–							12	21	22									22	SPACE	H.P
HT/KW	–	23	–							12	23	24									24	SPACE	HT/KW
SDHD	CABINET H23	25	20/3							12	25	26	3							100/3	26	TEMP FEED TO PNL 10A	SDHD
H.P	–	27	–							12	27	28	3							–	28	–	H.P
HT/KW	–	29	–							12	29	30	3							–	30	–	HT/KW
SDHD	CABINET G23	31	20/3							12	31	32	12							20/1	32	TELEPHONE EQUIP.	SDHD
H.P	–	33	–							12	33	34	12							20/1	34	TELEPHONE EQUIP.	H.P
HT/KW	–	35	–							12	35	36	12							20/1	36	TELEPHONE EQUIP.	HT/KW
SDHD	AFIS RACK H17	37	20/3							12	37	38	12							20/3	38	AFIS RACK H17	SDHD
H.P	–	39	–							12	39	40	12							–	40	–	H.P
HT/KW	–	41	–							12	41	42	12							–	42	–	HT/KW
				0	0	0	0	0	0					0	0	0	0	0	0				

CALCULATIONS	CONN. LOAD KVA	CONN. LOAD AMPS	FACTOR	DESIGN LOAD KVA	DESIGN LOAD AMPS
LIGHTING	0.0	0.0	1.25	0.0	0.0
CONV. OUTLETS	0.0	0.0	–	0.0	0.0
MOTORS	0.0	0.0	1	0.0	0.0
MISC	0.0	0.0	1	0.0	0.0
EWH	0.0	0.0	1	0.0	0.0
KITCHEN EQ.	0.0	0.0	0.65	0.0	0.0
SPARE	0.0	0.0	1	0.0	0.0
SPACE ONLY	0.0	0.0	1	0.0	0.0
TOTAL	0.0	0.0		0.0	0.0

PHASE LOADS	
A	0
B	0
C	0

REMARKS:

MOUNTING: SURFACE
VOLTS: 120/208, 3PH, 4W
MAIN SIZE: 225 AMPS
MAIN TYPE: MCB M.D.
BRACING: 22 KAIC 0

EMI JOB 17-0620 0

NOTE: ALL CONDUCTORS ARE #12 AWG UNLESS OTHERVISE NOTED HERE IN DR OR RISER DIAGRAM, OR AS NOTED IN THE SPECIFICATIONS FOR VOLTAGE DROP.
PROVIDE A DEDICATED NEUTRAL FOR EACH FLUORESCENT LIGHTING CIRCUIT. CONDUCTORS SERVING 20 AMP BRANCH CIRCUITS SHALL BE #10 AWG UNLESS OTHERWISE NOTED.
THE CIRCUIT BREAKER FEEDING THE SPD DEVICE SHALL BE INSTALLED AS CLOSE TO THE SPD DEVICES AS POSSIBLE TO MINIMIZE THE LEAD LENGTH. RELOCATE CIRCUIT BREAKERS AS REQUIRED

PANEL : UPS-A-CDMM

3 PHASE INFO	REMARKS	CKT.	POLES AND	LOAD SERVING VOLT AMPS A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	WIRE SIZE	CKT. NO.	CKT. NO.	WIRE SIZE	A LIGHTS	A POWER	B LIGHTS	B POWER	C LIGHTS	C POWER	POLES AND AMPS	CKT.	REMARKS	3 PHASE INFO
	RACK	1	20/1		360					12	1	2								20/1	2	SPARE	SDHD
H.P	RACK	3	20/1				360			12	3	4								20/1	4	SPARE	H.P
HT/KW	RACK	5	20/1						360	12	5	6								20/1	6	SPARE	HT/KW
SDHD	SPARE	7	20/1								7	8									8	SPACE	SDHD
H.P	SPACE	9									9	10									10	SPACE	H.P
HT/KW	SPACE	11									11	12									12	SPACE	HT/KW
				0	360	0	360	0	360					0	0	0	0	0	0				

CALCULATIONS	CONN. LOAD KVA	CONN. LOAD AMPS	FACTOR	DESIGN LOAD KVA	DESIGN LOAD AMPS
LIGHTING	0.0	0.0	1.25	0.0	0.0
CONV. OUTLETS	0.0	0.0	–	0.0	0.0
MOTORS	0.0	0.0	1	0.0	0.0
MISC	1.1	3.0	1	1.1	3.0
EWH	0.0	0.0	1	0.0	0.0
KITCHEN EQ.	0.0	0.0	0.65	0.0	0.0
SPARE	0.0	0.0	1	0.0	0.0
SPACE ONLY	0.0	0.0	1	0.0	0.0
TOTAL	1.1	3.0		1.1	3.0

PHASE LOADS	
A	360
B	360
C	360

REMARKS:
COORDINATE SURGE PROTECTION O.C.P. PER MANUFACTURER
PROVIDE WITH INTEGRAL SURGE PROTECTION DEVICE

MOUNTING: SURFACE
VOLTS: 120/208, 3PH, 4W
MAIN SIZE: 80 AMPS
MAIN TYPE: MCB M.D.
BRACING: 22 KAIC 0

EMI JOB 17-0620 0

NOTE: ALL CONDUCTORS ARE #12 AWG UNLESS OTHERVISE NOTED HERE IN DR OR RISER DIAGRAM, OR AS NOTED IN THE SPECIFICATIONS FOR VOLTAGE DROP.
PROVIDE A DEDICATED NEUTRAL FOR EACH FLUORESCENT LIGHTING CIRCUIT. CONDUCTORS SERVING 20 AMP BRANCH CIRCUITS SHALL BE #10 AWG UNLESS OTHERWISE NOTED.
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ENGINEERING MATRIX, INC.
CONSULTING ENGINEERS
2860 SCHERER DRIVE, SUITE 640
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CERT. OF AUTHORIZATION NO. 4288

SEAL:

DRAWING PHASE:
CONSTRUCTION DOCUMENTS

ISSUE DATE: 4-6-2018
EMI JOB NO. 17-0620

DRAWING REVISIONS:

DESOTO CENTER
MANATEE COUNTY SHERIFF'S OFFICE
C.R.A.C. UNIT AND U.P.S. UPGRADES
600 U.S. 301 Blvd. W. #202, Bradenton, FL 34205

DRAWN BY: DRJK CHECKED BY: GFB

DRAWING TITLE:
ELECTRICAL PANEL SCHEDULES

SCALE: N.T.S.
NORTH:

DRAWING NUMBER:
E3.3