Department of Administration
Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Purchase Order

Order Date: 03-08-2023

CORRECT ORDER NUMBER MUST APPEA ON ALL PACKAGES, INVOICES, AND SHIPPING PAPERS. QUESTIONS CONCERNING THIS ORDER SHOULD BE DIRECTED TO THE DEPARTMENT CONTACT.

Order Number:	CPO 0211 4554 GSD2300000015 1	**Procurement Folder:**	1165141
Document Name:	Building 54 HVAC Modifications Project	**Reason for Modification:**	
Document Description:	Building 54 HVAC Modifications Project	Award of CRFQ GSD2300000029	
Procurement Type:	Central Purchase Order		
Buyer Name:	Melissa Pettrey		
Telephone:	(304) 558-0094		
Email:	melissa.k.pettrey@wv.gov		
Shipping Method:	Best Way	**Effective Start Date:**	2023-04-01
Free on Board:	FOB Dest, Freight Prepaid	**Effective End Date:**	2024-05-26

VENDOR

Vendor Customer Code: 000000206308
CP&H INC
1500 MORGANTOWN INDUSTRIAL PARK

MORGANTOWN WV 26501-2339
US
Vendor Contact Phone: 304-296-7135 **Extension:**

Discount Details:

	Discount Allowed	Discount Percentage	Discount Days
#1	No	0.0000	0
#2	Not Entered		
#3	Not Entered		
#4	Not Entered		

DEPARTMENT CONTACT

Requestor Name: Patrick S O'Neill
Requestor Phone: 304-352-5492
Requestor Email: patrick.s.oneill@wv.gov

23
FILE LOCATION _____

INVOICE TO

DEPARTMENT OF ADMINISTRATION
GENERAL SERVICES DIVISION
103 MICHIGAN AVENUE
CHARLESTON WV 25305
US

SHIP TO

DEPARTMENT OF ADMINISTRATION
GENERAL SERVICES DIVISION - BLDG 54
400 ADAMS ST
FAIRMONT WV 26554
US

Total Order Amount:	$2,189,355.

3/21/2023

Purchasing Division's File Copy

ENTERED

MKP 03/15/2023

PURCHASING DIVISION AUTHORIZATION	ATTORNEY GENERAL APPROVAL AS TO FORM	ENCUMBRANCE CERTIFICATION
DATE: 3/20/2023	DATE: 3/23/2023	DATE: 3/23/2023
ELECTRONIC SIGNATURE ON FILE	ELECTRONIC SIGNATURE ON FILE	ELECTRONIC SIGNATURE ON FILE

Extended Description:

One-Time Purchase
Construction

The Vendor, CP&H, Inc., of Morgantown, WV agrees to enter into this one-time construction contract with the Department of Administration, General Services Division to provide all labor, materials, equipment, and incidentals for Bldg. 54 HVAC Modifications Project, located at 400 Adams Street, Fairmont, WV 26554, pe the bid requirements, specifications, terms and conditions, the information from the Project Manual and Drawings as developed by the Architect; Miller Engineering the information from Addendum No. 1 dated 1/20/2023, Addendum No. 2 dated 2/17/2023; the Vendor's submitted and accepted bid dated 3/1/2023 all incorporate herein by reference and made apart of hereof as also attached.

Line	Commodity Code	Quantity	Unit	Unit Price	Total Price
1	72151201	0.00000		0.000000	1999955.00
Service From	**Service To**	**Manufacturer**		**Model No**	
2023-04-01	2024-05-26				

Commodity Line Description: Base Bid

Extended Description:
Building 54 HVAC Modifications Project - per specifications

Line	Commodity Code	Quantity	Unit	Unit Price	Total Price
2	72151201	0.00000		0.000000	189400.00
Service From	**Service To**	**Manufacturer**		**Model No**	
2023-04-01	2024-05-26				

Commodity Line Description: Alternate # 1 - Six (6) fan coil units

Extended Description:
Building 54 HVAC Modifications Project - per specifications
Alternate # 1 - Six (6) fan coil units

GENERAL TERMS AND CONDITIONS:

1. CONTRACTUAL AGREEMENT: Issuance of an Award Document signed by the Purchasing Division Director, or his designee, and approved as to form by the Attorney General's office constitutes acceptance by the State of this Contract made by and between the State of West Virginia and the Vendor. Vendor's signature on its bid, or on the Contract if the Contract is not the result of a bid solicitation, signifies Vendor's agreement to be bound by and accept the terms and conditions contained in this Contract.

2. DEFINITIONS: As used in this Solicitation/Contract, the following terms shall have the meanings attributed to them below. Additional definitions may be found in the specifications included with this Solicitation/Contract.

2.1. "Agency" or **"Agencies"** means the agency, board, commission, or other entity of the State of West Virginia that is identified on the first page of the Solicitation or any other public entity seeking to procure goods or services under this Contract.

2.2. "Bid" or **"Proposal"** means the vendors submitted response to this solicitation.

2.3. "Contract" means the binding agreement that is entered into between the State and the Vendor to provide the goods or services requested in the Solicitation.

2.4. "Director" means the Director of the West Virginia Department of Administration, Purchasing Division.

2.5. "Purchasing Division" means the West Virginia Department of Administration, Purchasing Division.

2.6. "Award Document" means the document signed by the Agency and the Purchasing Division, and approved as to form by the Attorney General, that identifies the Vendor as the contract holder.

2.7. "Solicitation" means the official notice of an opportunity to supply the State with goods or services that is published by the Purchasing Division.

2.8. "State" means the State of West Virginia and/or any of its agencies, commissions, boards, etc. as context requires.

2.9. "Vendor" or **"Vendors"** means any entity submitting a bid in response to the Solicitation, the entity that has been selected as the lowest responsible bidder, or the entity that has been awarded the Contract as context requires.

3. CONTRACT TERM; RENEWAL; EXTENSION: The term of this Contract shall be determined in accordance with the category that has been identified as applicable to this Contract below:

☐ **Term Contract**

Initial Contract Term: The Initial Contract Term will be for a period of _____ _____. The Initial Contract Term becomes effective on the effective start date listed on the first page of this Contract, identified as the State of West Virginia contract cover page containing the signatures of the Purchasing Division, Attorney General, and Encumbrance clerk (or another page identified as _____), and the Initial Contract Term ends on the effective end date also shown on the first page of this Contract.

Renewal Term: This Contract may be renewed upon the mutual written consent of the Agency, and the Vendor, with approval of the Purchasing Division and the Attorney General's office (Attorney General approval is as to form only). Any request for renewal should be delivered to the Agency and then submitted to the Purchasing Division thirty (30) days prior to the expiration date of the initial contract term or appropriate renewal term. A Contract renewal shall be in accordance with the terms and conditions of the original contract. Unless otherwise specified below, renewal of this Contract is limited to _____ successive one (1) year periods or multiple renewal periods of less than one year, provided that the multiple renewal periods do not exceed the total number of months available in all renewal years combined. Automatic renewal of this Contract is prohibited. Renewals must be approved by the Vendor, Agency, Purchasing Division and Attorney General's office (Attorney General approval is as to form only)

☐ **Alternate Renewal Term** – This contract may be renewed for _____ successive _____ year periods or shorter periods provided that they do not exceed the total number of months contained in all available renewals. Automatic renewal of this Contract is prohibited. Renewals must be approved by the Vendor, Agency, Purchasing Division and Attorney General's office (Attorney General approval is as to form only)

Delivery Order Limitations: In the event that this contract permits delivery orders, a delivery order may only be issued during the time this Contract is in effect. Any delivery order issued within one year of the expiration of this Contract shall be effective for one year from the date the delivery order is issued. No delivery order may be extended beyond one year after this Contract has expired.

☑ **Fixed Period Contract:** This Contract becomes effective upon Vendor's receipt of the notice to proceed and must be completed within Four Hundred and Twenty (420) days.

☐ **Fixed Period Contract with Renewals:** This Contract becomes effective upon Vendor's receipt of the notice to proceed and part of the Contract more fully described in the attached specifications must be completed within _____ days. Upon completion of the work covered by the preceding sentence, the vendor agrees that:

☐ the contract will continue for _____ years;

☐ the contract may be renewed for _____ successive _____ year periods or shorter periods provided that they do not exceed the total number of months contained in all available renewals. Automatic renewal of this Contract is prohibited. Renewals must be approved by the Vendor, Agency, Purchasing Division and Attorney General's Office (Attorney General approval is as to form only).

☐ **One-Time Purchase:** The term of this Contract shall run from the issuance of the Award Document until all of the goods contracted for have been delivered, but in no event will this Contract extend for more than one fiscal year.

☐ **Construction/Project Oversight:** This Contract becomes effective on the effective start date listed on the first page of this Contract, identified as the State of West Virginia contract cover page containing the signatures of the Purchasing Division, Attorney General, and Encumbrance clerk (or another page identified as _____), and continues until the project for which the vendor is providing oversight is complete.

☐ **Other:** Contract Term specified in _____

4. AUTHORITY TO PROCEED: Vendor is authorized to begin performance of this contract on the date of encumbrance listed on the front page of the Award Document unless either the box for "Fixed Period Contract" or "Fixed Period Contract with Renewals" has been checked in Section 3 above. If either "Fixed Period Contract" or "Fixed Period Contract with Renewals" has been checked, Vendor must not begin work until it receives a separate notice to proceed from the State. The notice to proceed will then be incorporated into the Contract via change order to memorialize the official date that work commenced.

5. QUANTITIES: The quantities required under this Contract shall be determined in accordance with the category that has been identified as applicable to this Contract below.

☐ **Open End Contract:** Quantities listed in this Solicitation/Award Document are approximations only, based on estimates supplied by the Agency. It is understood and agreed that the Contract shall cover the quantities actually ordered for delivery during the term of the Contract, whether more or less than the quantities shown.

☐ **Service:** The scope of the service to be provided will be more clearly defined in the specifications included herewith.

☑ **Combined Service and Goods:** The scope of the service and deliverable goods to be provided will be more clearly defined in the specifications included herewith.

☐ **One-Time Purchase:** This Contract is for the purchase of a set quantity of goods that are identified in the specifications included herewith. Once those items have been delivered, no additional goods may be procured under this Contract without an appropriate change order approved by the Vendor, Agency, Purchasing Division, and Attorney General's office.

☐ **Construction:** This Contract is for construction activity more fully defined in the specifications.

6. EMERGENCY PURCHASES: The Purchasing Division Director may authorize the Agency to purchase goods or services in the open market that Vendor would otherwise provide under this Contract if those goods or services are for immediate or expedited delivery in an emergency. Emergencies shall include, but are not limited to, delays in transportation or an unanticipated increase in the volume of work. An emergency purchase in the open market, approved by the Purchasing Division Director, shall not constitute of breach of this Contract and shall not entitle the Vendor to any form of compensation or damages. This provision does not excuse the State from fulfilling its obligations under a One-Time Purchase contract.

7. REQUIRED DOCUMENTS: All of the items checked in this section must be provided to the Purchasing Division by the Vendor as specified:

☐ **LICENSE(S) / CERTIFICATIONS / PERMITS:** In addition to anything required under the Section of the General Terms and Conditions entitled Licensing, the apparent successful Vendor shall furnish proof of the following licenses, certifications, and/or permits upon request and in a form acceptable to the State. The request may be prior to or after contract award at the State's sole discretion.

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The apparent successful Vendor shall also furnish proof of any additional licenses or certifications contained in the specifications regardless of whether or not that requirement is listed above.

8. INSURANCE: The apparent successful Vendor shall furnish proof of the insurance identified by a checkmark below prior to Contract award. The insurance coverages identified below must be maintained throughout the life of this contract. Thirty (30) days prior to the expiration of the insurance policies, Vendor shall provide the Agency with proof that the insurance mandated herein has been continued. Vendor must also provide Agency with immediate notice of any changes in its insurance policies, including but not limited to, policy cancelation, policy reduction, or change in insurers. The apparent successful Vendor shall also furnish proof of any additional insurance requirements contained in the specifications prior to Contract award regardless of whether that insurance requirement is listed in this section.

Vendor must maintain:

☑ **Commercial General Liability Insurance** in at least an amount of: $1,000,000.00 per occurrence.

☑ **Automobile Liability Insurance** in at least an amount of: $1,000,000.00 per occurrence.

☐ **Professional/Malpractice/Errors and Omission Insurance** in at least an amount of: _____ per occurrence. Notwithstanding the forgoing, Vendor's are not required to list the State as an additional insured for this type of policy.

☑ **Commercial Crime and Third Party Fidelity Insurance** in an amount of: $100,000.00 per occurrence.

☐ **Cyber Liability Insurance** in an amount of: _____ per occurrence.

☐ **Builders Risk Insurance** in an amount equal to 100% of the amount of the Contract.

☐ **Pollution Insurance** in an amount of: _____ per occurrence.

☐ **Aircraft Liability** in an amount of: _____ per occurrence.

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9. WORKERS' COMPENSATION INSURANCE: Vendor shall comply with laws relating to workers compensation, shall maintain workers' compensation insurance when required, and shall furnish proof of workers' compensation insurance upon request.

10. VENUE: All legal actions for damages brought by Vendor against the State shall be brought in the West Virginia Claims Commission. Other causes of action must be brought in the West Virginia court authorized by statute to exercise jurisdiction over it.

11. LIQUIDATED DAMAGES: This clause shall in no way be considered exclusive and shall not limit the State or Agency's right to pursue any other available remedy. Vendor shall pay liquidated damages in the amount specified below or as described in the specifications:

☐ _____ for _____.

☑ Liquidated Damages Contained in the Specifications.

☐ Liquidated Damages Are Not Included in this Contract.

12. ACCEPTANCE: Vendor's signature on its bid, or on the certification and signature page, constitutes an offer to the State that cannot be unilaterally withdrawn, signifies that the product or service proposed by vendor meets the mandatory requirements contained in the Solicitation for that product or service, unless otherwise indicated, and signifies acceptance of the terms and conditions contained in the Solicitation unless otherwise indicated.

13. PRICING: The pricing set forth herein is firm for the life of the Contract, unless specified elsewhere within this Solicitation/Contract by the State. A Vendor's inclusion of price adjustment provisions in its bid, without an express authorization from the State in the Solicitation to do so, may result in bid disqualification. Notwithstanding the foregoing, Vendor must extend any publicly advertised sale price to the State and invoice at the lower of the contract price or the publicly advertised sale price.

14. PAYMENT IN ARREARS: Payments for goods/services will be made in arrears only upon receipt of a proper invoice, detailing the goods/services provided or receipt of the goods/services, whichever is later. Notwithstanding the foregoing, payments for software maintenance, licenses, or subscriptions may be paid annually in advance.

15. PAYMENT METHODS: Vendor must accept payment by electronic funds transfer and P-Card. (The State of West Virginia's Purchasing Card program, administered under contract by a banking institution, processes payment for goods and services through state designated credit cards.)

16. TAXES: The Vendor shall pay any applicable sales, use, personal property or any other taxes arising out of this Contract and the transactions contemplated thereby. The State of West Virginia is exempt from federal and state taxes and will not pay or reimburse such taxes.

17. ADDITIONAL FEES: Vendor is not permitted to charge additional fees or assess additional charges that were not either expressly provided for in the solicitation published by the State of West Virginia, included in the Contract, or included in the unit price or lump sum bid amount that Vendor is required by the solicitation to provide. Including such fees or charges as notes to the solicitation may result in rejection of vendor's bid. Requesting such fees or charges be paid after the contract has been awarded may result in cancellation of the contract.

18. FUNDING: This Contract shall continue for the term stated herein, contingent upon funds being appropriated by the Legislature or otherwise being made available. In the event funds are not appropriated or otherwise made available, this Contract becomes void and of no effect beginning on July 1 of the fiscal year for which funding has not been appropriated or otherwise made available. If that occurs, the State may notify the Vendor that an alternative source of funding has been obtained and thereby avoid the automatic termination. Non-appropriation or non-funding shall not be considered an event of default.

19. CANCELLATION: The Purchasing Division Director reserves the right to cancel this Contract immediately upon written notice to the vendor if the materials or workmanship supplied do not conform to the specifications contained in the Contract. The Purchasing Division Director may also cancel any purchase or Contract upon 30 days written notice to the Vendor in accordance with West Virginia Code of State Rules § 148-1-5.2.b.

20. TIME: Time is of the essence regarding all matters of time and performance in this Contract.

21. APPLICABLE LAW: This Contract is governed by and interpreted under West Virginia law without giving effect to its choice of law principles. Any information provided in specification manuals, or any other source, verbal or written, which contradicts or violates the West Virginia Constitution, West Virginia Code, or West Virginia Code of State Rules is void and of no effect.

22. COMPLIANCE WITH LAWS: Vendor shall comply with all applicable federal, state, and local laws, regulations and ordinances. By submitting a bid, Vendor acknowledges that it has reviewed, understands, and will comply with all applicable laws, regulations, and ordinances.

> **SUBCONTRACTOR COMPLIANCE:** Vendor shall notify all subcontractors providing commodities or services related to this Contract that as subcontractors, they too are required to comply with all applicable laws, regulations, and ordinances. Notification under this provision must occur prior to the performance of any work under the contract by the subcontractor.

23. ARBITRATION: Any references made to arbitration contained in this Contract, Vendor's bid, or in any American Institute of Architects documents pertaining to this Contract are hereby deleted, void, and of no effect.

24. MODIFICATIONS: This writing is the parties' final expression of intent. Notwithstanding anything contained in this Contract to the contrary no modification of this Contract shall be binding without mutual written consent of the Agency, and the Vendor, with approval of the Purchasing Division and the Attorney General's office (Attorney General approval is as to form only). Any change to existing contracts that adds work or changes contract cost, and were not included in the original contract, must be approved by the Purchasing Division and the Attorney General's Office (as to form) prior to the implementation of the change or commencement of work affected by the change.

25. WAIVER: The failure of either party to insist upon a strict performance of any of the terms or provision of this Contract, or to exercise any option, right, or remedy herein contained, shall not be construed as a waiver or a relinquishment for the future of such term, provision, option, right, or remedy, but the same shall continue in full force and effect. Any waiver must be expressly stated in writing and signed by the waiving party.

26. SUBSEQUENT FORMS: The terms and conditions contained in this Contract shall supersede any and all subsequent terms and conditions which may appear on any form documents submitted by Vendor to the Agency or Purchasing Division such as price lists, order forms, invoices, sales agreements, or maintenance agreements, and includes internet websites or other electronic documents. Acceptance or use of Vendor's forms does not constitute acceptance of the terms and conditions contained thereon.

27. ASSIGNMENT: Neither this Contract nor any monies due, or to become due hereunder, may be assigned by the Vendor without the express written consent of the Agency, the Purchasing Division, the Attorney General's office (as to form only), and any other government agency or office that may be required to approve such assignments.

28. WARRANTY: The Vendor expressly warrants that the goods and/or services covered by this Contract will: (a) conform to the specifications, drawings, samples, or other description furnished or specified by the Agency; (b) be merchantable and fit for the purpose intended; and (c) be free from defect in material and workmanship.

29. STATE EMPLOYEES: State employees are not permitted to utilize this Contract for personal use and the Vendor is prohibited from permitting or facilitating the same.

30. PRIVACY, SECURITY, AND CONFIDENTIALITY: The Vendor agrees that it will not disclose to anyone, directly or indirectly, any such personally identifiable information or other confidential information gained from the Agency, unless the individual who is the subject of the information consents to the disclosure in writing or the disclosure is made pursuant to the Agency's policies, procedures, and rules. Vendor further agrees to comply with the Confidentiality Policies and Information Security Accountability Requirements, set forth in http://www.state.wv.us/admin/purchase/privacy/default.html.

31. YOUR SUBMISSION IS A PUBLIC DOCUMENT: Vendor's entire response to the Solicitation and the resulting Contract are public documents. As public documents, they will be disclosed to the public following the bid/proposal opening or award of the contract, as required by the competitive bidding laws of West Virginia Code §§ 5A-3-1 et seq., 5-22-1 et seq., and 5G-1-1 et seq. and the Freedom of Information Act West Virginia Code §§ 29B-1-1 et seq.

DO NOT SUBMIT MATERIAL YOU CONSIDER TO BE CONFIDENTIAL, A TRADE SECRET, OR OTHERWISE NOT SUBJECT TO PUBLIC DISCLOSURE.

Submission of any bid, proposal, or other document to the Purchasing Division constitutes your explicit consent to the subsequent public disclosure of the bid, proposal, or document. The Purchasing Division will disclose any document labeled "confidential," "proprietary," "trade secret," "private," or labeled with any other claim against public disclosure of the documents, to include any "trade secrets" as defined by West Virginia Code § 47-22-1 et seq. All submissions are subject to public disclosure without notice.

32. LICENSING: In accordance with West Virginia Code of State Rules § 148-1-6.1.e, Vendor must be licensed and in good standing in accordance with any and all state and local laws and requirements by any state or local agency of West Virginia, including, but not limited to, the West Virginia Secretary of State's Office, the West Virginia Tax Department, West Virginia Insurance Commission, or any other state agency or political subdivision. Obligations related to political subdivisions may include, but are not limited to, business licensing, business and occupation taxes, inspection compliance, permitting, etc. Upon request, the Vendor must provide all necessary releases to obtain information to enable the Purchasing Division Director or the Agency to verify that the Vendor is licensed and in good standing with the above entities.

SUBCONTRACTOR COMPLIANCE: Vendor shall notify all subcontractors providing commodities or services related to this Contract that as subcontractors, they too are required to be licensed, in good standing, and up-to-date on all state and local obligations as described in this section. Obligations related to political subdivisions may include, but are not limited to, business licensing, business and occupation taxes, inspection compliance, permitting, etc. Notification under this provision must occur prior to the performance of any work under the contract by the subcontractor.

33. ANTITRUST: In submitting a bid to, signing a contract with, or accepting a Award Document from any agency of the State of West Virginia, the Vendor agrees to convey, sell, assign, or transfer to the State of West Virginia all rights, title, and interest in and to all causes of action it may now or hereafter acquire under the antitrust laws of the United States and the State of West Virginia for price fixing and/or unreasonable restraints of trade relating to the particular commodities or services purchased or acquired by the State of West Virginia. Such assignment shall be made and become effective at the time the purchasing agency tenders the initial payment to Vendor.

34. VENDOR NON-CONFLICT: Neither Vendor nor its representatives are permitted to have any interest, nor shall they acquire any interest, direct or indirect, which would compromise the performance of its services hereunder. Any such interests shall be promptly presented in detail to the Agency.

35. VENDOR RELATIONSHIP: The relationship of the Vendor to the State shall be that of an independent contractor and no principal-agent relationship or employer-employee relationship is contemplated or created by this Contract. The Vendor as an independent contractor is solely liable for the acts and omissions of its employees and agents. Vendor shall be responsible for selecting, supervising, and compensating any and all individuals employed pursuant to the terms of this Solicitation and resulting contract. Neither the Vendor, nor any employees or subcontractors of the Vendor, shall be deemed to be employees of the State for any purpose whatsoever. Vendor shall be exclusively responsible for payment of employees and contractors for all wages and salaries, taxes, withholding payments, penalties, fees, fringe benefits, professional liability insurance premiums, contributions to insurance and pension, or other deferred compensation plans, including but not limited to, Workers' Compensation and Social Security obligations, licensing fees, etc. and the filing of all necessary documents, forms, and returns pertinent to all of the foregoing.

Vendor shall hold harmless the State, and shall provide the State and Agency with a defense against any and all claims including, but not limited to, the foregoing payments, withholdings, contributions, taxes, Social Security taxes, and employer income tax returns.

36. INDEMNIFICATION: The Vendor agrees to indemnify, defend, and hold harmless the State and the Agency, their officers, and employees from and against: (1) Any claims or losses for services rendered by any subcontractor, person, or firm performing or supplying services, materials, or supplies in connection with the performance of the Contract; (2) Any claims or losses resulting to any person or entity injured or damaged by the Vendor, its officers, employees, or subcontractors by the publication, translation, reproduction, delivery, performance, use, or disposition of any data used under the Contract in a manner not authorized by the Contract, or by Federal or State statutes or regulations; and (3) Any failure of the Vendor, its officers, employees, or subcontractors to observe State and Federal laws including, but not limited to, labor and wage and hour laws.

37. NO DEBT CERTIFICATION: In accordance with West Virginia Code §§ 5A-3-10a and 5-22-1(i), the State is prohibited from awarding a contract to any bidder that owes a debt to the State or a political subdivision of the State. By submitting a bid, or entering into a contract with the State, Vendor is affirming that (1) for construction contracts, the Vendor is not in default on any monetary obligation owed to the state or a political subdivision of the state, and (2) for all other contracts, neither the Vendor nor any related party owe a debt as defined above, and neither the Vendor nor any related party are in employer default as defined in the statute cited above unless the debt or employer default is permitted under the statute.

38. CONFLICT OF INTEREST: Vendor, its officers or members or employees, shall not presently have or acquire an interest, direct or indirect, which would conflict with or compromise the performance of its obligations hereunder. Vendor shall periodically inquire of its officers, members and employees to ensure that a conflict of interest does not arise. Any conflict of interest discovered shall be promptly presented in detail to the Agency.

39. REPORTS: Vendor shall provide the Agency and/or the Purchasing Division with the following reports identified by a checked box below:

☑ Such reports as the Agency and/or the Purchasing Division may request. Requested reports may include, but are not limited to, quantities purchased, agencies utilizing the contract, total contract expenditures by agency, etc.

☐ Quarterly reports detailing the total quantity of purchases in units and dollars, along with a listing of purchases by agency. Quarterly reports should be delivered to the Purchasing Division via email at purchasing.division@wv.gov.

40. BACKGROUND CHECK: In accordance with W. Va. Code § 15-2D-3, the State reserves the right to prohibit a service provider's employees from accessing sensitive or critical information or to be present at the Capitol complex based upon results addressed from a criminal background check. Service providers should contact the West Virginia Division of Protective Services by phone at (304) 558-9911 for more information.

41. PREFERENCE FOR USE OF DOMESTIC STEEL PRODUCTS: Except when authorized by the Director of the Purchasing Division pursuant to W. Va. Code § 5A-3-56, no contractor may use or supply steel products for a State Contract Project other than those steel products made in the United States. A contractor who uses steel products in violation of this section may be subject to civil penalties pursuant to W. Va. Code § 5A-3-56. As used in this section:

a. "State Contract Project" means any erection or construction of, or any addition to, alteration of or other improvement to any building or structure, including, but not limited to, roads or highways, or the installation of any heating or cooling or ventilating plants or other equipment, or the supply of and materials for such projects, pursuant to a contract with the State of West Virginia for which bids were solicited on or after June 6, 2001.

b. "Steel Products" means products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated or otherwise similarly processed, or processed by a combination of two or more or such operations, from steel made by the open heath, basic oxygen, electric furnace, Bessemer or other steel making process.

c. The Purchasing Division Director may, in writing, authorize the use of foreign steel products if:

    1. The cost for each contract item used does not exceed one tenth of one percent (.1%) of the total contract cost or two thousand five hundred dollars ($2,500.00), whichever is greater. For the purposes of this section, the cost is the value of the steel product as delivered to the project; or

    2. The Director of the Purchasing Division determines that specified steel materials are not produced in the United States in sufficient quantity or otherwise are not reasonably available to meet contract requirements.

42. PREFERENCE FOR USE OF DOMESTIC ALUMINUM, GLASS, AND STEEL: In Accordance with W. Va. Code § 5-19-1 et seq., and W. Va. CSR § 148-10-1 et seq., for every contract or subcontract, subject to the limitations contained herein, for the construction, reconstruction, alteration, repair, improvement or maintenance of public works or for the purchase of any item of machinery or equipment to be used at sites of public works, only domestic aluminum, glass or steel products shall be supplied unless the spending officer determines, in writing, after the receipt of offers or bids, (1) that the cost of domestic aluminum, glass or steel products is unreasonable or inconsistent with the public interest of the State of West Virginia, (2) that domestic aluminum, glass or steel products are not produced in sufficient quantities to meet the contract requirements, or (3) the available domestic aluminum, glass, or steel do not meet the contract specifications. This provision only applies to public works contracts awarded in an amount more than fifty thousand dollars ($50,000) or public works contracts that require more than ten thousand pounds of steel products.

The cost of domestic aluminum, glass, or steel products may be unreasonable if the cost is more than twenty percent (20%) of the bid or offered price for foreign made aluminum, glass, or steel products. If the domestic aluminum, glass or steel products to be supplied or produced in a "substantial labor surplus area", as defined by the United States Department of Labor, the cost of domestic aluminum, glass, or steel products may be unreasonable if the cost is more than thirty percent (30%) of the bid or offered price for foreign made aluminum, glass, or steel products. This preference shall be applied to an item of machinery or equipment, as indicated above, when the item is a single unit of equipment or machinery manufactured primarily of aluminum, glass or steel, is part of a public works contract and has the sole purpose or of being a permanent part of a single public works project. This provision does not apply to equipment or machinery purchased by a spending unit for use by that spending unit and not as part of a single public works project.

All bids and offers including domestic aluminum, glass or steel products that exceed bid or offer prices including foreign aluminum, glass or steel products after application of the preferences provided in this provision may be reduced to a price equal to or lower than the lowest bid or offer price for foreign aluminum, glass or steel products plus the applicable preference. If the reduced bid or offer prices are made in writing and supersede the prior bid or offer prices, all bids or offers, including the reduced bid or offer prices, will be reevaluated in accordance with this rule.

43. INTERESTED PARTY SUPPLEMENTAL DISCLOSURE: W. Va. Code § 6D-1-2 requires that for contracts with an actual or estimated value of at least $1 million, the Vendor must submit to the Agency a disclosure of interested parties prior to beginning work under this Contract. Additionally, the Vendor must submit a supplemental disclosure of interested parties reflecting any new or differing interested parties to the contract, which were not included in the original pre-work interested party disclosure, within 30 days following the completion or termination of the contract. A copy of that form is included with this solicitation or can be obtained from the WV Ethics Commission. This requirement does not apply to publicly traded companies listed on a national or international stock exchange. A more detailed definition of interested parties can be obtained from the form referenced above.

44. PROHIBITION AGAINST USED OR REFURBISHED: Unless expressly permitted in the solicitation published by the State, Vendor must provide new, unused commodities, and is prohibited from supplying used or refurbished commodities, in fulfilling its responsibilities under this Contract.

45. VOID CONTRACT CLAUSES: This Contract is subject to the provisions of West Virginia Code § 5A-3-62, which automatically voids certain contract clauses that violate State law.

46. ISRAEL BOYCOTT: Bidder understands and agrees that, pursuant to W. Va. Code § 5A-3-63, it is prohibited from engaging in a boycott of Israel during the term of this contract.

ADDITIONAL TERMS AND CONDITIONS (Construction Contracts Only)

1. CONTRACTOR'S LICENSE: Until June 15, 2021, West Virginia Code § 21-11-2, and after that date, § 30-42-2, requires that all persons desiring to perform contracting work in this state be licensed. The West Virginia Contractors Licensing Board is empowered to issue the contractor's license. Applications for a contractor's license may be made by contacting the West Virginia Contractor Licensing Board.

The apparent successful Vendor must furnish a copy of its contractor's license prior to the issuance of a contract award document.

2. BONDS: The following bonds must be submitted:

a. **BID BOND:** Pursuant to the requirements contained in W. Va. Code § 5-22-1(c), All Vendors submitting a bid on a construction project shall furnish a valid bid bond in the amount of five percent (5%) of the total amount of the bid protecting the State of West Virginia. **THE BID BOND MUST BE SUBMITTED WITH THE BID OR VENDOR'S BID WILL BE DISQUALIFIED.**

b. **PERFORMANCE BOND:** The apparent successful Vendor shall provide a performance bond in the amount of 100% of the contract. The performance bond must be received by the Purchasing Division prior to Contract award. (Attorney General requires use of the State approved bond forms found at: www.state.wv.us/admin/purchase/forms2.html)

c. **LABOR/MATERIAL PAYMENT BOND**: The apparent successful Vendor shall provide a labor/material payment bond in the amount of 100% of the Contract value. The labor/material payment bond must be delivered to the Purchasing Division prior to Contract award. (Attorney General requires use of the State approved bond forms found at: www.state.wv.us/admin/purchase/forms2.html)

d. **MAINTENANCE BOND:** The apparent successful Vendor shall provide a two (2) year maintenance bond covering the roofing system if the work impacts an existing roof. The amount of the bond must be equal to the price associated with the percentage of the project impacting the roof. The maintenance bond must be issued and delivered to the Purchasing Division prior to Contract award. (Attorney General requires use of the State approved bond forms found at: www.state.wv.us/admin/purchase/forms2.html)

In lieu of the Bid Bond, the Vendor may provide certified checks, cashier's checks, or irrevocable letters of credit. Any certified check, cashier's check, or irrevocable letter of credit provided in lieu of the bid bond must be of the same amount required of the Bid Bond and delivered with the bid.

3. DRUG-FREE WORKPLACE AFFIDAVIT: W. Va. Code § 21-1D-5 provides that any solicitation for a public improvement contract requires each Vendor that submits a bid for the work to submit an affidavit that the Vendor has a written plan for a drug-free workplace policy. If the affidavit is not submitted with the bid submission, the Purchasing Division shall promptly request by telephone and electronic mail that the low bidder and second low bidder provide the affidavit within one business day of the request. Failure to submit the affidavit within one business day of receiving the request shall result in disqualification of the bid. To comply with this law, Vendor should complete the enclosed drug-free workplace affidavit and submit the same with its bid. Failure to submit the signed and notarized drugfree workplace affidavit or a similar affidavit that fully complies with the requirements of the applicable code, within one business day of being requested to do so shall result in disqualification of Vendor's bid. Pursuant to W. Va. Code 21-1D-2(b) and (k), this provision does not apply to public improvement contracts the value of which is $100,000 or less or temporary or emergency repairs.

3.1. DRUG-FREE WORKPLACE POLICY: Pursuant to W. Va. Code § 21-1D-4, Vendor and its subcontractors must implement and maintain a written drug-free workplace policy that complies with said article. The awarding public authority shall cancel this contract if: (1) Vendor fails to implement and maintain a written drug-free workplace policy described in the preceding paragraph, (2) Vendor fails to provide information regarding implementation of its drug-free workplace policy at the request of the public authority; or (3) Vendor provides to the public authority false information regarding the contractor's drug-free workplace policy.

Pursuant to W. Va. Code 21-1D-2(b) and (k), this provision does not apply to public improvement contracts the value of which is $100,000 or less or temporary or emergency repairs.

4. DRUG FREE WORKPLACE REPORT: Pursuant to W. Va. Code § 21-1D-7b, no less than once per year, or upon completion of the project, every contractor shall provide a certified report to the public authority which let the contract. For contracts over $25,000, the public authority shall be the West Virginia Purchasing Division. For contracts of $25,000 or less, the public authority shall be the agency issuing the contract. The report shall include:

(1) Information to show that the education and training service to the requirements of West Virginia Code § 21-1D-5 was provided;

(2) The name of the laboratory certified by the United States Department of Health and Human Services or its successor that performs the drug tests;

(3) The average number of employees in connection with the construction on the public improvement;

(4) Drug test results for the following categories including the number of positive tests and the number of negative tests: (A) Pre-employment and new hires; (B) Reasonable suspicion; (C) Post-accident; and (D) Random.

Vendor should utilize the attached Certified Drug Free Workplace Report Coversheet when submitting the report required hereunder. Pursuant to W. Va. Code 21-1D-2(b) and (k), this provision does not apply to public improvement contracts the value of which is $100,000 or less or temporary or emergency repairs.

5. AIA DOCUMENTS: All construction contracts that will be completed in conjunction with architectural services procured under Chapter 5G of the West Virginia Code will be governed by the attached AIA documents, as amended by the Supplementary Conditions for the State of West Virginia, in addition to the terms and conditions contained herein.

6. PROHIBITION AGAINST GENERAL CONDITIONS: Notwithstanding anything contained in the AIA Documents or the Supplementary Conditions, the State of West Virginia will not pay for general conditions, or winter conditions, or any other condition representing a delay in the contracts. The Vendor is expected to mitigate delay costs to the greatest extent possible and any costs associated with Delays must be specifically and concretely identified. The state will not consider an average daily rate multiplied by the number of days extended to be an acceptable charge.

7. GREEN BUILDINGS MINIMUM ENERGY STANDARDS: In accordance with § 22-29-4, all new building construction projects of public agencies that have not entered the schematic design phase prior to July 1, 2012, or any building construction project receiving state grant funds and appropriations, including public schools, that have not entered the schematic design phase prior to July 1, 2012, shall be designed and constructed complying with the ICC International Energy Conservation Code, adopted by the State Fire Commission, and the ANSI/ASHRAE/IESNA Standard 90.1-2007: Provided, That if any construction project has a commitment of federal funds to pay for a portion of such project, this provision shall only apply to the extent such standards are consistent with the federal standards.

8. LOCAL LABOR MARKET HIRING REQUIREMENT: Pursuant to West Virginia Code §21-1C-1 et seq., Employers shall hire at least seventy-five percent of employees for public improvement construction projects from the local labor market, to be rounded off, with at least two employees from outside the local labor market permissible for each employer per project.

Any employer unable to employ the minimum number of employees from the local labor market shall inform the nearest office of Workforce West Virginia of the number of qualified employees needed and provide a job description of the positions to be filled.

If, within three business days following the placing of a job order, Workforce West Virginia is unable to refer any qualified job applicants to the employer or refers less qualified job applicants than the number requested, then Workforce West Virginia shall issue a waiver to the employer stating the unavailability of applicant and shall permit the employer to fill any positions covered by the waiver from outside the local labor market. The waiver shall be in writing and shall be issued within the prescribed three days. A waiver certificate shall be sent to both the employer for its permanent project records and to the public authority.

Any employer who violates this requirement is subject to a civil penalty of $250 per each employee less than the required threshold of seventy-five percent per day of violation after receipt of a notice of violation.

Any employer that continues to violate any provision of this article more than fourteen calendar days after receipt of a notice of violation is subject to a civil penalty of $500 per each employee less than the required threshold of seventy-five percent per day of violation.

The following terms used in this section have the meaning shown below.

(1) The term "construction project" means any construction, reconstruction, improvement, enlargement, painting, decorating or repair of any public improvement let to contract in an amount equal to or greater than $500,000. The term "construction project" does not include temporary or emergency repairs;

(2) The term "employee" means any person hired or permitted to perform hourly work for wages by a person, firm or corporation in the construction industry; The term "employee" does not include:(i) Bona fide employees of a public authority or individuals engaged in making temporary or emergency repairs;(ii) Bona fide independent contractors; or(iii) Salaried supervisory personnel necessary to assure efficient execution of the employee's work;

(3) The term "employer" means any person, firm or corporation employing one or more employees on any public improvement and includes all contractors and subcontractors;

(4) The term "local labor market" means every county in West Virginia and any county outside of West Virginia if any portion of that county is within fifty miles of the border of West Virginia;

(5) The term "public improvement" includes the construction of all buildings, roads, highways, bridges, streets, alleys, sewers, ditches, sewage disposal plants, waterworks, airports and all other structures that may be let to contract by a public authority, excluding improvements funded, in whole or in part, by federal funds.

9. DAVIS-BACON AND RELATED ACT WAGE RATES:

☐ The work performed under this contract is federally funded in whole, or in part. Pursuant to _____, Vendors are required to pay applicable Davis-Bacon wage rates.

☑ The work performed under this contract is not subject to Davis-Bacon wage rates.

10. SUBCONTRACTOR LIST SUBMISSION: In accordance with W. Va. Code § 5-22-1, the apparent low bidder on a contract valued at more than $250,000.00 for the construction, alteration, decoration, painting or improvement of a new or existing building or structure shall submit a list of all subcontractors who will perform more than $25,000.00 of work on the project including labor and materials. (This section does not apply to any other construction projects, such as highway, mine reclamation, water or sewer projects.) The subcontractor list shall be provided to the Purchasing Division within one business day of the opening of bids for review.
If the apparent low bidder fails to submit the subcontractor list, the Purchasing Division shall promptly request by telephone and electronic mail that the low bidder and second low bidder provide the subcontractor list within one business day of the request. Failure to submit the subcontractor list within one business day of receiving the request shall result in disqualification of the bid.

If no subcontractors who will perform more than $25,000.00 of work are to be used to complete the project, the apparent low bidder must make this clear on the subcontractor list, in the bid itself, or in response to the Purchasing Division's request for the subcontractor list.

a. Required Information. The subcontractor list must contain the following information:

i. Bidder's name

ii. Name of each subcontractor performing more than $25,000 of work on the project.

iii. The license number of each subcontractor, as required by W. Va. Code § 21-11-1 et. seq.

iv. If applicable, a notation that no subcontractor will be used to perform more than $25,000.00 of work. (This item iv. is not required if the vendor makes this clear in the bid itself or in documentation following the request for the subcontractor list.)

b. Subcontractor List Submission Form: The subcontractor list may be submitted in any form, including the attached form, as long as the required information noted above is included. If any information is missing from the bidder's subcontractor list submission, it may be obtained from other documents such as bids, emails, letters, etc. that accompany the subcontractor list submission.

c. Substitution of Subcontractor. Written approval must be obtained from the State Spending Unit before any subcontractor substitution is permitted. Substitutions are not permitted unless:

i. The subcontractor listed in the original bid has filed for bankruptcy;

ii. The subcontractor in the original bid has been debarred or suspended; or

iii. The contractor certifies in writing that the subcontractor listed in the original bid fails, is unable, or refuses to perform his subcontract.

Subcontractor List Submission (Construction Contracts Only)

Bidder's Name: CP&H Inc.

☐ Check this box if no subcontractors will perform more than $25,000.00 of work to complete the project.

Subcontractor Name	License Number if Required by W. Va. Code § 21-11-1 et. seq.
Mechanical Systems & Services	WV051929
ARCOR Mechanical	WV050959
Commercial Builders WV	WV003713
Angus Contracting	WV044040
Trane	Vendor

Attach additional pages if necessary

DESIGNATED CONTACT: Vendor appoints the individual identified in this Section as the Contract Administrator and the initial point of contact for matters relating to this Contract.

(Printed Name and Title) Jay Wade, President CP&H Inc.

(Address) 1500 Morgantown Industrial Park, Morgantown WV 26501

(Phone Number) / (Fax Number) 304-296-7135

(Email address) jay@cphwv.com

CERTIFICATION AND SIGNATURE: By signing below, or submitting documentation through *wv*OASIS, I certify that: I have reviewed this Solicitation/Contract in its entirety; that I understand the requirements, terms and conditions, and other information contained herein; that this bid, offer or proposal constitutes an offer to the State that cannot be unilaterally withdrawn; that the product or service proposed meets the mandatory requirements contained in the Solicitation/Contract for that product or service, unless otherwise stated herein; that the Vendor accepts the terms and conditions contained in the Solicitation, unless otherwise stated herein; that I am submitting this bid, offer or proposal for review and consideration; that this bid or offer was made without prior understanding, agreement, or connection with any entity submitting a bid or offer for the same material, supplies, equipment or services; that this bid or offer is in all respects fair and without collusion or fraud; that this Contract is accepted or entered into without any prior understanding, agreement, or connection to any other entity that could be considered a violation of law; that I am authorized by the Vendor to execute and submit this bid, offer, or proposal, or any documents related thereto on Vendor's behalf; that I am authorized to bind the vendor in a contractual relationship; and that to the best of my knowledge, the vendor has properly registered with any State agency that may require registration.

By signing below, I further certify that I understand this Contract is subject to the provisions of West Virginia Code § 5A-3-62, which automatically voids certain contract clauses that violate State law; and that pursuant to W. Va. Code 5A-3-63, the entity entering into this contract is prohibited from engaging in a boycott against Israel.

CP&H Inc. DBA City Plumbing & Heating Inc
(Company)

(Signature of Authorized Representative)

Jay Wade, President 3/1/2023
(Printed Name and Title of Authorized Representative) (Date)

304-296-7135
(Phone Number) (Fax Number)

Jay@cphwv.com
(Email Address)

REQUEST FOR QUOTATION
Building 54 HVAC Modifications Project
CRFQ GSD2300000029

GENERAL CONSTRUCTION SPECIFICATIONS

1. **PURPOSE AND SCOPE:** The West Virginia Purchasing Division is soliciting bids on behalf of the WV Department of Administration, General Services Division ("Agency" and "Owner") to establish a contract for HVAC Modifications for Building 54 in Fairmont, WV.

   This project will address improvements related to controls and equipment concerns. The renovations will be performed while the building remains occupied. The existing system utilizes three (3) air handling systems with chilled and hot water (35% propylene glycol) configured for both fan and non-fan powered VAV with reheat.

   The heat source is a gas fired condensing hot water boilers. The cooling source is an air-cooled chiller with an ice storage system. The ice storage system will be removed in its entirety by the project.

2. **DEFINITIONS:** The terms listed below shall have the meanings assigned to them below. Additional definitions can be found in section 2 of the General Terms and Conditions and in the Specification's Manual as defined below.

   2.1. **"Construction Services"** means the upgrades to the HVAC modifications, as more fully described in these specifications and the Specifications/Project Manual.

   2.2. **"Pricing Page"** means the pages contained in wvOASIS, attached hereto as Exhibit A, upon which Vendor should list its proposed price for the Construction Services.

   2.3. **"Solicitation"** means the official notice of an opportunity to supply the State with Construction Services that is published by the Purchasing Division.

   2.4. **"Specifications/Project Manual"** means the American Institute of Architect forms, specifications, plans, drawings, and related documents developed by the architect, engineer, or Agency that provide detailed instructions on how the Construction Services are to be performed along with any American Institute of Architects documents ("AIA documents") attached thereto.

3. **ORDER OF PRECEDENCE:** This General Construction Specifications document will have priority over, and supersede, anything contained in the Specifications/Project Manual.

4. QUALIFICATIONS: Vendor, or Vendor's staff if requirements are inherently limited to individuals rather than corporate entities, shall have the following minimum qualifications:

4.1. **Experience:** Vendor, or Vendor's supervisory staff assigned to this project, must have successfully completed at least Three (3) projects that involved work similar to that described in the Specifications/Project Manual. Compliance with this experience requirement will be determined prior to contract award by the State through references provided by the Vendor upon request, through knowledge or documentation of the Vendor's past projects, through confirmation of experience requirements from the architect assisting the State in this project, or some other method that the State determines to be acceptable. Vendor must provide any documentation requested by the State to assist in confirmation of compliance with this provision. References, documentation, or other information to confirm compliance with this experience requirement may be requested after bid opening and prior to contract award.

5. CONTRACT AWARD: The Contract is intended to provide Agency with a purchase price for the Construction Services. The Contract will be awarded to the lowest qualified responsible bidder meeting the required specifications. If the Pricing Pages contain alternates/add-ons, the Contract will be awarded based on the grand total of the base bid and any alternates/add-ons selected.

5.1. All bidders are required to provide a copy of the completed Exhibit A pricing page with their bid.

6. SELECTION OF ALTERNATES: Pursuant to W. Va. Code § 5-22-1(f), any solicitation of bids shall include no more than five alternates. Alternates, if accepted, shall be accepted in the order in which they are listed on the bid form. Any unaccepted alternate contained within a bid shall expire 90 days after the date of the opening of bids for review. Determination of the lowest qualified responsible bidder shall be based on the sum of the base bid and any alternates accepted. Alternate selection will be identified in the Purchase Order.

7. PROGRESS PAYMENTS: The Vendor will be paid in the form of periodic progress payments for work completed. Payment requests along with documentation supporting the request will be submitted to and reviewed by the Architect. If approved, the Architect will communicate approval to the Owner and Owner will process payment. The Owner reserves the right to withhold liquidated damages from progress payments. Progress payments will be made no more than monthly.

Approval and payment of progress payments will be based on Contractor's submission of a payment allocation schedule which allocates the entire contract sum to payment milestones. Architect and Owner will review the payment allocation and may mandate changes that they believe are necessary.

8. **RETAINAGE:** Agency is entitled to withhold Ten Percent (10%) from each progress payment made as retainage. Agency will partially release retainage upon certification of substantial completion by the Architect in accordance with this Contract but will continue to retain amounts sufficient to cover activities needed to reach final completion.

9. **PERFORMANCE:** Vendor shall perform the Construction Services in accordance with this document and the Specifications/Project Manual.

10. **SUBSTANTIAL AND FINAL COMPLETION:** Vendor shall achieve Substantial Completion by Three hundred and Ninety (390) calendar days and Final Completion by Four hundred and Twenty (420) calendar days after the Contract start date established by the issuance of the Notice to Proceed. Failure to meet the deadlines established herein, unless extended by change order authorizing additional time free of liquidated damages, will result in liquidated damages being applied.

11. **LIQUIDATED DAMAGES:** Vendor shall pay Liquidated Damages in the amount of $2,500.00 per calendar day for every calendar day beyond the date for Substantial Completion of the overall contract, as established by the issuance of the Notice to Proceed, for which Substantial Completion of the overall project has not been achieved.

12. **PROJECT PLANS:** Copies of the project plans can be obtained by contacting the entity identified below.

    Hard Copies of the plans and specifications may be obtained from:

    Miller Engineering, Inc.
    429 Laurel Run Road
    Carmichaels, PA 15320-2543
    Phone: 304-291-2246

    by interested parties by paying $475.00 each for sets of printed/bound documents and/or $50.00 each for a digital set (CD-ROM), plus the cost of shipping (if applicable); however, such cost is not refundable.

    Copies of project plans can be examined at the following locations:

    Kanawha Valley Builders Association
    1627 Bigley Avenue
    Charleston, WV 25302
    Phone: 304-342-7141
    Fax: 304-343-8014
    Email: luther@kvba.com

Contractors Association of West Virginia
2114 Kanawha Boulevard East
Charleston, West Virginia 25311
Phone: 304-342-1166
Fax: 304-342-1074
Email: planroom@cawv.org

Construction Employers Association NCWV
2794 White Hall Blvd
White Hall, WV 26554
Phone: 304-367-1290
Fax: 304-367-0126
Email: ceaplanroom@ceawv.com

Parkersburg Marietta Contractors Association
2905 Emerson Avenue
Parkersburg, WV 26104
Phone: 304-485-6485
Fax: 304-428-7622
Email: pmcadesk@gmail.com

Reed Construction Data
30 Technology Parkway South
Suite 100
Norcross, GA 30092
Phone: 800-364-2059
Fax: 800-317-0870
Email: projectinquiries@isqft.com

Pennsylvania Builders Exchange
1813 N. Franklin Street
Pittsburgh, PA 15233
Phone: 412-922-4200
Fax: 412-928-9406
Email: karen@pbe.org

Dodge Data and Analytics
4300 Beltway Place, Suite 180
Arlington, TX 76018-5253
Phone: 800-393-6343
Email: support@construction.com

Ohio Valley Construction Employer's Council
21 Armory Drive
Wheeling, WV 26003
Phone: (304)242-0520
Fax: (304)242-7261
Email: ovcec@ovcec.com

13. **SUBSTITUTIONS:** Any substitution requests must be submitted in accordance with the official question and answer period described in the INSTRUCTIONS TO VENDORS SUBMITTING BIDS, Paragraph 4. Vendor Question Deadline.

14. **FACILITIES ACCESS:** Performance of Contract Services may require access cards and/or keys to gain entrance to Agency's facilities. In the event that access cards and/or keys are required:

14.1. Vendor must identify principal service personnel which will be issued access cards and/or keys to perform service.

14.2. Vendor will be responsible for controlling cards and keys and will pay replacement fee if the cards or keys become lost or stolen.

14.3. Vendor shall notify Agency immediately of any lost, stolen, or missing card or key.

14.4. Anyone performing under this Contract will be subject to Agency's security protocol and procedures.

14.5. Vendor shall inform all staff of Agency's security protocol and procedures.

15. MISCELLANEOUS:

15.1. Contract Manager: During its performance of this Contract, Vendor must designate and maintain a primary contract manager responsible for overseeing Vendor's responsibilities under this Contract. The Contract manager must be available during normal business hours to address any customer service or other issues related to this Contract. Vendor should list its Contract manager and his or her contact information below.

Contract Manager: Jay Wade

Telephone Number: 304-296-7135

Fax Number: 304-291-5269

Email Address: jay@cphwv.com

16. Owner's Representative: Owner's representative for notice purposes is:

Name: **Patrick O'Neill**
Telephone Number: **(304)352-5514**
Fax Number: **(304)558-1475**
Email Address: **Patrick.S.Oneill@wv.gov**

17. Initial Decision Maker: Miller Engineering, Inc., the Engineer, shall serve as the Initial Decision Maker in matters relating to this contract.

REQUEST FOR QUOTATION
Building 54 HVAC Modifications Project
CRFQ GSD2300000029

Exhibit A – Pricing Page

Name of Bidder:

CP&H, Inc. dba City Plumbing & Heating

The Bidder, being familiar with and understanding the Bidding Documents and also having examined the site and being familiar with all local conditions affecting the project hereby proposes to furnish all labor, material, equipment, supplies and transportation and to perform all Work in accordance with the Bidding Documents within the time set forth for the sum of:

Base Bid (Commodity Line 1 in *wv*OASIS) $ 1,999,955.00 (A)

One Million Nine Hundred Ninety Nine Thousand Nine Hundred Fifty Five Dollars and 00/100

(Show amount in both words and numbers)

Alternate # 1 (Commodity Line 2 in *wv*OASIS)– Installation of six (6) fan coil units in locations shown in the project drawings.

$ 189,400.00 (B)

One Hundred Eighty Nine Thousand Four Hundred Dollars and 00/100

(Show amount in both words and numbers)

Total Bid Amount (A+B) $ 2,189,355.00 (C)

Two Million One Hundred Eighty Nine Thousand Three Hundred Fifty Five Dollars and 00/100

(Show amount in both words and numbers)

Department of Administration
Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Centralized Request for Quote
Construction

Proc Folder:	1165141
Doc Description:	Building 54 HVAC Modifications Project
Proc Type:	Central Purchase Order
Reason for Modification:	Addendum No.1

Date Issued	Solicitation Closes	Solicitation No	Version
2023-01-20	2023-03-01 13:30	CRFQ 0211 GSD2300000029	2

BID RECEIVING LOCATION

BID CLERK
DEPARTMENT OF ADMINISTRATION
PURCHASING DIVISION
2019 WASHINGTON ST E
CHARLESTON WV 25305
US

VENDOR

Vendor Customer Code:

Vendor Name :

Address :

Street :

City :

State : **Country :** **Zip :**

Principal Contact :

Vendor Contact Phone: **Extension:**

FOR INFORMATION CONTACT THE BUYER

Melissa Pettrey
(304) 558-0094
melissa.k.pettrey@wv.gov

Vendor Signature X **FEIN#** **DATE**

All offers subject to all terms and conditions contained in this solicitation

ADDITIONAL INFORMATION

Addendum No. 1 is issued to publish and distribute the attached information to the vendor community.

****

Request for Quotation
CONSTRUCTION

The West Virginia Purchasing Division is soliciting bids on behalf of the WV Department of Administration, General Services Division ("Agency" and "Owner") to establish a contract for HVAC Modifications for Building 54 in Fairmont, WV., per the bid requirements, specifications and terms and conditions as attached hereto.

PROJECT MANUALS AND DRAWINGS ARE NOT ATTACHED TO THIS SOLICITATION. SEE SECTION 12 OF THE GENERAL CONSTRUCTION SPECIFICATIONS FOR MORE INFORMATION

INVOICE TO		SHIP TO	
DEPARTMENT OF ADMINISTRATION		DEPARTMENT OF ADMINISTRATION	
GENERAL SERVICES DIVISION		GENERAL SERVICES DIVISION - BLDG 54	
103 MICHIGAN AVENUE		400 ADAMS ST	
CHARLESTON	WV	FAIRMONT	WV
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Base Bid				

Comm Code	Manufacturer	Specification	Model #
72151201			

Extended Description:
Building 54 HVAC Modifications Project - per specifications

INVOICE TO		SHIP TO	
DEPARTMENT OF ADMINISTRATION		DEPARTMENT OF ADMINISTRATION	
GENERAL SERVICES DIVISION		GENERAL SERVICES DIVISION - BLDG 54	
103 MICHIGAN AVENUE		400 ADAMS ST	
CHARLESTON	WV	FAIRMONT	WV
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
2	Alternate # 1 - Six (6) fan coil units				

Comm Code	Manufacturer	Specification	Model #
72151201			

Extended Description:
Building 54 HVAC Modifications Project - per specifications
Alternate # 1 - Six (6) fan coil units

SCHEDULE OF EVENTS

Line	Event	Event Date
1	Mandatory Pre-bid meeting @ 11:00 AM	2023-02-01
2	Vendor question deadline @ 3:00 PM	2023-02-15

SOLICITATION NUMBER: CRFQ GSD2300000029
Addendum Number: 1

The purpose of this addendum is to modify the solicitation identified as ("Solicitation") to reflect the change(s) identified and described below.

Applicable Addendum Category:

[ ] Modify bid opening date and time

[✓] Modify specifications of product or service being sought

[ ] Attachment of vendor questions and responses

[ ] Attachment of pre-bid sign-in sheet

[✓] Correction of error

[ ] Other

Description of Modification to Solicitation:

Addendum is issued to publish and distribute the following information to the Vendor community.

1. To provide clarifications to specifications that were initially published with the solicitation, per Attachment A.

2. To make correction in the INSTRUCTIONS TO VENDORS SUBMITTING BIDS, to illustrate a change to the pre-bid meeting, scheduled for Wednesday, February 1, 2023 at 11:00am. The pre-bid meeting shall be a NON-MANDATORY PRE-BID, per Attachment A.

No other changes.

Additional Documentation: Documentation related to this Addendum (if any) has been included herewith as Attachment A and is specifically incorporated herein by reference.

Terms and Conditions:

1. All provisions of the Solicitation and other addenda not modified herein shall remain in full force and effect.

2. Vendor should acknowledge receipt of all addenda issued for this Solicitation by completing an Addendum Acknowledgment, a copy of which is included herewith. Failure to acknowledge addenda may result in bid disqualification. The addendum acknowledgement should be submitted with the bid to expedite document processing.

ATTACHMENT A

MILLER
Engineering, Inc.

ADDENDUM #1

Project Name: WV GSD Building 54 HVAC Modifications Rebid
Date: 1/20/2023
Addendum #: 1

Clarifications:

1. Trane wireless communications sensor Model Number WCS-SD digital display sensor is acceptable for the project. The sensors will be programmed to function as coordinated with the Engineer and Owner prior to installation. Programming may vary by location in the building.

2. Any reference to a natural gas meter to be monitored and trended by the BAS is hereby deleted from the documents. The project has no such requirement.

3. The existing stairwell pressurization interface will be re-used. Per the WVSFM, there is no alteration to the previously installed and approved system, so it is to remain. The new BAS will provide all necessary interface to the existing pressurization system to match all interface functions of the current pressurization panel/system, as stated in the requirement in the project documents.

4. Any paint touchup from the installation of BAS devices and equipment is a contract requirement. Vendor will perform all touchup/ damage repair associated with the installation of new systems and devices. Standard of quality of repairs will align with the "local area" in the vicinity of the repair in question, as determined by the Engineer.

5. In regards to the project requirement that "Each BAS panel will have a dedicated UPS capable of running the panel for at least three hours. Any buss nodes or wireless repeaters must also be covered by a UPS.". The design intent to be met is that each system panel must be able to "ride through" a power interruption to both protect the panels, allow rapid BAS restoration without rebooting, and permit reporting to the central monitoring station, presuming the Owner's network is available.

6. Controls: The VAV's and TB's serving the following areas by room number will incorporate CO2 sensors and control as specified: 213, 223, 224, 230, 240, 245, 246, 252, 307, 308, 316, 322, 325, 328, 329, 334, 341, 349A, 349B, 408, 409, 410, 411, 413, 420, 420A, 421, 444, 447, 519, 521, 531, 532, 539, 563, 571, & 577. For groups of rooms served by a common box, the sensors will be located prior to installation in coordination with the Owner. This clarification does not eliminate CO2 sensors dedicated to AHUs or return ducts as specified.

Requests for Substitution:

1. No requests for substitutions have been received.

Administrative:

1. Refer to the RFQ and Addenda for questions related to bid dates and times

All herein becomes part of the scope project documents and the scope of project work. Contractor is to acknowledge this as Addendum #1 on the Bid Form.

Respectfully submitted this 20th day of January, 2023.

Craig Miller PE
President
Miller Engineering, Inc.

INSTRUCTIONS TO VENDORS SUBMITTING BIDS

1. REVIEW DOCUMENTS THOROUGHLY: The attached documents contain a solicitation for bids. Please read these instructions and all documents attached in their entirety. These instructions provide critical information about requirements that if overlooked could lead to disqualification of a Vendor's bid. All bids must be submitted in accordance with the provisions contained in these instructions and the Solicitation. Failure to do so may result in disqualification of Vendor's bid.

2. MANDATORY TERMS: The Solicitation may contain mandatory provisions identified by the use of the words "must," "will," and "shall." Failure to comply with a mandatory term in the Solicitation will result in bid disqualification.

3. PREBID MEETING: The item identified below shall apply to this Solicitation.

☐ A pre-bid meeting will not be held prior to bid opening

☑ A ~~**MANDATORY**~~ **PRE-BID** meeting will be held at the following place and time:

NON-MANDATORY
Building 54
400 Adams Street
Fairmont, WV 26554

Wednesday, February 1, 2023 @ 11:00am

All Vendors submitting a bid must attend the mandatory pre-bid meeting. Failure to attend the mandatory pre-bid meeting shall result in disqualification of the Vendor's bid. No one individual is permitted to represent more than one vendor at the pre-bid meeting. Any individual that does attempt to represent two or more vendors will be required to select one vendor to which the individual's attendance will be attributed. The vendors not selected will be deemed to have not attended the pre-bid meeting unless another individual attended on their behalf.

An attendance sheet provided at the pre-bid meeting shall serve as the official document verifying attendance. Any person attending the pre-bid meeting on behalf of a Vendor must list on the attendance sheet his or her name and the name of the Vendor he or she is representing.

Additionally, the person attending the pre-bid meeting should include the Vendor's E-Mail address, phone number, and Fax number on the attendance sheet. It is the Vendor's responsibility to locate the attendance sheet and provide the required information. Failure to complete the attendance sheet as required may result in disqualification of Vendor's bid.

All Vendors should arrive prior to the starting time for the pre-bid. Vendors who arrive after the starting time but prior to the end of the pre-bid will be permitted to sign in but are charged with knowing all matters discussed at the pre-bid.

Department of Administration
Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Centralized Request for Quote
Construction

Proc Folder: 1165141			**Reason for Modification:**
Doc Description: Building 54 HVAC Modifications Project			Addendum No. 2
Proc Type: Central Purchase Order			
Date Issued	**Solicitation Closes**	**Solicitation No**	**Version**
2023-02-17	2023-03-01 13:30	CRFQ 0211 GSD2300000029	3

BID RECEIVING LOCATION

BID CLERK
DEPARTMENT OF ADMINISTRATION
PURCHASING DIVISION
2019 WASHINGTON ST E
CHARLESTON WV 25305
US

VENDOR

Vendor Customer Code:

Vendor Name :

Address :

Street :

City :

State : **Country :** **Zip :**

Principal Contact :

Vendor Contact Phone: **Extension:**

FOR INFORMATION CONTACT THE BUYER
Melissa Pettrey
(304) 558-0094
melissa.k.pettrey@wv.gov

Vendor Signature X **FEIN#** **DATE**

All offers subject to all terms and conditions contained in this solicitation

ADDITIONAL INFORMATION
Addendum No. 2 is issued to publish and distribute the attached information to the vendor community. ********** Request for Quotation **CONSTRUCTION** The West Virginia Purchasing Division is soliciting bids on behalf of the WV Department of Administration, General Services Division ("Agency" and "Owner") to establish a contract for HVAC Modifications for Building 54 in Fairmont, WV., per the bid requirements, specifications and terms and conditions as attached hereto. ***PROJECT MANUALS AND DRAWINGS ARE NOT ATTACHED TO THIS SOLICITATION. SEE SECTION 12 OF THE GENERAL CONSTRUCTION SPECIFICATIONS FOR MORE INFORMATION***

INVOICE TO		SHIP TO	
DEPARTMENT OF ADMINISTRATION		DEPARTMENT OF ADMINISTRATION	
GENERAL SERVICES DIVISION		GENERAL SERVICES DIVISION - BLDG 54	
103 MICHIGAN AVENUE		400 ADAMS ST	
CHARLESTON	WV	FAIRMONT	WV
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Base Bid				

Comm Code	Manufacturer	Specification	Model #
72151201			

Extended Description:
Building 54 HVAC Modifications Project - per specifications

INVOICE TO		SHIP TO	
DEPARTMENT OF ADMINISTRATION		DEPARTMENT OF ADMINISTRATION	
GENERAL SERVICES DIVISION		GENERAL SERVICES DIVISION - BLDG 54	
103 MICHIGAN AVENUE		400 ADAMS ST	
CHARLESTON	WV	FAIRMONT	WV
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
2	Alternate # 1 - Six (6) fan coil units				

Comm Code	Manufacturer	Specification	Model #
72151201			

Extended Description:
Building 54 HVAC Modifications Project - per specifications
Alternate # 1 - Six (6) fan coil units

SCHEDULE OF EVENTS

Line	Event	Event Date
1	Mandatory Pre-bid meeting @ 11:00 AM	2023-02-01
2	Vendor question deadline @ 3:00 PM	2023-02-15

SOLICITATION NUMBER: CRFQ GSD2300000029
Addendum Number: 2

The purpose of this addendum is to modify the solicitation identified as ("Solicitation") to reflect the change(s) identified and described below.

Applicable Addendum Category:

[ ] Modify bid opening date and time

[✔] Modify specifications of product or service being sought

[✔] Attachment of vendor questions and responses

[ ] Attachment of pre-bid sign-in sheet

[ ] Correction of error

[✔] Other

Description of Modification to Solicitation:

Addendum is issued to publish and distribute the following information to the Vendor community.

1. To provide clarification on stairwell pressurization system requirements, per Attachment A.
2. To provide responses to Vendor technical questions, per Attachment A.
3. To provide response to Substitution request that was submitted prior to bid, per Attachment A.
4. To provide drawings of existing system, per Attachment A.

No other changes.

Additional Documentation: Documentation related to this Addendum (if any) has been included herewith as Attachment A and is specifically incorporated herein by reference.

Terms and Conditions:

1. All provisions of the Solicitation and other addenda not modified herein shall remain in full force and effect.

2. Vendor should acknowledge receipt of all addenda issued for this Solicitation by completing an Addendum Acknowledgment, a copy of which is included herewith. Failure to acknowledge addenda may result in bid disqualification. The addendum acknowledgement should be submitted with the bid to expedite document processing.

ATTACHMENT A

ADDENDUM #2

Project Name: WV GSD Building 54 HVAC Modifications Rebid
Date: 2/16/2023
Addendum #: 2

Clarifications:

1. The existing stairwell pressurization interface may be re-used or replaced at the discretion of the Bidder. Per the WVSFM, there is no alteration to the previously installed and approved system, so it is to remain. The new BAS will provide all necessary interface to the existing pressurization system to match all interface functions of the current pressurization panel/system, as stated in the requirement in the project documents.

Questions:

Q 1. We have a substitution request for Chiller specified in the B54 documents. Will the Arctic Chill PACVMV0600D (document provided) be an acceptable substitution?
A 1. The substitution request is not accepted. The request is incomplete and therefore is not accepted, also the request does not employ screw compressors, or a serviceable shell and tube heat exchanger, both of which are project requirements. Refer to the project documents in regards to the composition of a substitution request, which clearly indicate the information necessary for a substitution request.

Q 2. As discussed during the walkthrough. Will using backplates behind zone sensors be accepted as an alternative for touch up painting?
A 2. Commercially available, standard electrical industry size back plates, matching the plate color found in the particular space, are an acceptable alternative to patching and painting. Custom made back plates are not acceptable.

Q 3. Please add Trane wireless sensor WCS-SC02 as an acceptable sensor for CO2 monitoring.
A 3. The sensor is acceptable for CO2 monitoring.

Q 4. Can a PDF or DWG of the original building drawings be provided on oasis? The original drawings are from Tower engineering, project number 2011227. We need a way to confirm all smoke damper locations.
A 4. The record submission of the Tower drawings and the duct submittal drawings are attached. Note that where the record drawings reference RFI's, the referenced RFI's are not available.

Q 5. The smoke evac system has smoke dampers wired back to vav boxes in multiple locations. This needs to be fixed during the project. Please advise what to do about this.
A 5. The BAS installation is a performance based requirement. Install the necessary controls hardware and wiring to effect the proper operation of the smoke damper. It is a project requirement to remove abandoned wiring, this applies to any

Q 6. Does additional paperwork need to be provided for the Chiller substitution request?
A 6. See answer to #1.

Q 7. Please give at least a week between providing the mechanical drawings and the bid date.
A 7. The bid date remains unchanged.

Q 8. As discussed in the walkthrough does the state still want to require the dedicated UPS battery backups at each panel?
A 8. UPS protection, as called for in the documents, remains a project requirement.

Q 9. Can the engineer modify the spec in a way that BAS contractors can competitively bid this job? I think it would be best if Trane provided an integration number that all mechanicals could carry in their price. If Trane will not provide this breakout there is no way for other contractors to bid any of you jobs. The specs recognize other vendors but everything must be tied back through Trane proprietary system.
A9: The engineer of record, nor the Owner, can modify the fact that the Owner utilized Trane Ensemble as their Building Automation System. Neither the Engineer nor the Owner can compel a vendor to provide pricing to perform such an integration.

Requests for Substitution:

1. Request was made for Arctic Chill PACVMV0600D. It is not accepted, see answer to #1 above.

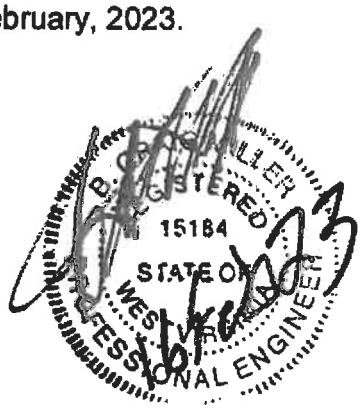
Administrative:

1. Refer to the RFQ and Addenda for questions related to bid dates and times

All herein becomes part of the scope project documents and the scope of project work. Contractor is to acknowledge this as Addendum #2 on the Bid Form.

Respectfully submitted this 16th day of February, 2023.

Craig Miller PE
President
Miller Engineering, Inc.



Shop Drawing Submittal Form

Project Name:	WV New State Office Building - Fairmont
Contractors Name:	P.J. Dick Incorporated
Supplier / Manufacturer:	Stuart-McMunn / Air Systems
Specification Section Number:	233113 - Metal Ducts
Comments: HVAC Ductwork Plans for Floors 1-5 and Roof Opening Plans	

The Omni Associates - Architects
1543 Fairmont Avenue - Suite 201
Fairmont, WV 26554
voice: 304.367.1417
facsimile: 304.367.1418

www.omniassociates.com

(Contractors Review Stamp)

This Document has been reviewed for conformance to Contract Documents and submitted to Architect for approval. An approval does not relieve Supplier/Subcontractor of their responsibility to comply with the Contract Documents.

Date 1/22/2014

Submittal No. 233113-02 - 001

PJ DICK

(Architects Review Stamp)

OMNI ASSOCIATES - ARCHITECTS

SUBMITTAL NUMBER: 233113-02

DATE RECEIVED: 1.22.14

- ☐ NO EXCEPTIONS NOTED
- ☒ IMPLEMENT EXCEPTIONS NOTED
- ☐ REVISE AND RESUBMIT
- ☐ REJECTED - RESUBMIT
- ☐ SUBMIT SPECIFIED ITEM

This conditional review is limited in scope and not detailed and is only for conformance with the design concept and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming quantities, verifying dimensions, selecting fabrication procedures and construction techniques, and coordinating and safely performing the Work. The Architect has not reviewed and is not responsible for substitutions to or deviations from the Contract Documents not clearly noted by the Contractor and specifically accepted by the Architect in writing or by the Architect's issuance of an Information Bulletin.

BY: _____ DATE: 1.30.14

304.367.1417 omniassociates.com

(Consultants Review Stamp)

TOWER ENGINEERING
115 Evergreen Heights Drive, Suite 400
Pittsburgh, Pennsylvania 15229
Phone: (412) 931-8888
Fax: (412) 939-2525

SUBMITTAL REVIEW PROJECT NO.

- ☐ NO EXCEPTIONS TAKEN
- ☐ NOT ACCEPTABLE
- ☒ MAKE CORRECTIONS NOTED
- ☐ REVISE & RESUBMIT
- ☒ REFER TO SUBMITTAL COVER SHEET FOR COMMENTS

Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

By: CWeiland Date: 01/29/2014

(Comments)

TOWER ENGINEERING

Submittal Cover Sheet

ESTC Project Name:	Fairmont Office Building	Date Received:	01-24-2014
ESTC Project No.:	2011227	Date Sent:	01-29-2014
Client:	Omni Architects		
Client Project No.:	20856	Contractor:	Stuart-McMunn Company

Manufacturer Or Supplier	Item or System	Recommended Action	Comments
Air Systems Sheet Metal	Ductwork Plans – Floors 1 thru 5 and Roof	Make Corrections Noted	See Below

Comments:

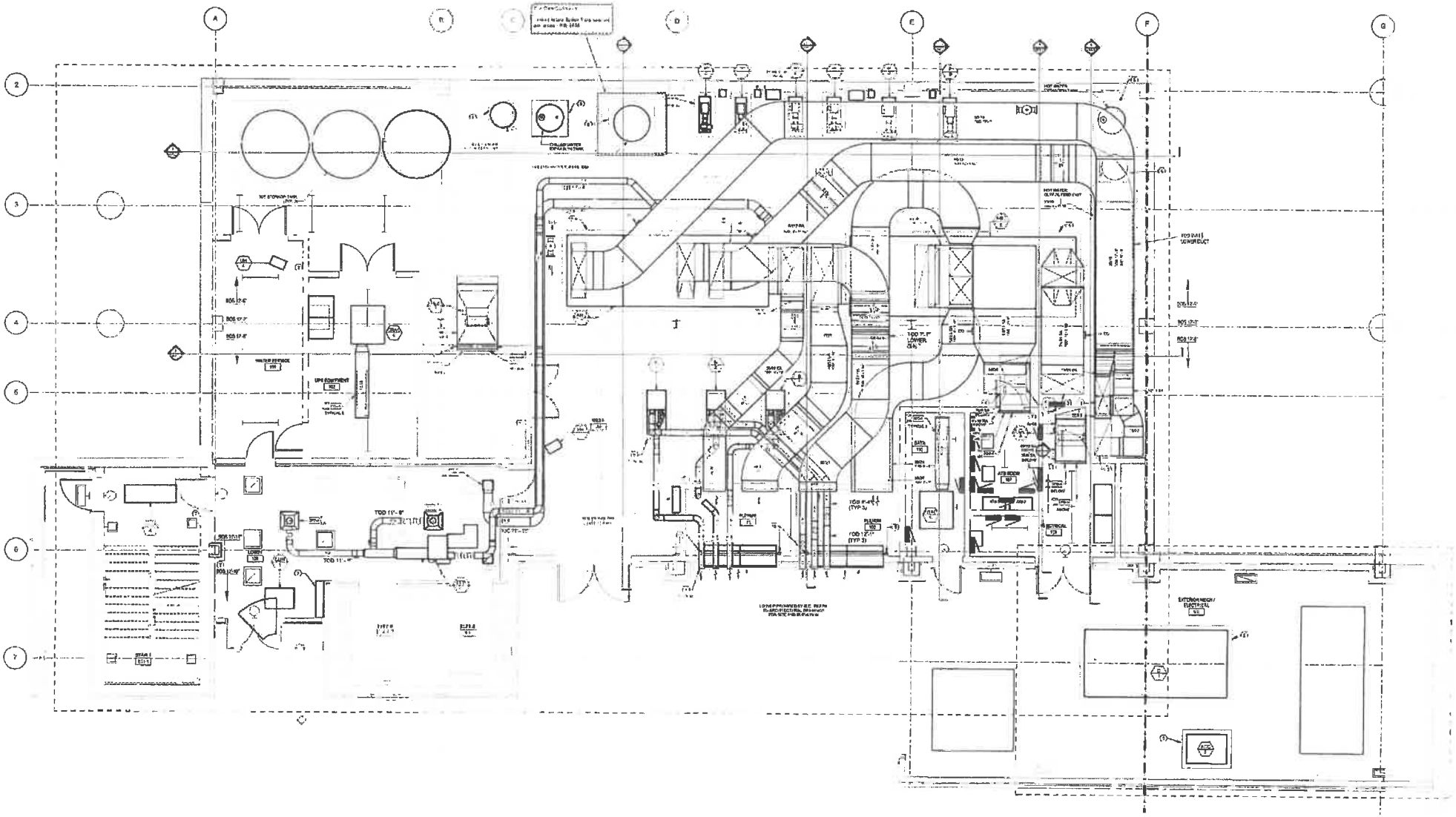
1. Supply fan SF-1 and SF-2 and their associated ductwork are not shown on the roof plan. Verify these items have been coordinated.
2. Air cooled condensing units ACC-1 thru ACC-4 and ACC-4 are not shown on the roof plan. Verify these items have been coordinated.

Reviewed By: Cory Weiland

Cory Weiland
Tower Engineering

Note: Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

115 Evergreen Heights Drive, Suite 400, Pittsburgh, Pennsylvania 15229
Phone 412.931.8888 ■ Fax 412.939.2525 ■ tower@estower.com



FIRST FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

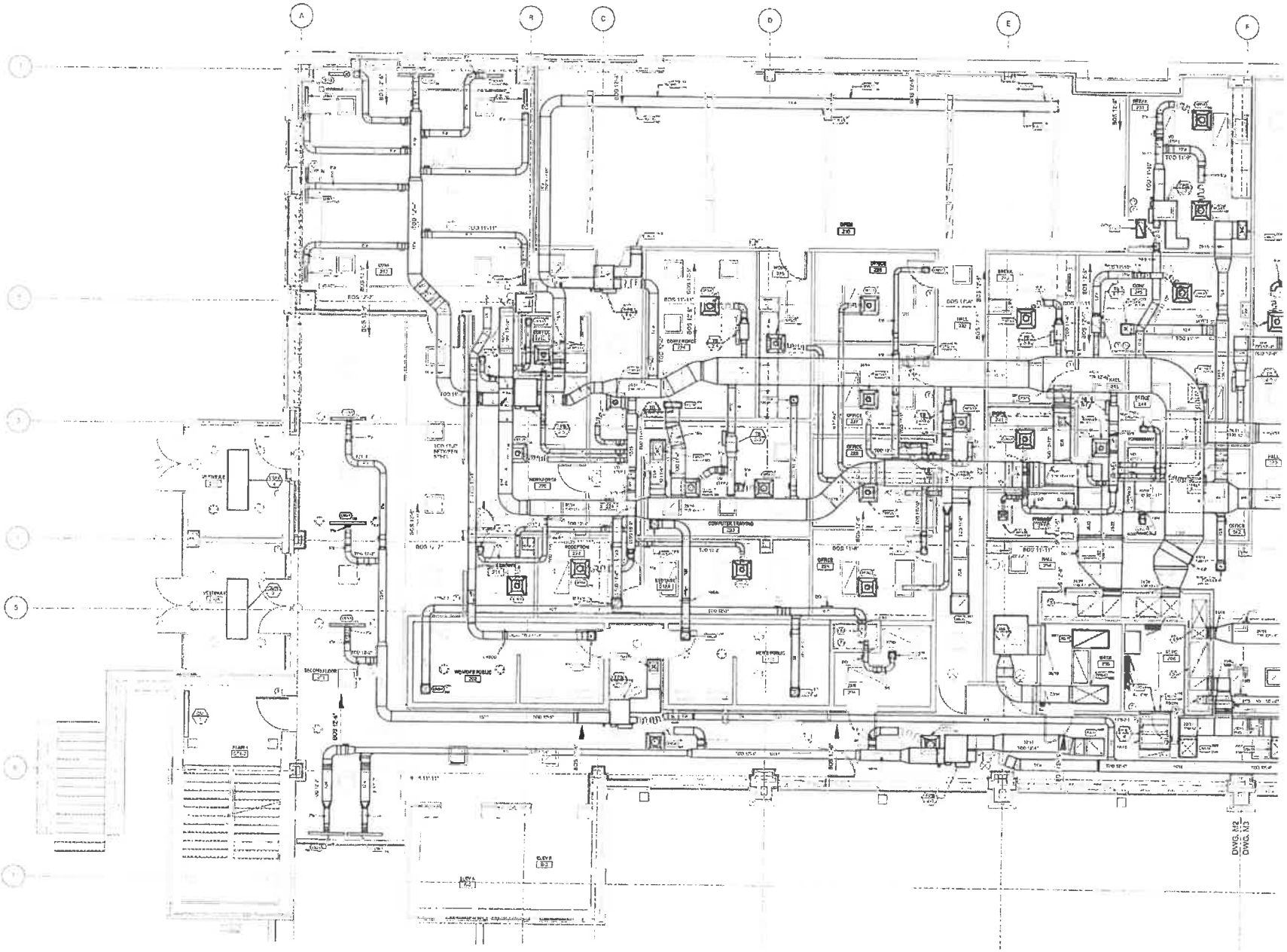
NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DATE 10-17-13

M1



SECOND FLOOR PLAN HVAC

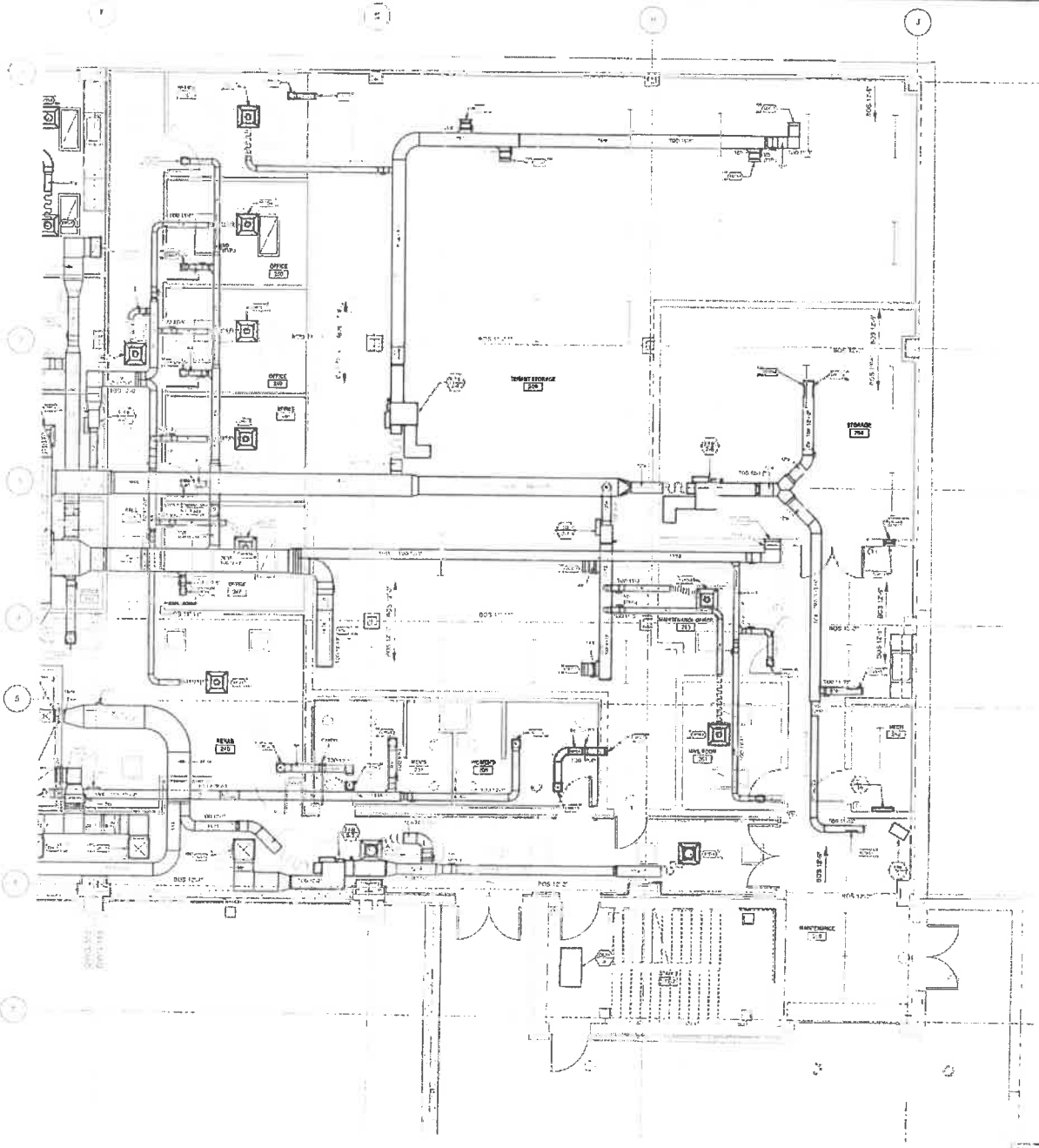
SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DWG. M2



SECOND FLOOR PLAN HVAC

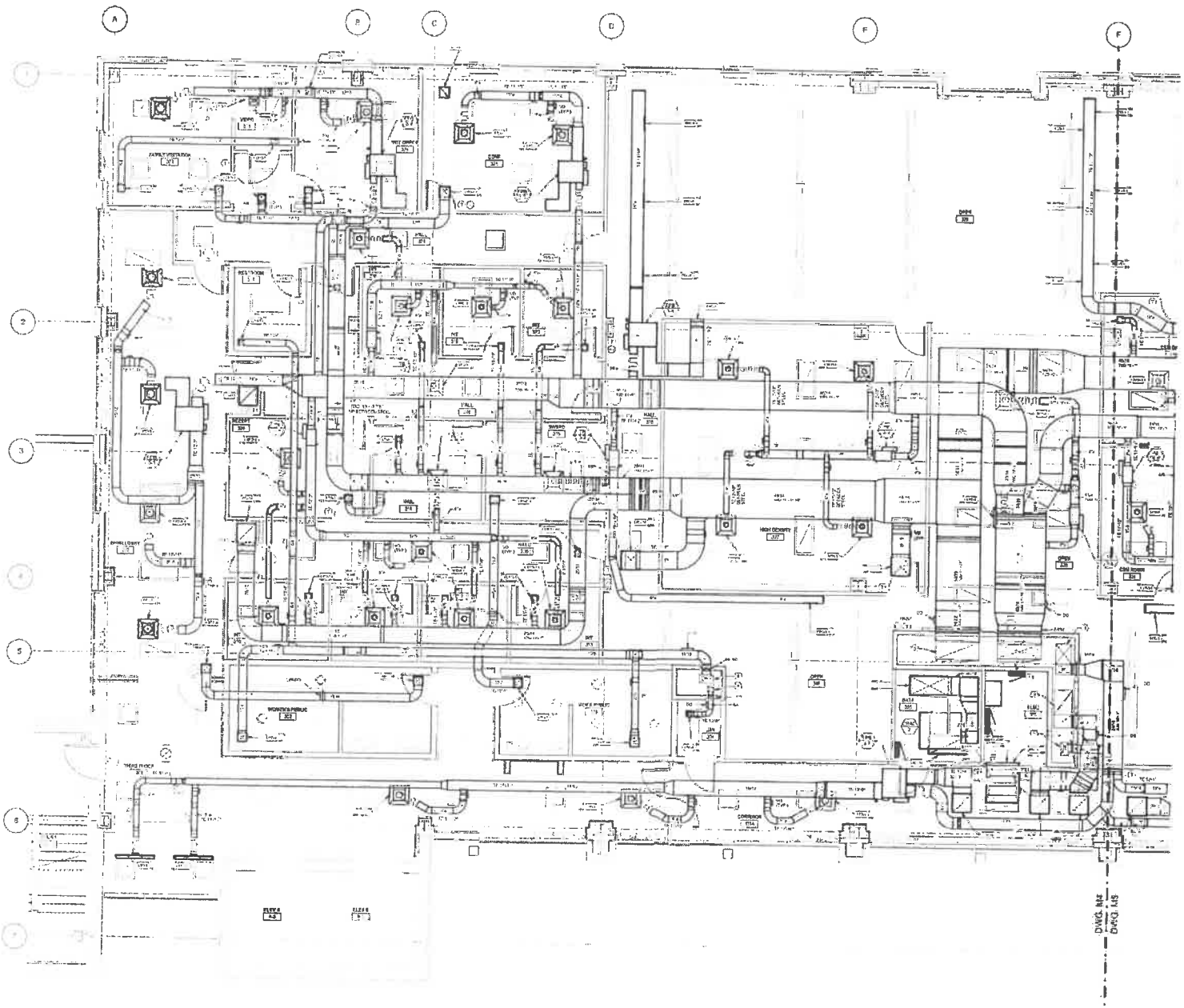
SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M3



THIRD FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

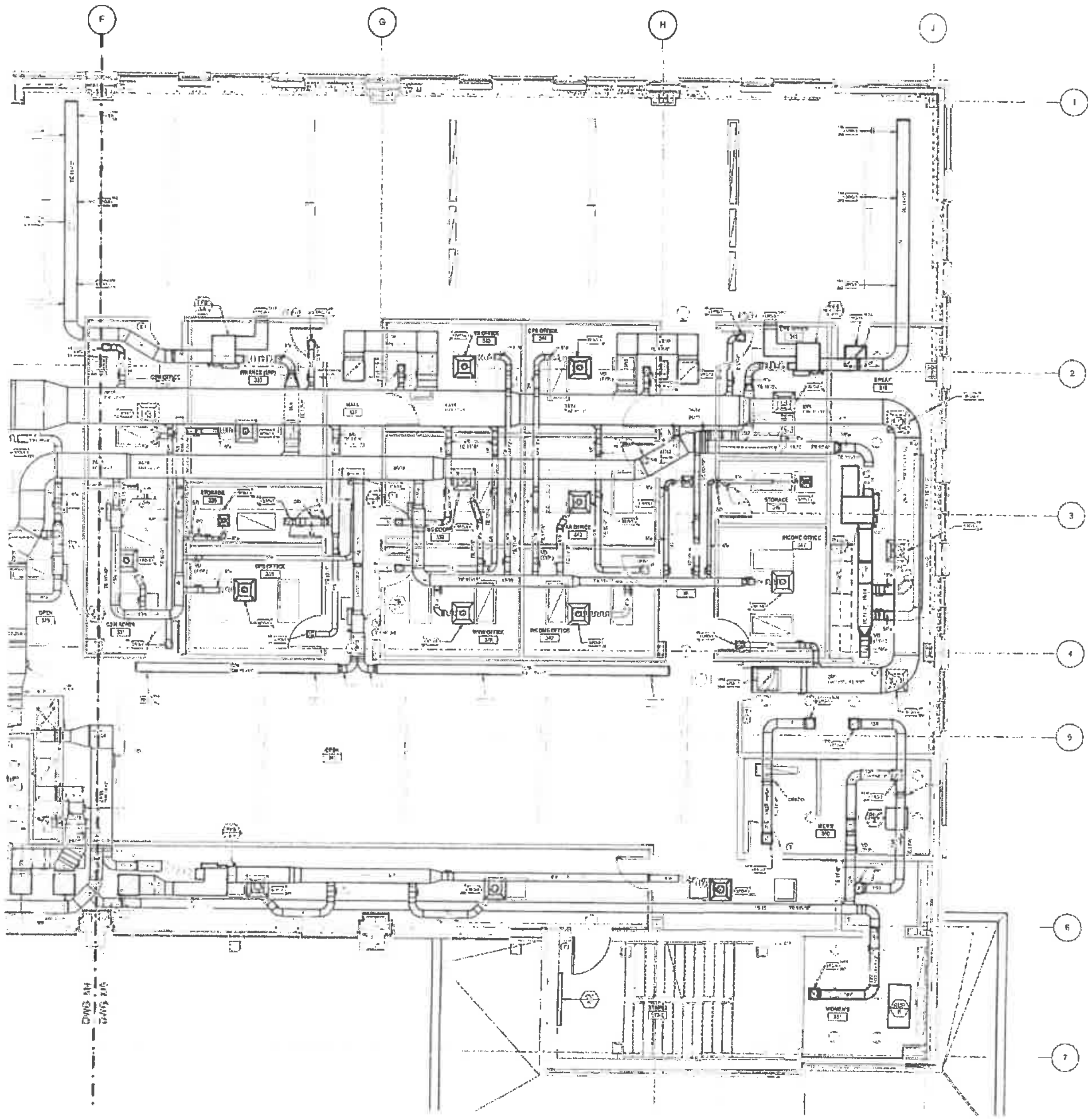
NO.	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DATE 12-20-11

M4



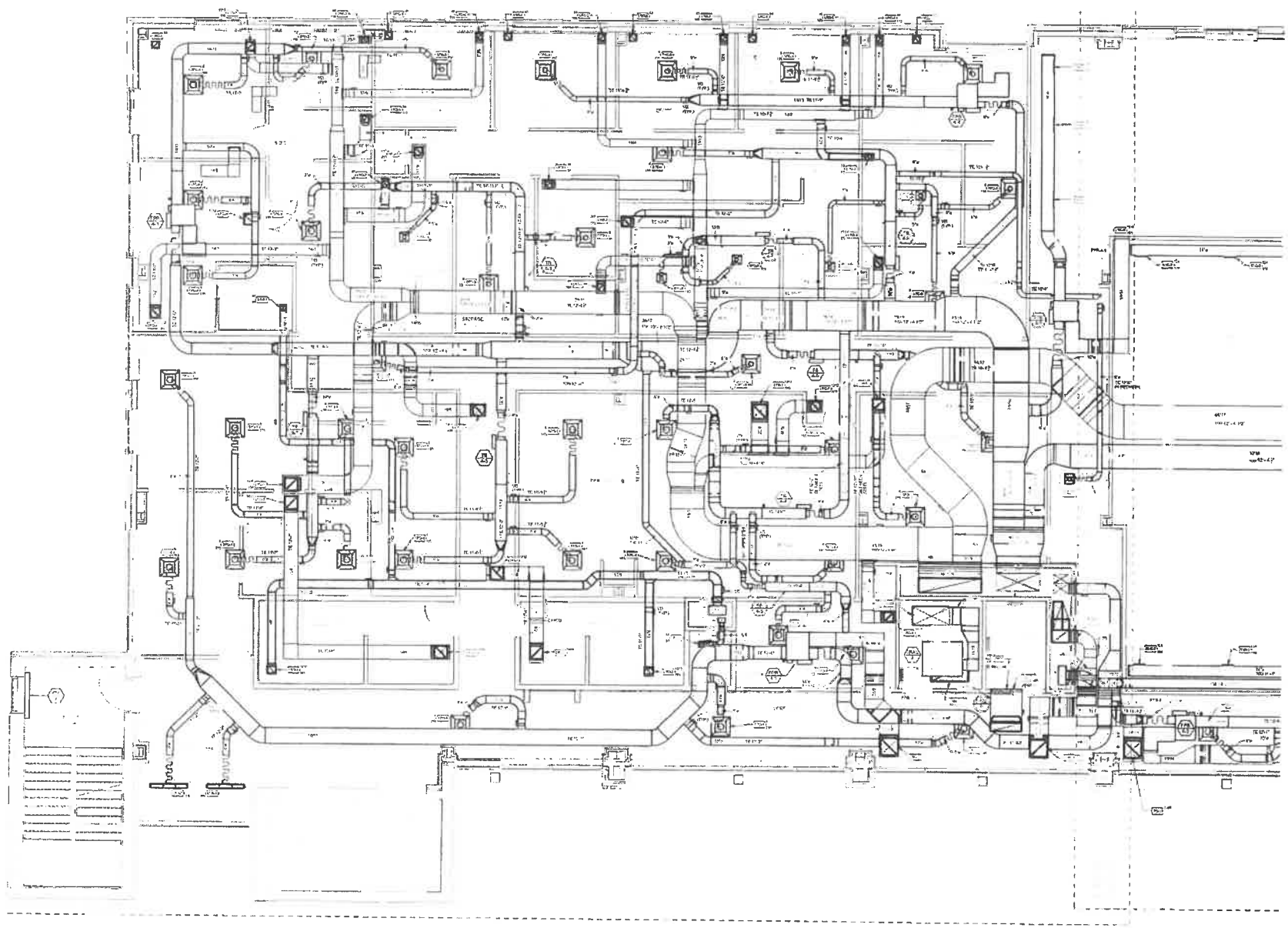
THIRD FLOOR PLAN HVAC

NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M5



FOURTH FLOOR PLAN HVAC

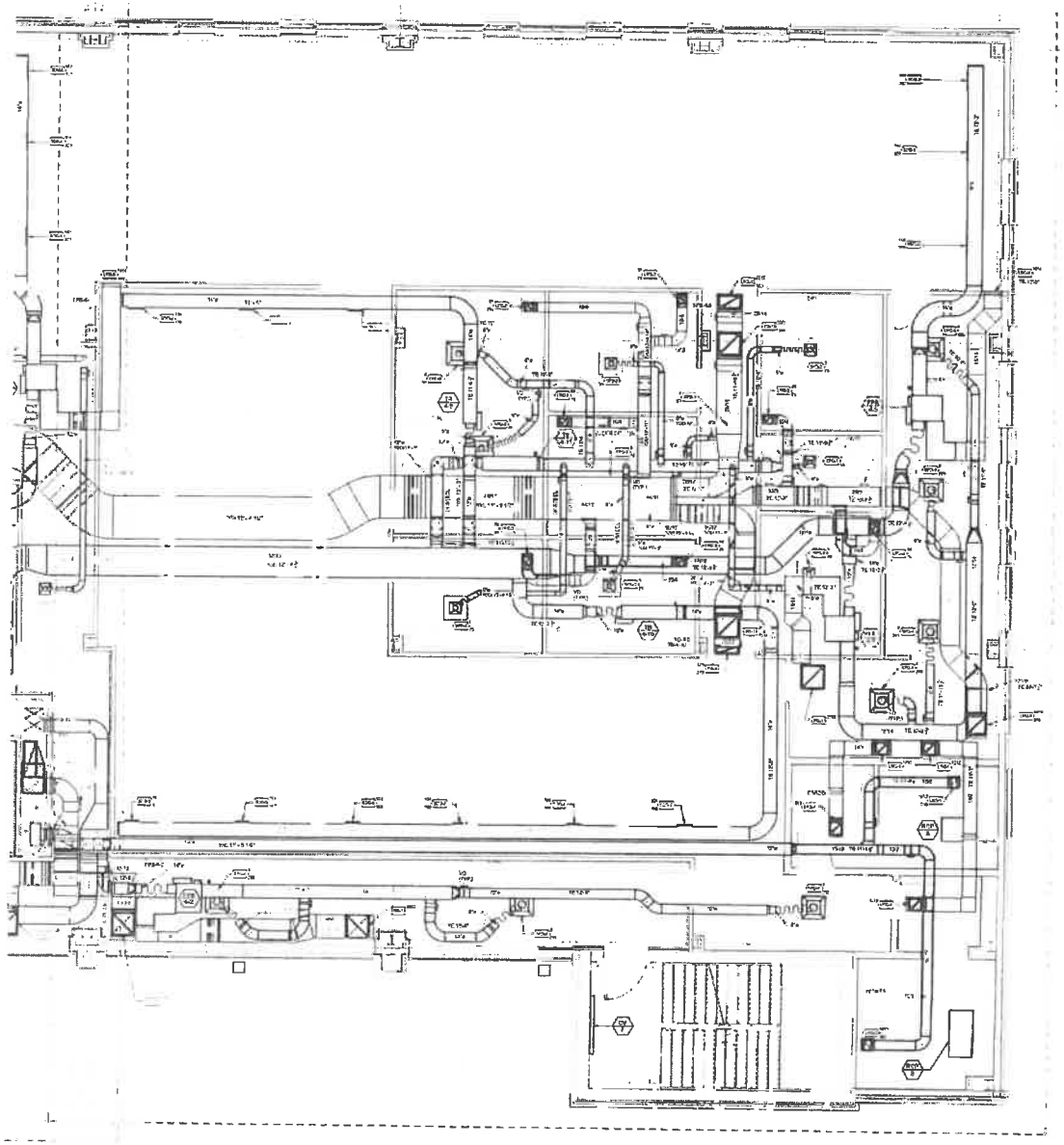
SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M6



FOURTH FLOOR PLAN HVAC

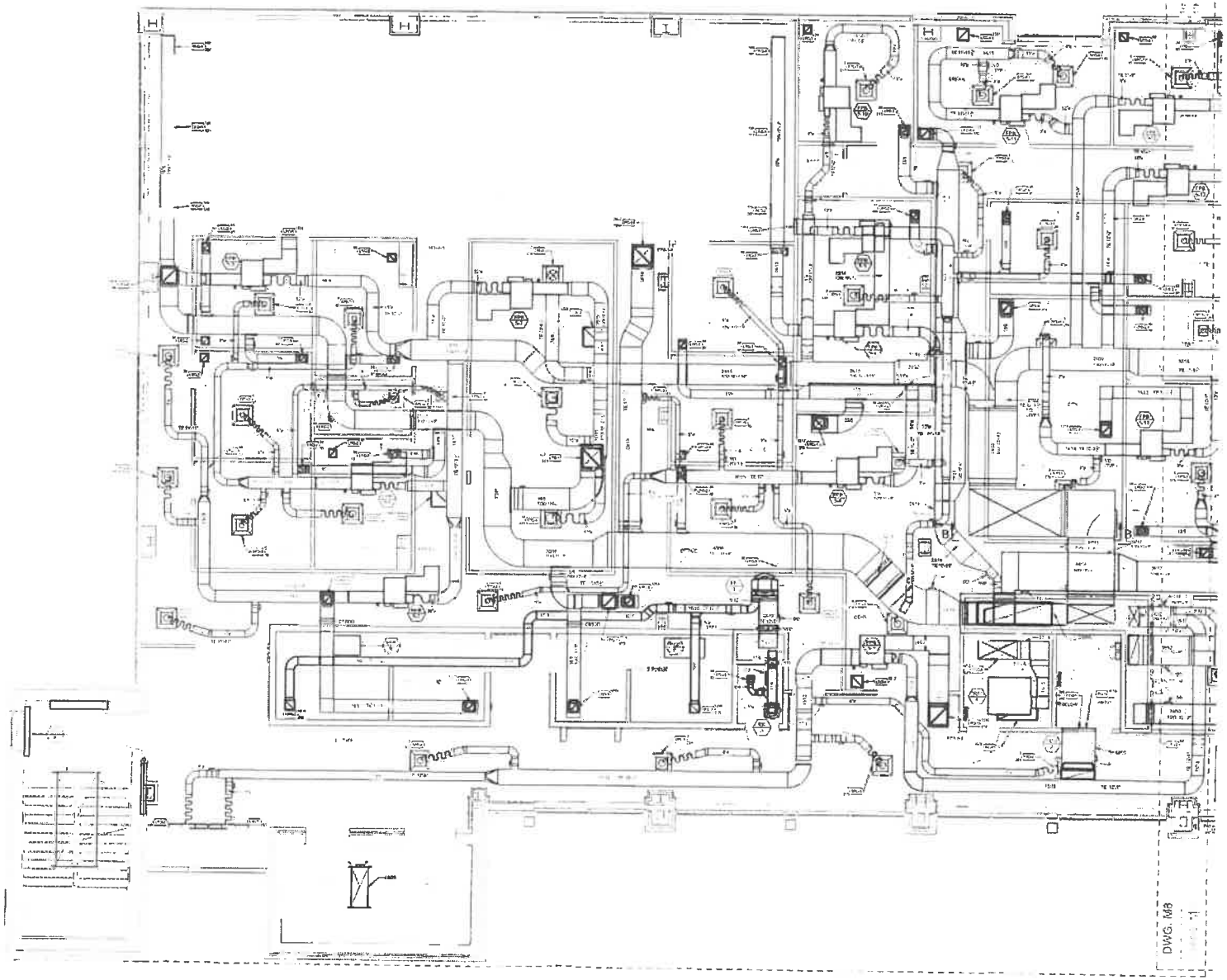
SCALE 1/4"=1'-0"

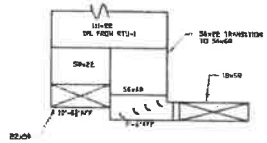
NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M7





SECTION B–B

FIFTH FLOOR PLAN HVAC

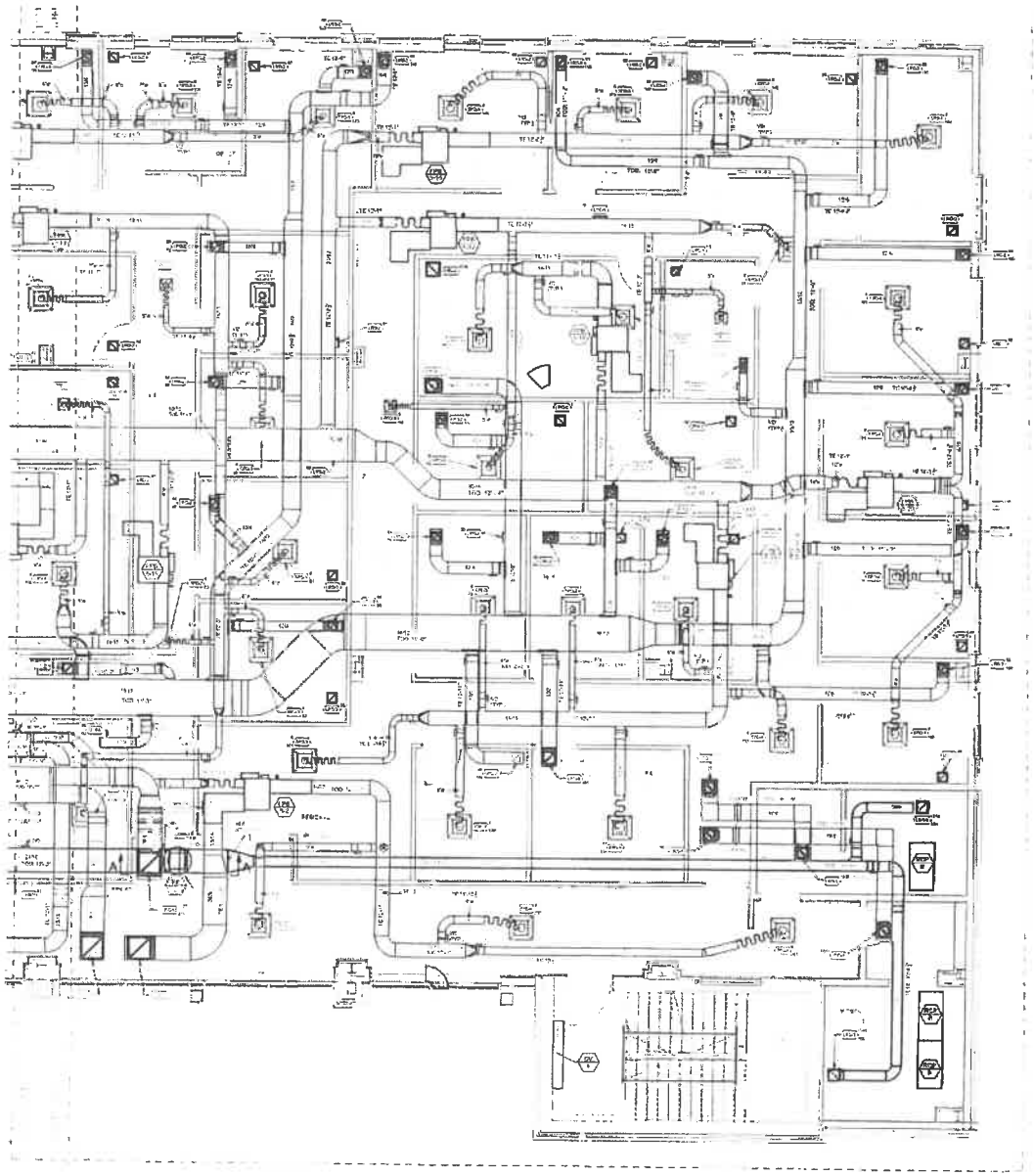
SCALE 1/4"=1'-0"

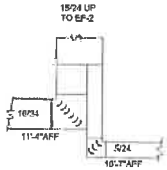
NO	DESCRIPTION	DATE
1	-	

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

MB





SECTION A–A

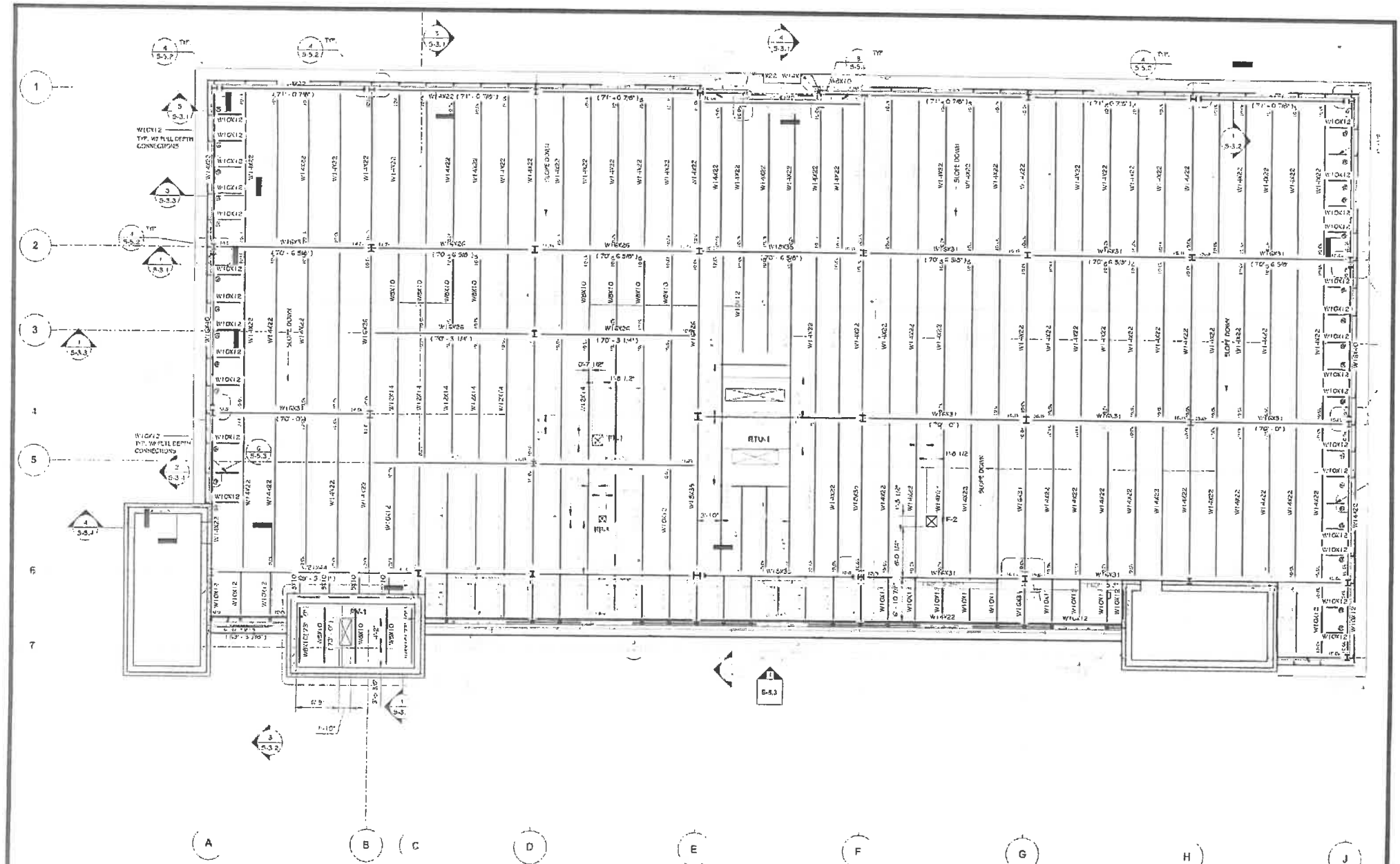
FIFTH FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV



ROOF PLAN

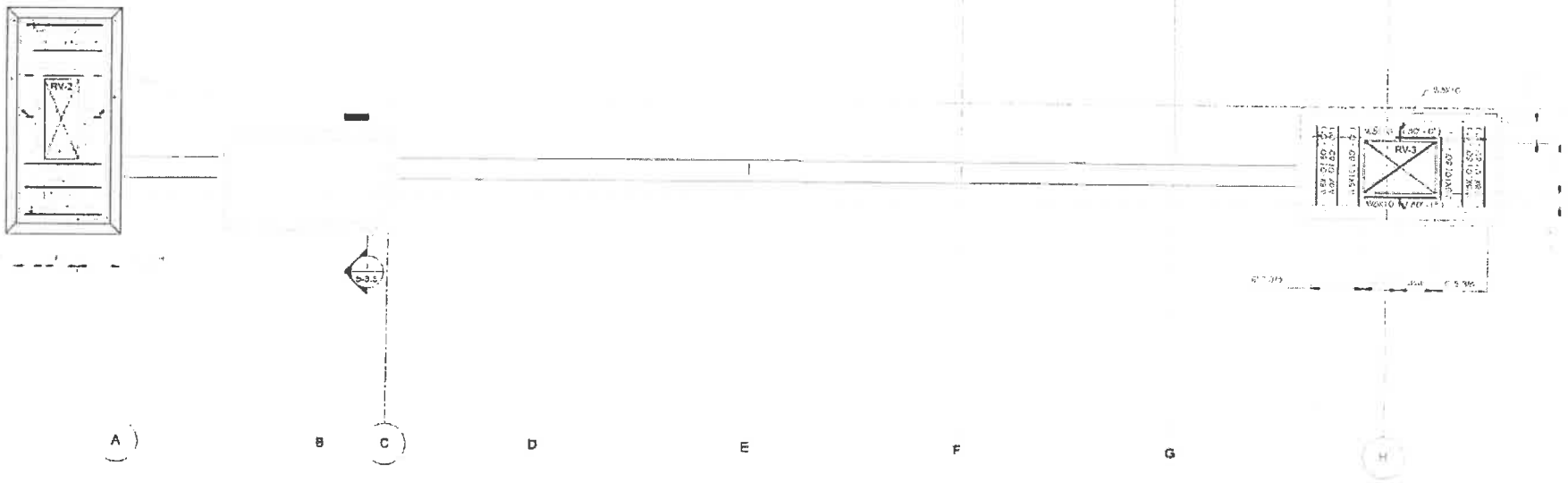
SCALE 1/4"=1'-0"

NOTE
OPENING DIMENSIONS ARE FOR
INSIDE CLEARANCES

NEW STATE OFFICE
BUILDING FAIRMOUNT

FAIRMONT, WV

RO 1



NOTE
OPENING DIMENSIONS ARE FOR INSIDE CLEARANCES

ROOF PLAN

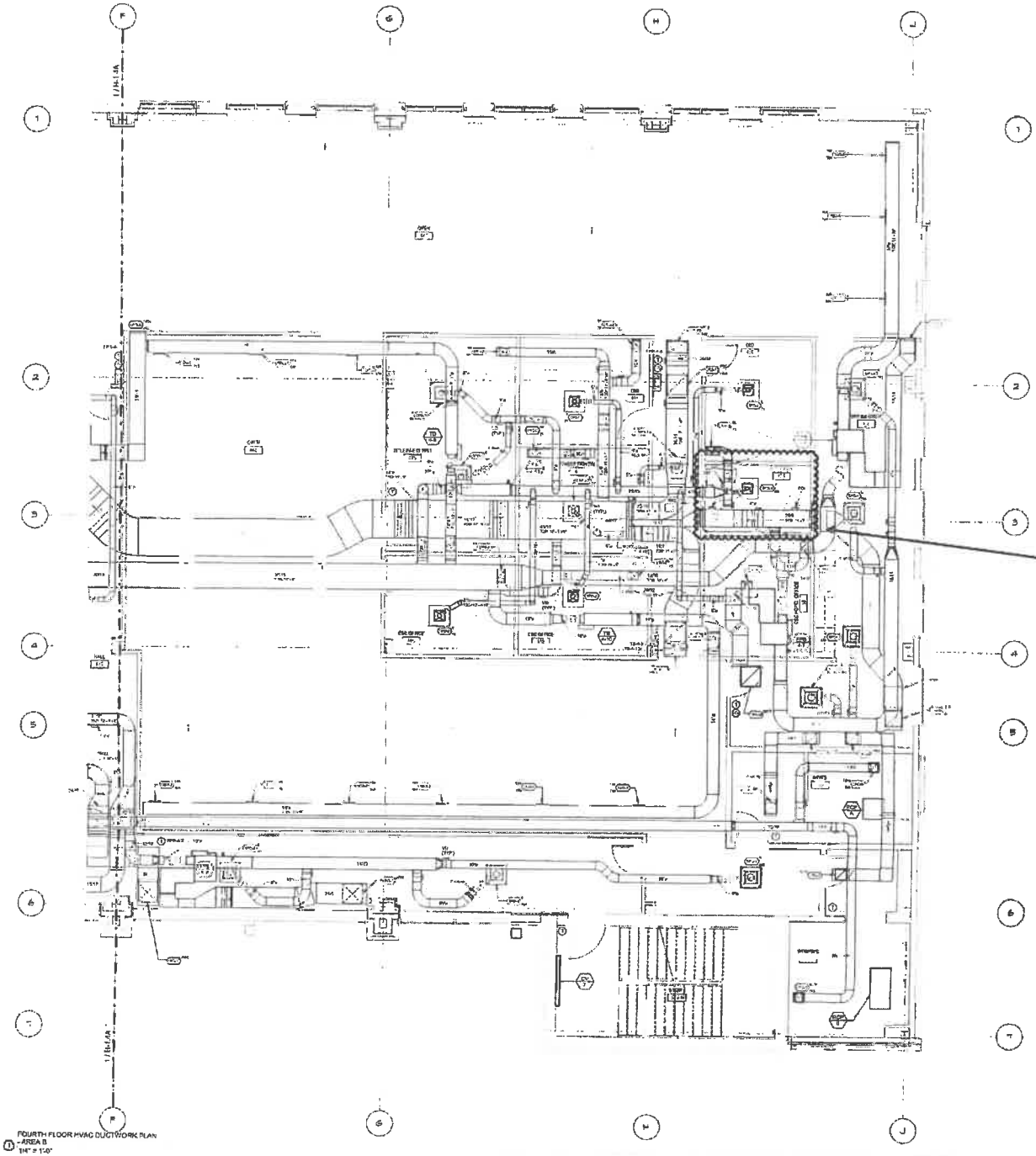
SCALE 1/4"=1'-0"

N

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

RO 2



FOURTH FLOOR HVAC DUCTWORK PLAN
1 - AREA B
1/4" = 1'-0"

NEW STATE OFFICE
BUILDING + FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

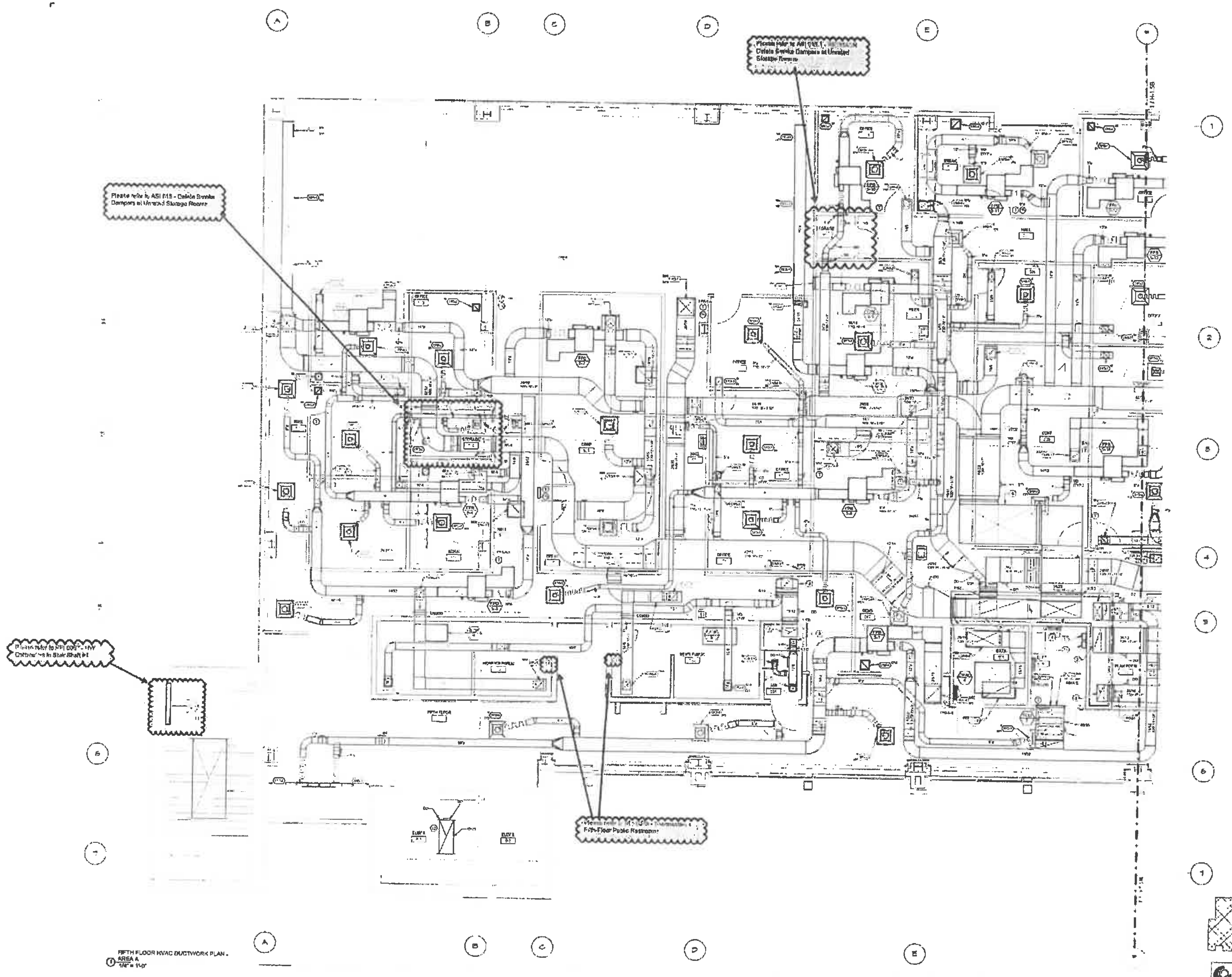
BID DOCUMENTS

A B

FOURTH FLOOR HVAC DUCTWORK PLAN - AREA B

TOWER ENGINEERING

H-1.4B



CODED NOTES - SHEET H-1.5A

1. 11/18 SA DUCT UP FROM FLOOR BELOW. TRANSITION DUCT INTO A 24/12 SA DUCT IN RISER AND CONTINUE TO SERVE FIFTH FLOOR. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
2. 32/12 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
3. 36/10 EA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
4. 36/22 SA DUCT DOWN TO FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
5. RA DUCT UP FROM FLOOR BELOW. TRANSITION THE RA RISER INTO A 44/28 RA DUCT. COMBINE THE 44/28 RA DUCT, THE 25/28 RA DUCT, AND THE RA DUCT INTO A SINGLE RA DUCT USING A DIVIDED FLOW FITTING. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. CONTINUE THE RA DUCT UP THROUGH ROOF TO ROOFTOP UNIT RTU-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY IN ROOF CURB AND MAKE FINAL CONNECTION TO RTU-1 RETURN AIR OPENING.
6. 111/22 SA DUCT DOWN FROM ROOFTOP UNIT RTU-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY IN ROOF CURB FROM RTU-1 SUPPLY AIR OPENING. SPLIT THE 111/22 SA DUCT INTO A 55/22 SA DUCT AND A 56/22 SA DUCT USING A DIVIDED FLOW FITTING.
7. 24/12 EA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
8. EA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
9. COMBINE A 22/11 EA DUCT AND A EA DUCT INTO A SINGLE 31/22 EA DUCT USING A DIVIDED FLOW FITTING AND CONTINUE THE 31/22 UP THROUGH ROOF TO EXHAUST FAN EF-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-1.
10. EA DUCT UP THROUGH ROOF TO EXHAUST FAN EF-3 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-3.
11. PLENUM GRILLE. DO NOT CONNECT TO DUCT ABOVE.
12. 48/20 OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-1 ON ROOF ABOVE. PROVIDE A SMOKE DAMPER AND DUCT MOUNTED SMOKE DETECTOR IN DUCT. DUCT SHALL BE WRAPPED IN FIRE RATED INSULATION.
13. VARIABLE FREQUENCY DRIVE (VFD) FOR SUPPLY FAN SF-1. COORDINATE INSTALLATION WITH THE ELECTRICAL DRAWINGS AND MOUNT VFD TO WALL.
14. VARIABLE FREQUENCY DRIVE (VFD) FOR SUPPLY FAN SF-2. COORDINATE INSTALLATION WITH THE ELECTRICAL DRAWINGS AND MOUNT VFD TO WALL.
16. OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-2 ON ROOF ABOVE. PROVIDE AN AUTOMATIC CONTROL DAMPER IN DUCT.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
FAIRMONT, WV

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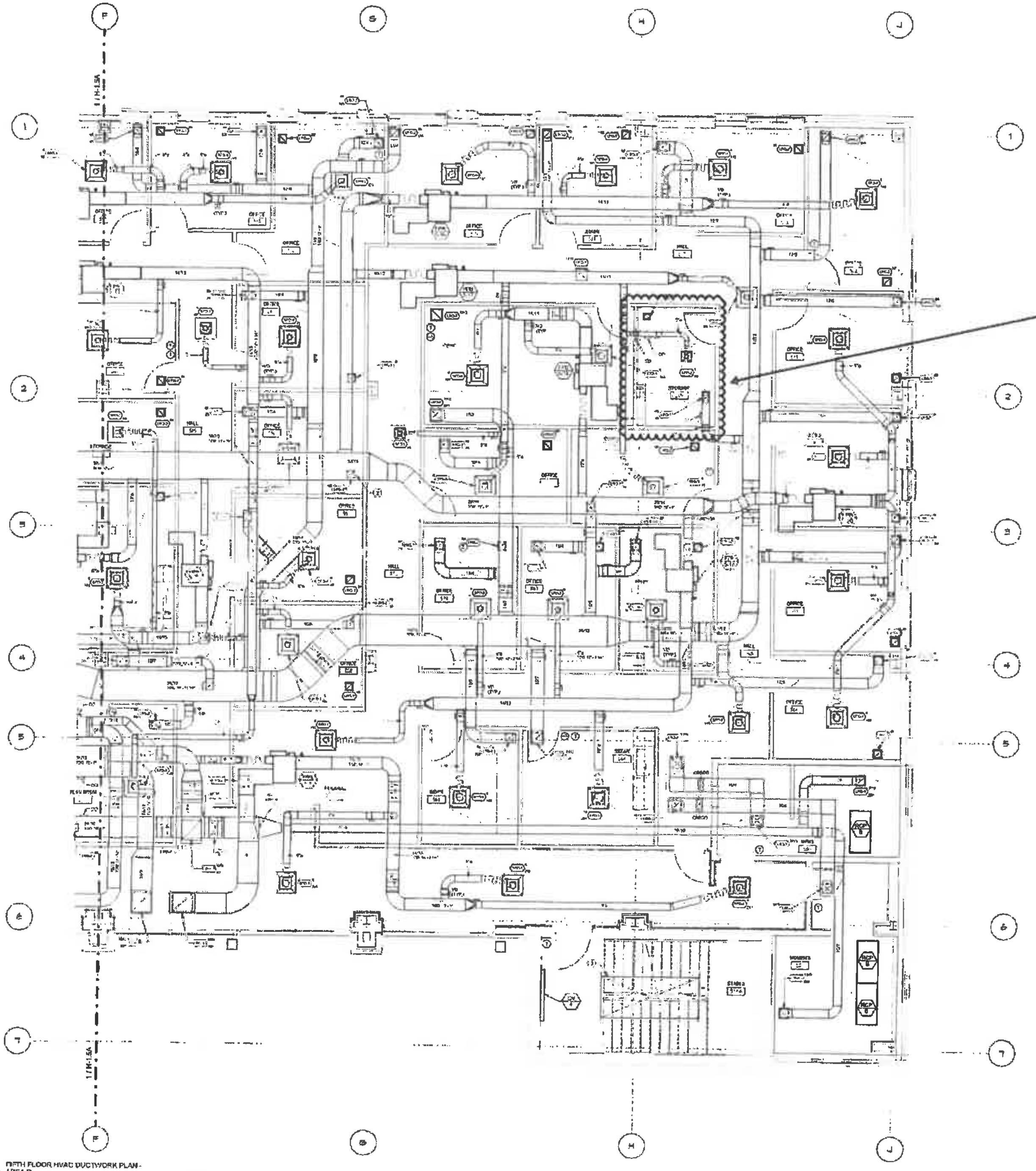
FIFTH FLOOR HVAC DUCTWORK PLAN - AREA A

TOWER ENGINEERING

H-1.5A

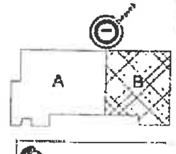
CODED NOTES - SHEET H-1.5B

1. COMBINE A 24/10 EA DUCT AND A 24/6 EA DUCT INTO A SINGLE 24/16 EA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 24/16 DUCT UP THROUGH ROOF TO EXHAUST FAN EF-2 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-2.
2. PLENUM GRILLE. DO NOT CONNECT TO DUCT ABOVE.
3. 48/14 OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-3 ON ROOF ABOVE. PROVIDE AN AUTOMATIC CONTROL DAMPER IN DUCT.



Please refer to ASI 015 - Delete Smoke Dampers at Unrated Storage Rooms

1 FIFTH FLOOR HVAC DUCTWORK PLAN - AREA B
1/4" = 1'-0"



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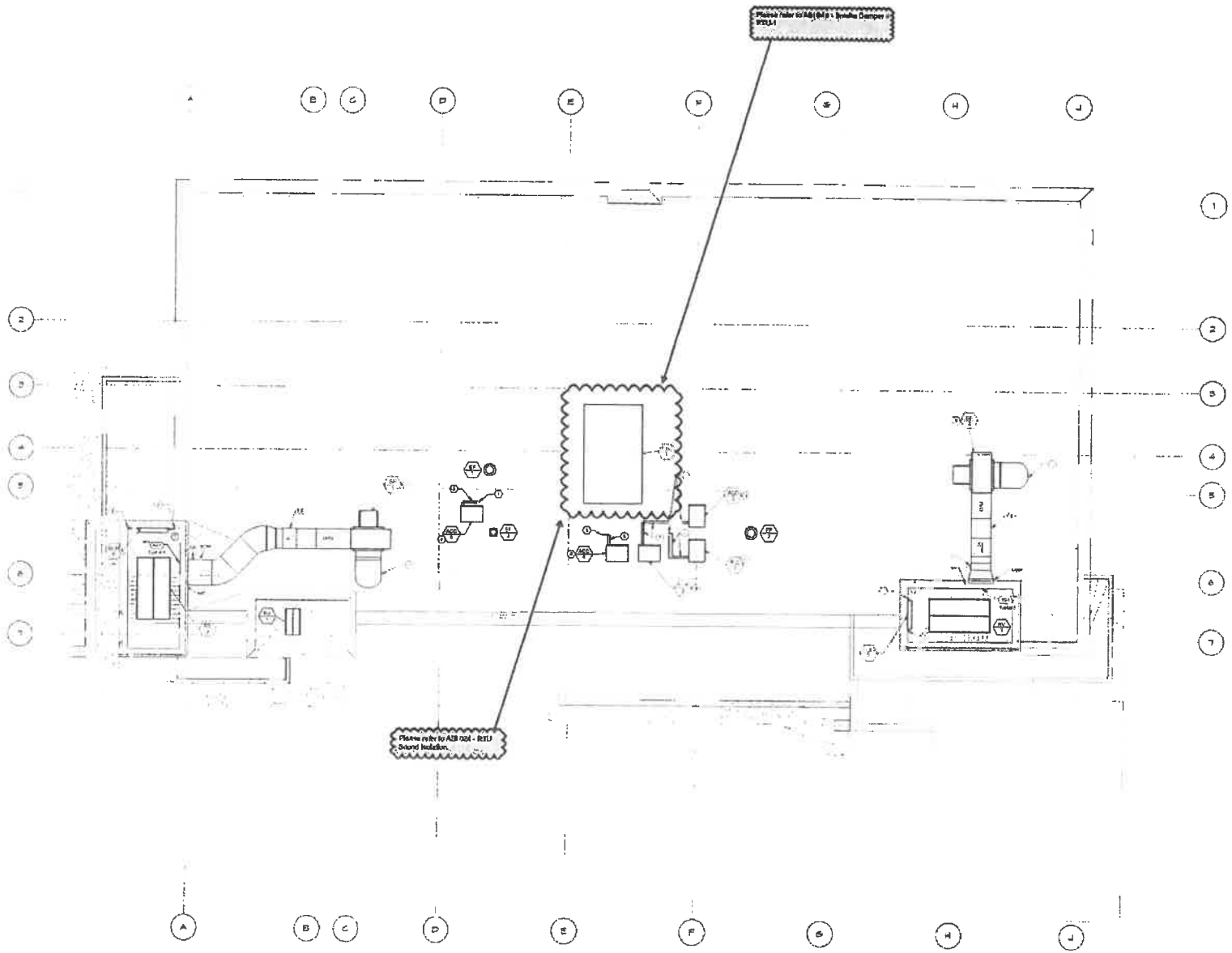
FIFTH FLOOR HVAC DUCTWORK PLAN - AREA B

TOWER ENGINEERING

H-1.5B



CODED NOTES - SHEET H-1.6

1. REFRIGERANT LIQUID AND SUCTION PIPING DOWN THROUGH ROOF TO FLOOR BELOW. PROVIDE PIPE PORTAL AT ROOF PENETRATION SIZE PIPING IN ACCORDANCE WITH THE EQUIPMENT MANUFACTURERS RECOMMENDATIONS. REFER TO DRAWING H2-5A FOR CONTINUATION OF PIPING.
2. 3/4" MWS AND WWS PIPING UP FROM FLOOR BELOW. REFER TO DRAWING H-2.5A FOR CONTINUATION OF PIPING.
3. 3/4" MWS AND WWS PIPING UP FROM FLOOR BELOW. REFER TO DRAWING H-2.5B FOR CONTINUATION OF PIPING.
4. MOUNT AIR COOLED CONDENSING UNIT ON EQUIPMENT RAILS. REFER TO HVAC DETAILS FOR REQUIREMENTS.
5. PROVIDE EQUIPMENT RAILS AND MOUNT PIPING TO RAIL. REFER TO HVAC DETAILS FOR REQUIREMENTS.
6. PROVIDE EQUIPMENT RAIL AND INSULATE DUCTWORK TO RAIL. REFER TO HVAC DETAILS FOR REQUIREMENTS.
7. EXPERIMENTAL 825 BTU/F DUCT ELBOWED DOWN AT A 45° ANGLE. PROVIDE BIRDSCREEN IN OPENING. TRANSITION DUCT AS NECESSARY AND CONNECT TO SUPPLY FAN.
8. MOUNT SUPPLY FAN ON EQUIPMENT RAILS. REFER TO HVAC DETAILS FOR REQUIREMENTS.

1 ROOF HVAC PLAN
1/8" = 1'-0"

NRW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
410 ROGERS STREET
FAIRMONT, WV

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03/02/2017

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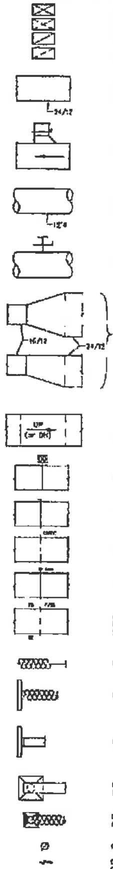
ROOF HVAC PLAN

TOWER ENGINEERING

H-1.6

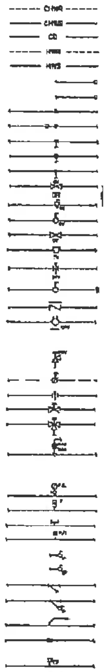
HVAC SYMBOLS & ABBREVIATIONS

SHEET METAL SYMBOLS



- SUPPLY AIR DUCT TURNED UP
- SUPPLY AIR DUCT TURNED DOWN
- RETURN, EXHAUST OR RELIEF AIR DUCT TURNED UP
- RETURN, EXHAUST OR RELIEF AIR DUCT TURNED DOWN
- RECTANGULAR DUCT. DIMENSION IS FREE AREA. FOR LINED DUCT ADD 1-1/2 INCHES TO EACH DIMENSION TO GET OUTSIDE DIMENSION OF SHEET METAL. (1ST FIGURE, SIDE SHOWN; 2ND FIGURE, SIDE NOT SHOWN.)
- RECTANGULAR MAIN DUCT WITH 45° CLINCH COLLAR, AND VOLUME DAMPER IN SUB-DUCT. (PER SMACNA DUCT CONSTRUCTION STANDARDS)
- ROUND DUCT. SINGLE WALL. FOR DOUBLE WALL DUCT REQUIREMENTS, SEE SPECIFICATION AND/OR SEE CODED NOTES ON PLANS.
- ROUND MAIN DUCT WITH 90° TAP OR 90° SADDLE TAP AND VOLUME DAMPER IN SUB-DUCT. (PER SMACNA DUCT CONSTRUCTION STANDARDS)
- TRANSITIONS. GIVE SIZES. NOTE F.O.T. (FLAT ON TOP), OR F.O.B. (FLAT ON BOTTOM) IF APPLICABLE.
- INCLINED RISE (UP) OR DROP (DN) ARROW IN DIRECTION OF AIR FLOW
- DUCT MOUNTED SMOKE DETECTOR
- VOLUME DAMPER
- COUNTER BALANCED BACKDRAFT DAMPER (CBBDD)
- AUTOMATIC AIR DAMPER
- FIRE DAMPER (FD) FIRE/SMOKE DAMPER (F/SD) SMOKE DAMPER (SD)
- FLEXIBLE DUCT
- FLEXIBLE DUCT CONNECTION TO LINEAR SLOT DIFFUSER
- ROUND HARD METAL DUCT CONNECTION TO LINEAR SLOT DIFFUSER
- FLEXIBLE DUCT OR ROUND HARD METAL DUCT CONNECTION, WITH NO 90° ELBOW, TO SQUARE DIFFUSER.
- DIRECTION DIFFUSER (SLD). DARKENED QUADRANT(S) NO AIR FLOW. 3-WAY FLOW SHOWN
- ROUND DUCT
- DIRECTION OF AIR FLOW IN OR OUT OF EQUIPMENT OR AN AIR TERMINAL DEVICE.

PIPING SYMBOLS



- CHILLED WATER RETURN
- CHILLED WATER SUPPLY
- COIL CONDENSATE DRAIN
- HOT WATER RETURN
- HOT WATER SUPPLY
- PIPING TURNED UP
- PIPING TURNED DOWN
- 90° RISE OR DROP IN PIPE
- 45° RISE OR DROP IN PIPE
- PIPE TAKEOFF FROM TOP OF MAIN
- PIPE TAKEOFF FROM BOTTOM OF MAIN
- PIPE TAKEOFF FROM SIDE OF MAIN
- GATE VALVE
- BALL VALVE
- GLOBE VALVE
- PLUG VALVE
- BUTTERFLY VALVE
- DRAIN VALVE WITH HOSE CONNECTION (HOSE CONNECTION)
- CHECK VALVE
- FLOW CONTROL VALVE WITH GPM INDICATED WHEN LOCATED IN MAINS OR SERVING MULTIPLE UNITS. WHEN SERVING SINGLE-UNIT, REFER TO EQUIPMENT SCHEDULES.
- PRESSURE RELIEF VALVE
- PRESSURE REDUCING VALVE WITH BUILT-IN CHECK VALVE
- UNION
- TWO-WAY CONTROL VALVE
- THREE-WAY CONTROL VALVE
- AIR VENT. INSTALL AT ALL HIGH POINTS IN SYSTEM. AAV=AUTOMATIC. MAV=MANUAL. EXTEND DRAIN LINE FROM ALL AUTOMATIC AIR VENTS TO NEAREST CONDENSATE DRAIN LINE OR SAFE WASTE.
- PRESSURE GAUGE AND COCK
- THERMOMETER
- WELL IN PIPING
- PRESSURE/TEMPERATURE PORT
- HOSE BIBB
- HOSE BIBB W/CAP
- STRAINER
- STRAINER WITH BLOWDOWN AND HOSE CONNECTION (HOSE BIBB)
- DIRECTION OF PIPE SLOPE (DOWN)
- DIRECTION OF FLOW IN PIPE
- FLOW SWITCH

GENERAL DRAWING SYMBOLS

- CODED NOTE
  'NO' DENOTES SEQUENTIAL ALPHANUMERIC DESIGNATION
- EQUIPMENT TAG
  (REFER TO APPROPRIATE SCHEDULE)
  'ID' DENOTES EQUIPMENT TYPE (I.E. EF=EXHAUST FAN)
  'FL' DENOTES FLOOR EQUIPMENT IS LOCATED ON
  'NO' DENOTES SEQUENTIAL ALPHANUMERIC DESIGNATION
- DIFFUSER, REGISTER, GRILLE TAG
  (REFER TO APPROPRIATE SCHEDULE)
  'ID' DENOTES DIFFUSER, REGISTER, GRILLE TYPE
  (I.E. SCD=SQUARE CONE DIFFUSER)
  'SZ' DENOTES NECK SIZE AND BLOW PATTERN
  (I.E. 12Ø=12"Ø OR 12"x12" NECK WITH 3-WAY BLOW PATTERN)
  'CFM' INDICATES AIR FLOW RATE IN CFM
  OBD INDICATES THAT AN OPPOSED BLADE DAMPER SHALL BE PROVIDED
  (I.E. WHEN OBD NOT SHOWN, NO OPPOSED BLADE DAMPER SHALL BE PROVIDED)
- SECTION INDICATOR
  'NO' DENOTES SEQUENTIAL ALPHABETIC DESIGNATION
  'D1' DENOTES DRAWING ON WHICH SECTION CUT
  'D2' DENOTES DRAWING ON WHICH SECTION IS LOCATED
- REVISION INDICATOR
  'NO' DENOTES REVISION LEVEL

CONTROL SYMBOLS

- HUMIDISTAT OR HUMIDITY SENSOR
- THERMOSTAT OR TEMPERATURE SENSOR
- CARBON MONOXIDE SENSOR
- CARBON DIOXIDE SENSOR

GENERAL NOTES: (ALL DRAWINGS)

A. UNLESS CONDITIONS DO NOT PERMIT, ALL RADIUSED ELBOWS SHOWN ON THE DRAWINGS SHALL BE PROVIDED. WHERE CONDITIONS DO NOT PERMIT, MITERED RECTANGULAR ELBOWS WITH TURNING VANES MAY BE PROVIDED IN LIEU OF RADIUSED ELBOWS. THE RADIUSED RECTANGULAR ELBOWS SHALL HAVE A RADIUSED HEEL AND A RADIUSED THROAT, AND SHALL HAVE A CENTERLINE RADIUS NOT LESS THAN 1.5 TIMES THE DUCT WIDTH.

B. ALL MITERED RECTANGULAR DUCT ELBOWS HAVING AN ANGLE GREATER THAN 45° SHALL BE PROVIDED WITH TURNING VANES.

C. DUCTWORK SHALL NOT BE INSTALLED ABOVE ELECTRICAL PANELS. COORDINATE DUCTWORK WITH ELECTRICAL CONTRACTOR.

D. FINAL THERMOSTAT, SENSOR, AND EXHAUST FAN SWITCH LOCATIONS MUST BE APPROVED BY THE ARCHITECT AND OWNER PRIOR TO INSTALLATION.

E. DUCT DETECTORS SHALL BE PROVIDED BY THE E.C. AND MOUNTED BY THE H.C. THE E.C. SHALL PROVIDE ALL POWER WIRING AND FIRE ALARM CONTROL WIRING FOR THE DETECTORS. THE H.C. SHALL PROVIDE ALL FAN SHUTDOWN CONTROL WIRING.

F. THE HVAC CONTRACTOR SHALL PROVIDE ACCESS PANELS FOR ALL EQUIPMENT INSTALLED ABOVE INACCESSIBLE CEILINGS AND INSTALLED WITHIN DRYWALL BULKHEADS, WALLS, ETC. THAT REQUIRES ACCESS SUCH AS BALANCING VALVES, EQUIPMENT, SWITCHES, ETC. THE CONTRACTOR SHALL COORDINATE THE LOCATION OF ACCESS PANELS WITH ALL OTHER TRADES AND THE ARCHITECT.

ABBREVIATIONS

ACC	AIR COOLED CONDENSER
AAD	AUTOMATIC AIR DAMPER
AD	ACCESS DOOR
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
AP	ACCESS PANEL
AS	AIR SEPARATOR
ATC	AUTOMATIC TEMPERATURE CONTROL
B	BOILER
BDD	BACK-DRAFT DAMPER
BFP	BACK-FLOW PREVENTER
BFV	BUTTERFLY VALVE
BJ	BETWEEN JOISTS / BEAMS
BL STL	BLACK STEEL
BTUH	BRITISH THERMAL UNITS/HOUR
BV	BALL VALVE
C	CHILLER
CC	COOLING COIL
CD	COIL CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CLG	CEILING
CO	CLEAN OUT
CUH	CABINET UNIT HEATER
CV	CONNECTOR
DB	DRY BULB
DD	DUCT MOUNTED SMOKE DETECTOR
DN	DOWN
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE (°F)
EF	EXHAUST FAN
ESP	EXTERNAL STATIC PRESSURE
ET	EXPANSION TANK
FD	FIRE DAMPER
F/S D	FIRE AND SMOKE DAMPER
FCU	FAN COIL UNIT
FPB	FAN POWERED BOX
GC	GENERAL CONTRACTOR
GFU	GLYCOL FEED UNIT
GPM	GALLONS PER MINUTE
GV	GATE VALVE
H	HUMIDISTAT OR HUMIDITY SENSOR
HB	DRAIN VALVE WITH HOSE CONNECTION (HOSE BIBB)
HC	HVAC CONTRACTOR
HVAC	HEATING, VENTILATING & AIR CONDITIONING
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
KW	KILOWATT
L	LOUVER OR LIQUID (REFRIGERANT)
LAT	LEAVING AIR TEMPERATURE (°F)
LSD	LINEAR SLOT DIFFUSER
LSR	LINEAR SLOT RETURN
MAX	MAXIMUM
MBH	1000 BTUH
MANUF	MANUFACTURER
MIN	MINIMUM
OA	OUTDOOR AIR
OBD	OPPOSED BLADE DAMPER
P	PUMP
PC	PLUMBING CONTRACTOR
PD	PRESSURE DROP
PG	PRESSURE GAUGE
PRV	PRESSURE RELIEF VALVE
PV	PLUG VALVE
RA	RETURN AIR
RCD	ROUND CONE DIFFUSER
RCP	RADIANT CEILING PANEL (HOT WATER)
RL	REFRIGERANT LIQUID
RPM	REVOLUTIONS PER MINUTE
RS	REFRIGERANT SUCTION
SA	SUPPLY AIR
SCD	SQUARE CONE DIFFUSER (4-WAY BLOW PATTERN)
SD	SMOKE DAMPER
SF	SUPPLY FAN
SLD	SQUARE DIRECTIONAL DIFFUSER
SPD	SQUARE PLAQUE DIFFUSER
ST STL (SS)	STAINLESS STEEL
T	THERMOSTAT OR TEMPERATURE SENSOR
TB	TERMINAL BOX
TDV	TRIPLE DUTY VALVE
TJ	THRU JOISTS
UH	UNIT HEATER
VEL	VELOCITY
VFD	VARIABLE FREQUENCY DRIVE
VOL D (VD)	VOLUME DAMPER
WB	WET BULB

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
FAIRMONT, WV

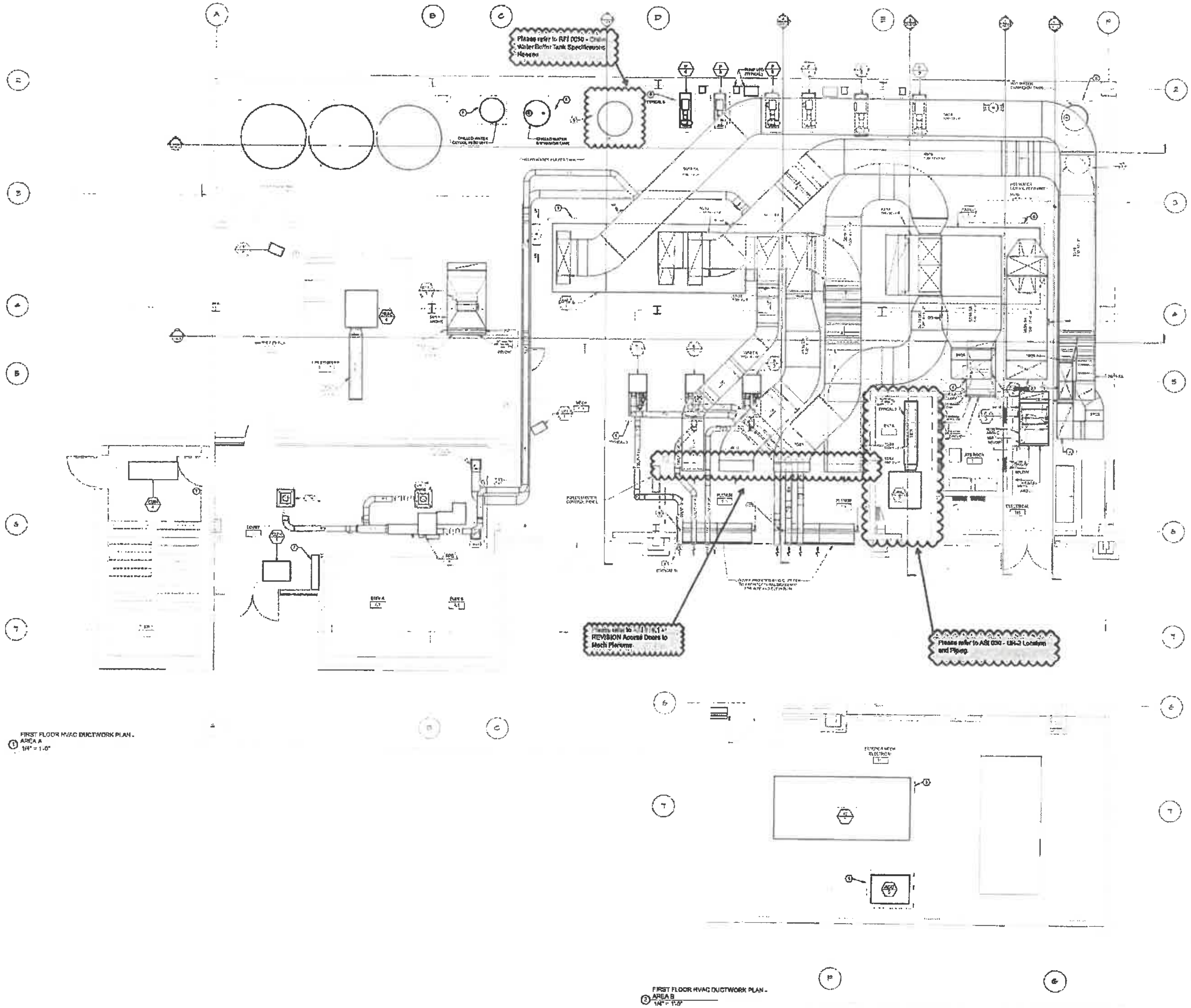
BID DOCUMENTS
3/08/2013

TOWER ENGINEERING

Project Number 201123

HVAC SYMBOLS AND ABBREVIATIONS

H-1.0



① FIRST FLOOR HVAC DUCTWORK PLAN - AREA A
1/4" = 1'-0"

② FIRST FLOOR HVAC DUCTWORK PLAN - AREA B
1/4" = 1'-0"

CODED NOTES - SHEET H-1.1

1. COMBINE A 10/25 RA DUCT RISER AND A 25/19 RA DUCT RISER INTO A SINGLE 51/19 RA DUCT RISER USING A DIVIDED FLOW FITTING. CONTINUE DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
2. 50/22 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. SPLIT THE 50/22 RA DUCT INTO A 25/22 RA DUCT AND A 25/22 RA DUCT USING A DIVIDED FLOW FITTING. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
3. [illegible] RA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
4. [illegible] RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
5. [illegible] CONCRETE EQUIPMENT PAD. EXTEND PAD [illegible] BEYOND ALL FOUR SIDES OF EQUIPMENT. REFER TO CONCRETE PAD (ON GRADE) DETAIL ON DRAWING H-4.1.
6. [illegible] CONCRETE EQUIPMENT PAD. EXTEND PAD [illegible] BEYOND ALL FOUR SIDES OF EQUIPMENT. REFER TO CONCRETE PAD DETAIL ON DRAWING H-4.1.
7. FIRE FIGHTERS' SMOKE CONTROL STATION. MOUNT BOTTOM OF [illegible] TO WALL [illegible] AFF.
8. BOILER FLUE AND COMBUSTION AIR DUCTS SHALL TERMINATE THROUGH SIDEWALL ABOVE LOUVERS. TERMINATE DUCTS WITH AN APPROVED WALL CAP AND THIMBLE FURNISHED BY THE BOILER MANUFACTURER. REFER TO ARCHITECTURAL DRAWINGS FOR ELEVATIONS.
9. PROVIDE A [illegible] AUTOMATIC AIR DAMPER ASSOCIATED WITH AHU-1. MOUNT DAMPER IN DUCT SLEEVE ATTACHED TO LOUVER.
10. PROVIDE A [illegible] AUTOMATIC AIR DAMPER ASSOCIATED WITH AHU-2. MOUNT DAMPER IN DUCT SLEEVE ATTACHED TO LOUVER.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
[illegible] STREET
FAIRMONT, WV

BID DOCUMENTS
[illegible]

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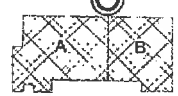
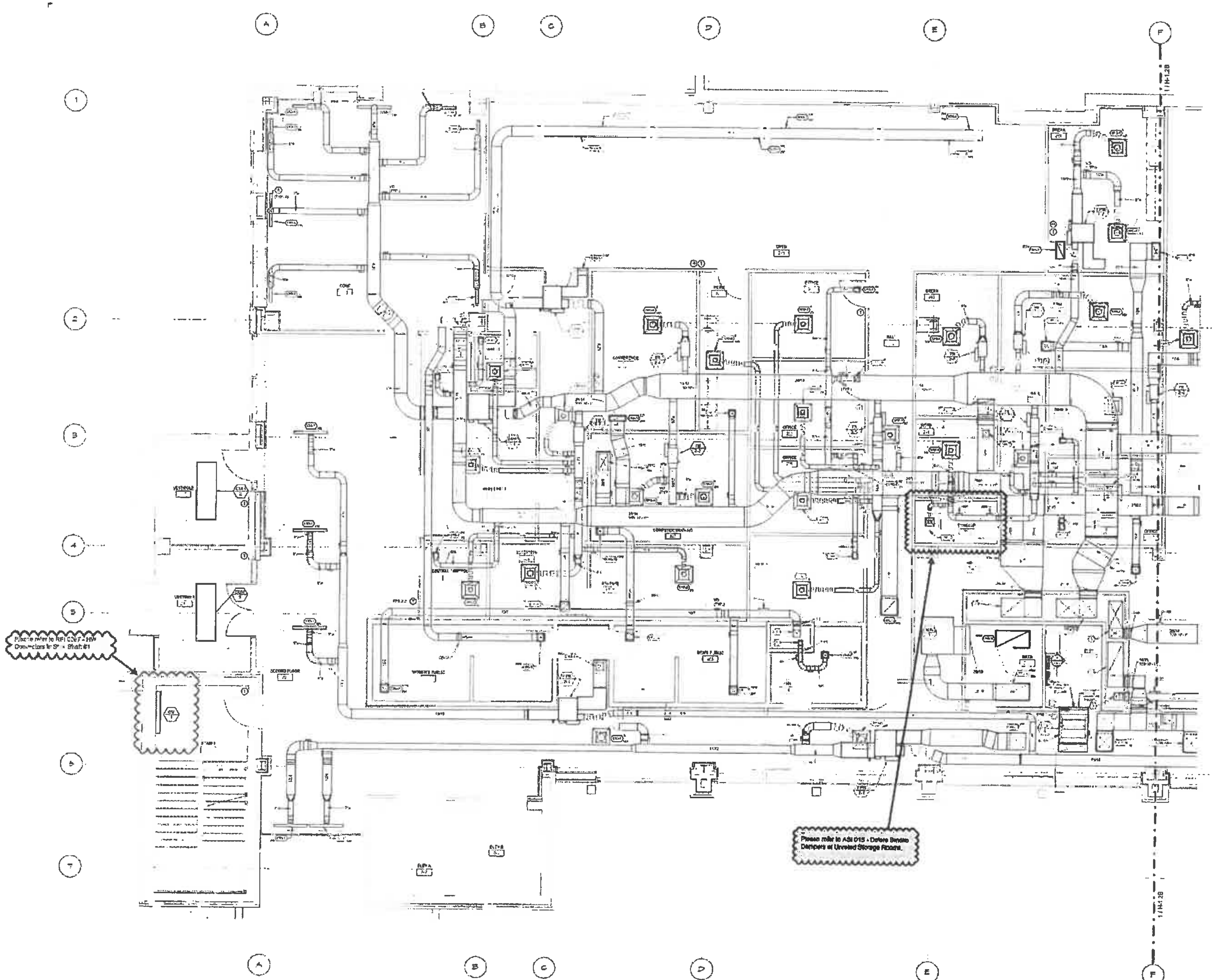


FIRST FLOOR HVAC DUCTWORK PLAN

H-1.1

TOWER ENGINEERING
[illegible], Pittsburgh, Pennsylvania [illegible]
Phone [illegible]
Fax [illegible]

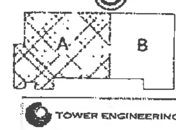
Project Number [illegible]



SECOND FLOOR HVAC DUCTWORK PLAN
1 - AREA A
1/8" = 1'-0"

CODED NOTES - SHEET H-1.2A

1. [illegible] SA DUCT UP FROM FLOOR BELOW. SPLIT THE [illegible] SA DUCT INTO A [illegible] SA DUCT AND A [illegible] SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE [illegible] SA DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS H-1.3 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
2. [illegible] RA DUCT DOWN FROM FLOOR ABOVE. COMBINE THE [illegible] RA DUCT AND THE [illegible] RA DUCT INTO A SINGLE [illegible] RA DUCT USING A DIVIDED FLOW FITTING. TRANSITION THE [illegible] RA DUCT INTO A [illegible] RA DUCT IN RISER AND CONTINUE THE [illegible] RA DUCT DOWN TO FLOOR BELOW. REFER TO DRAWINGS H-1.1 AND H-1.1A FOR CONTINUATION OF DUCTWORK.
3. [illegible] EA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DWG. H-1.3A FOR CONTINUATION OF DUCT.
4. [illegible] SA DUCT UP FROM FLOOR BELOW. SPLIT THE [illegible] SA DUCT INTO A [illegible] SA DUCT AND A [illegible] SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE [illegible] SA DUCT UP TO FLOOR ABOVE. PROVIDE COMBINATION FIRE/SMOKE DAMPERS AT SHAFT PENETRATIONS. REFER TO DRAWINGS H-1.3 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
5. [illegible] RA DUCT DOWN FROM FLOOR ABOVE. COMBINE THE [illegible] RA DUCT AND THE [illegible] RA DUCT INTO A SINGLE [illegible] RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE [illegible] RA DUCT DOWN TO FLOOR BELOW. PROVIDE COMBINATION FIRE/SMOKE DAMPERS AT SHAFT PENETRATIONS. REFER TO DRAWINGS H-1.1 AND H-1.1A FOR CONTINUATION OF DUCTWORK.
6. [illegible] EA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.3A FOR CONTINUATION OF DUCT.
7. [illegible] EA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.3A FOR CONTINUATION OF DUCT.
8. [illegible] SUPPLY DUCT DOWN TO LINEAR SLOT DIFFUSER. PROVIDE CUSTOM PLENUM BOX AND ATTACH TO DIFFUSER. PLENUM BOX SHALL BE A MINIMUM 10-INCHES HIGH AND SHALL BE INSULATED. TRANSITION SUPPLY DUCT AS NECESSARY AND CONNECT TO TOP OF PLENUM BOX.



NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
[illegible] STREET
FAIRMONT, WV

BID DOCUMENTS
[illegible]

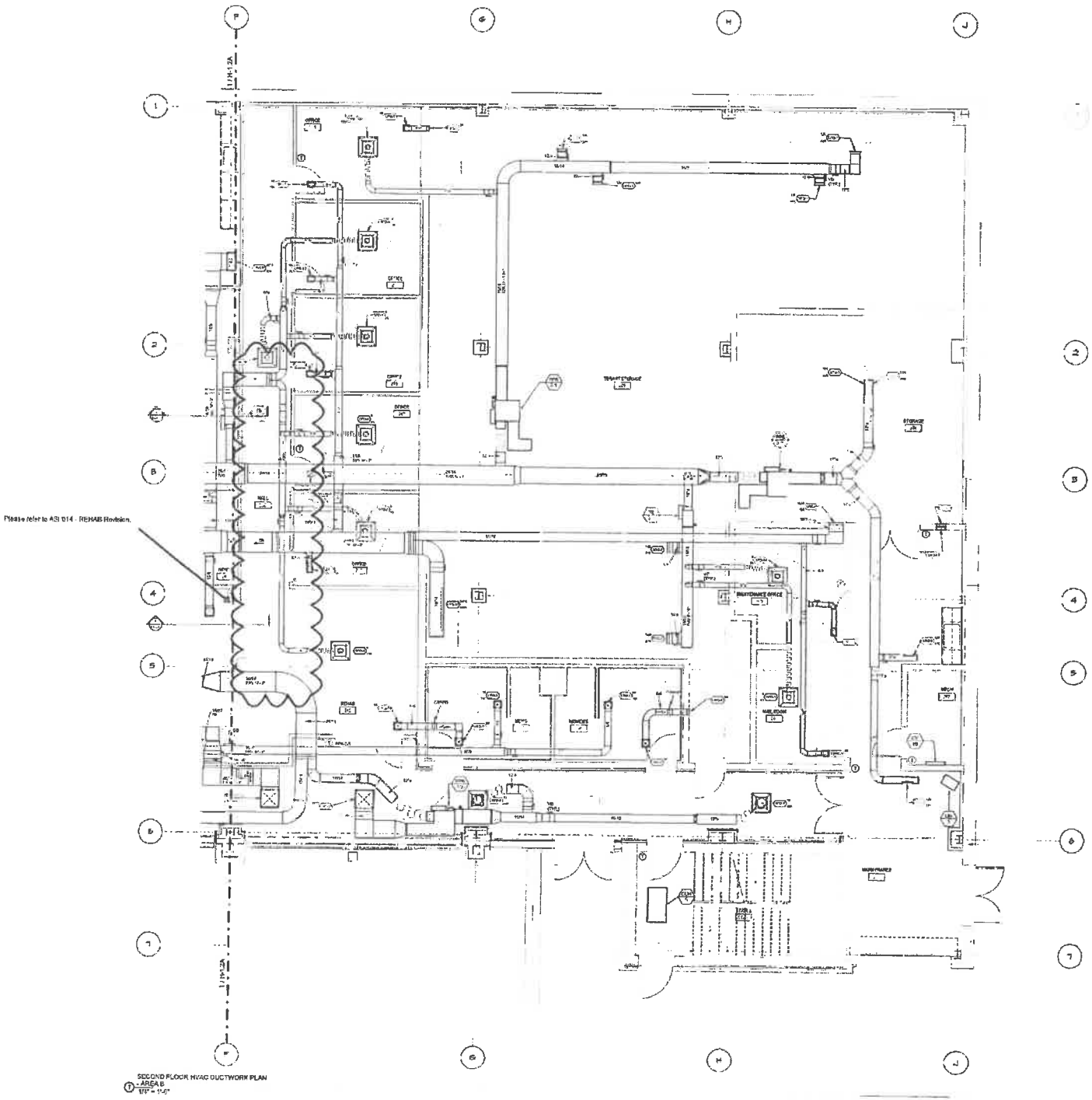
omni

TOWER ENGINEERING
[illegible]
Phone [illegible]
Fax [illegible]

Project Number [illegible]

SECOND FLOOR HVAC DUCTWORK PLAN - AREA A

H-1.2A



SECOND FLOOR HVAC DUCTWORK PLAN - AREA B
1/8" = 1'-0"

WWW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

BID DOCUMENTS
8/06/2013

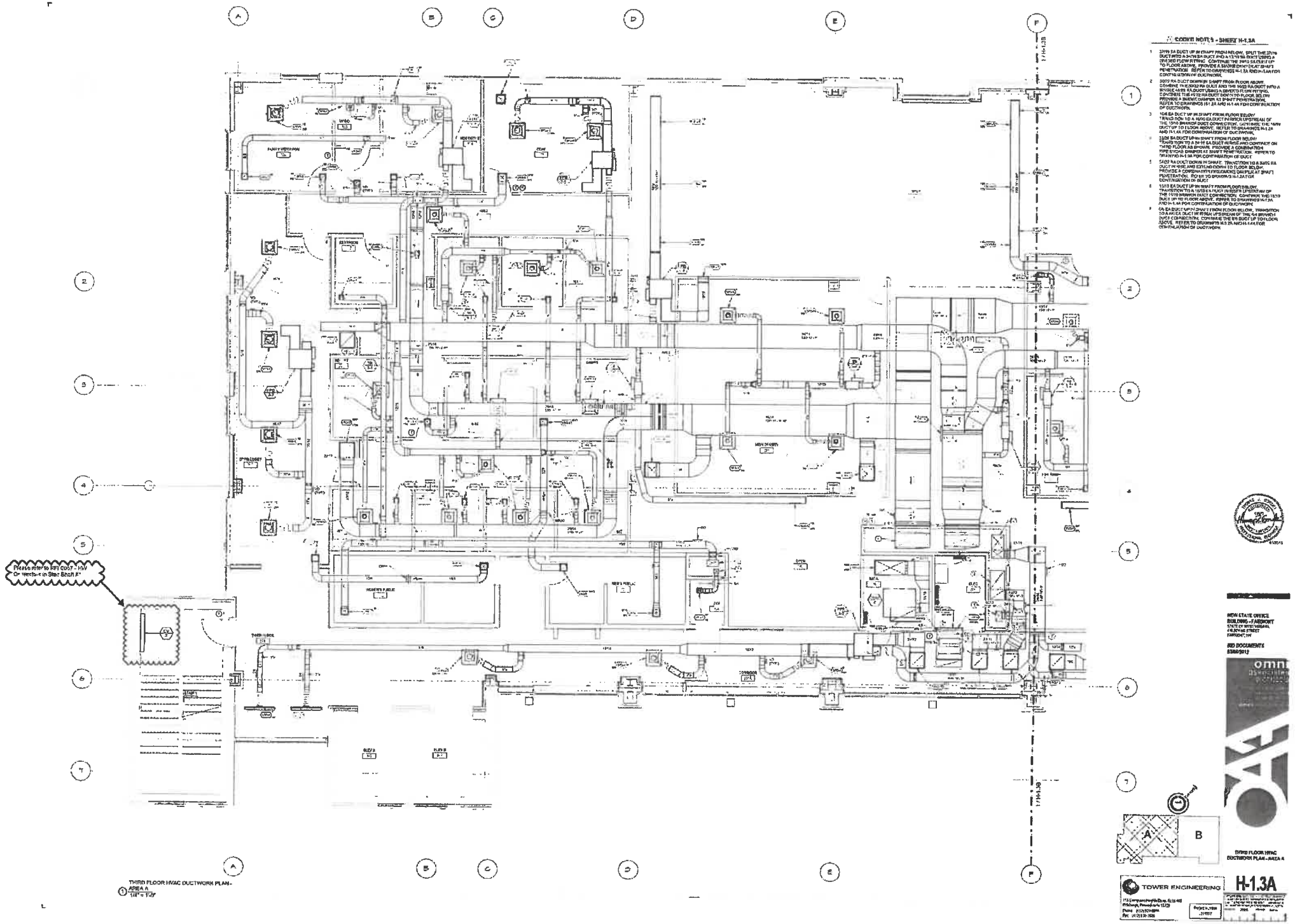
omni associates

A B

SECOND FLOOR HVAC DUCTWORK PLAN - AREA B

TOWER ENGINEERING

H-1.2B



KEYNOTES - SHEET H-1.3A

1. 37x9 SA DUCT UP IN SHAFT FROM BELOW, SPLIT THE 37x9 DUCT INTO A 24x18 SA DUCT AND A 13x18 SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 24x18 SA DUCT UP TO FLOOR ABOVE. PROVIDE A BARRIER DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS M-1.3A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
2. 30x22 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. COMBINE THE 30x22 RA DUCT AND THE 16x22 RA DUCT INTO A SINGLE 46x22 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 46x22 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A BARRIER DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS M-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
3. 10x6 EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION 10 A 16x10 EA DUCT IN RISER UPSTREAM OF THE 10x10 BRANCH DUCT CONNECTION. CONTINUE THE 16x10 DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS M-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
4. 12x06 SA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 24x18 SA DUCT IN RISER AND CONTINUE ON THIRD FLOOR AS SHOWN. PROVIDE A COMBINATION PIPE & DUCT BARRIER AT SHAFT PENETRATION. REFER TO DRAWING M-1.3A FOR CONTINUATION OF DUCT.
5. 54x22 RA DUCT DOWN IN SHAFT. TRANSITION 30 & 24x22 RA DUCT IN RISE AND EXTEND DOWN TO FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS M-1.2A FOR CONTINUATION OF DUCT.
6. 12x10 EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 16x10 EA DUCT IN RISER UPSTREAM OF THE 10x10 BRANCH DUCT CONNECTION. CONTINUE THE 16x10 DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS M-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
7. 6A EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 6A EA DUCT IN RISE UPSTREAM OF THE 6A BRANCH DUCT CONNECTION. CONTINUE THE 6A DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS M-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.

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STATE OF WEST VIRGINIA
416 JACKSON STREET
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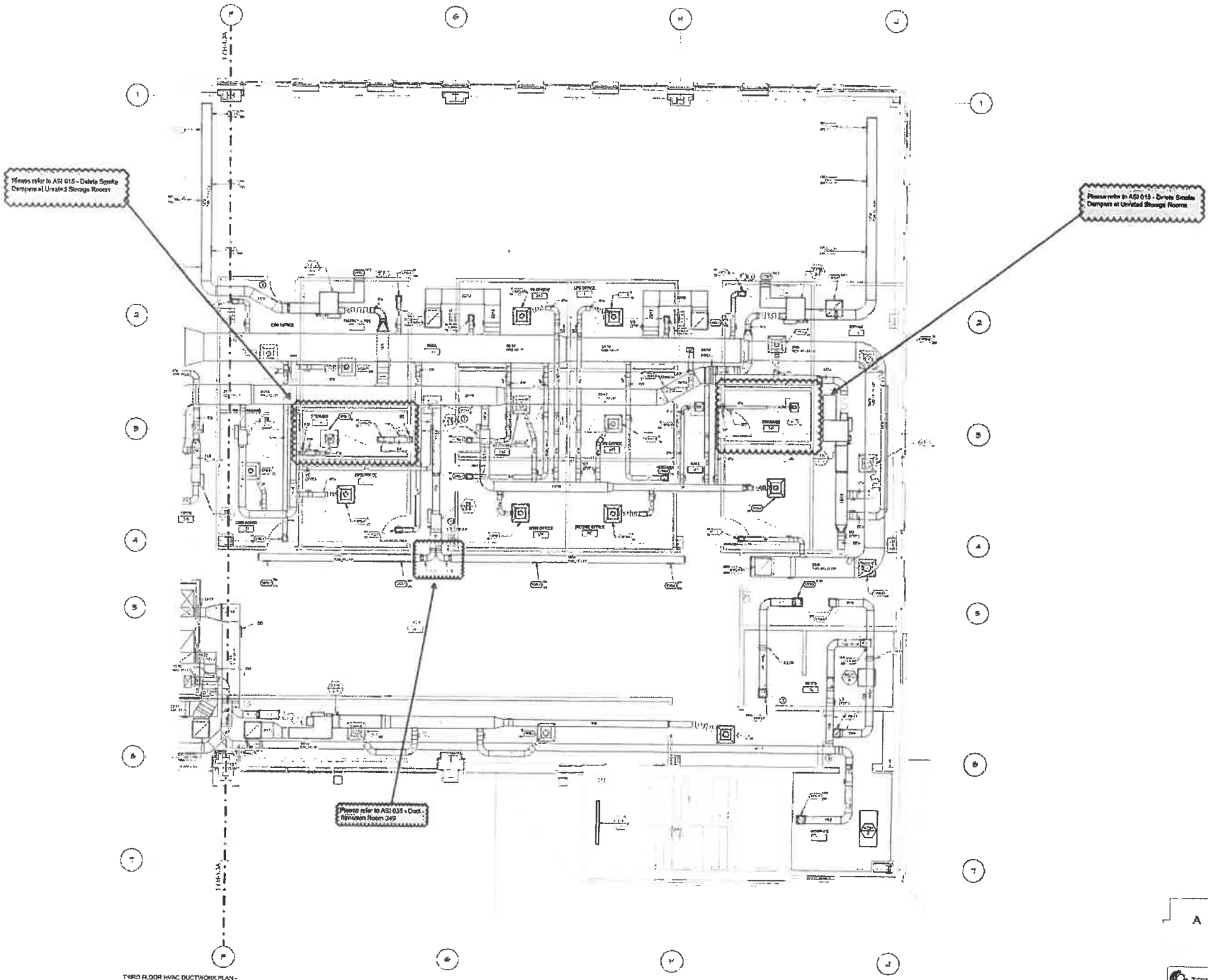
THIRD FLOOR HVAC DUCTWORK PLAN - AREA A

TOWER ENGINEERING

H-1.3A



THIRD FLOOR HVAC DUCTWORK PLAN - AREA B
1/4" = 1'-0"

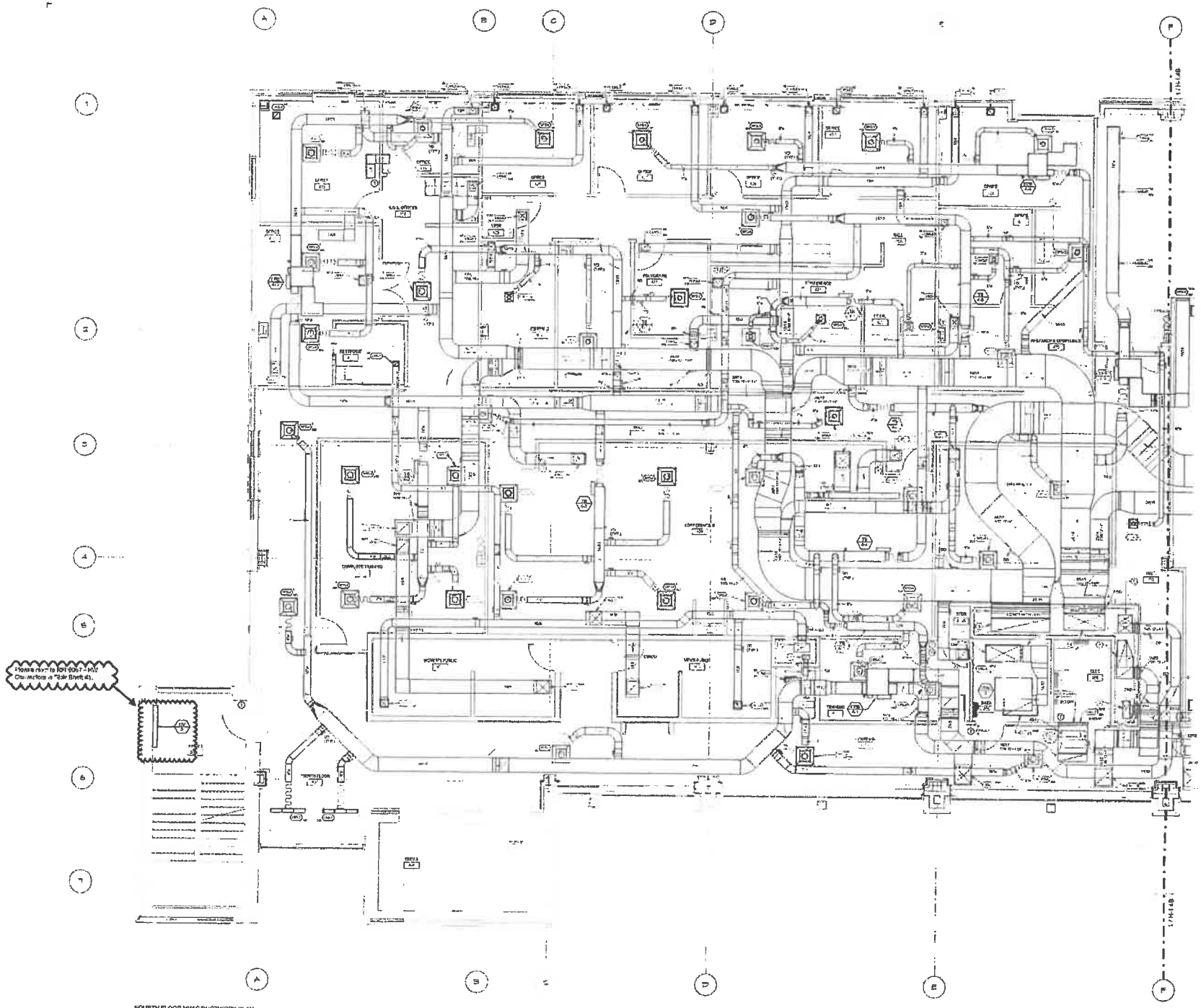
WDW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
400 MAIN STREET
FAIRMONT, WV

BID DOCUMENTS
03/06/2015

THIRD FLOOR HVAC DUCTWORK PLAN - AREA B

TOWER ENGINEERING

H-1.3B



FOURTH FLOOR HVAC DUCTWORK PLAN
1 - AREA A
1/4" = 1'-0"

(1) CODED NOTES - SHEETH-1.4A

1 24X12 RA DUCT UP IN SHAFT FROM BELOW. SPLIT THE 24X12 RA DUCT INTO A 12X12 RA DUCT AND A 12X12 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 12X12 DUCT UP TO FLOOR ABOVE. PROVIDE A 12X12 DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.5A FOR CONTINUATION OF DUCTWORK.

2 36"12 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. TRANSITION THE 36"12 DUCT TO A 24X12 DUCT AND CONTINUE, WITH A 24X12 RA DUCT INTO A SINGLE 30X12 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 30X12 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A 30X12 DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-2.2 AND H-1.5A FOR CONTINUATION OF DUCTWORK.

3 16"10 RA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 24X10 RA DUCT UPSTREAM OF THE 12X10 BRANCH DUCT. CONTINUE THE 24X10 RA DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.5A FOR CONTINUATION OF DUCTWORK.

4 30X12 SA DUCT DOWN IN FROM FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION REFER TO DRAWING H-1.5A FOR CONTINUATION OF DUCT.

5 CONVERT THE 42X18 RA DUCT AND THE 8"X8 RA DUCT INTO A SINGLE 60X18 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 60X18 DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION REFER TO DRAWING H-1.5A FOR CONTINUATION OF DUCT.

6 16"10 EA DUCT UP FROM FLOOR BELOW. TRANSITION TO A 24X10 DUCT IN FRONT UPSTREAM OF THE 12X10 BRANCH DUCT CONNECTION. CONTINUE THE 24X10 DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.5A FOR CONTINUATION OF DUCTWORK.

7 8"X 8"A DUCT UP FROM FLOOR BELOW. TRANSITION TO A 18"X 8" IN FRONT UPSTREAM OF THE 10"X 8" BRANCH DUCT CONNECTION. CONTINUE THE 18"X 8" DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.5A FOR CONTINUATION OF DUCTWORK.

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03/06/2013

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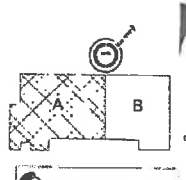


FOURTH FLOOR HVAC DUCTWORK PLAN - AREA A

TOWER ENGINEERING

H-1.4A

Shop Drawing Submittal Form

Project Name:	WV New State Office Building - Fairmont
Contractors Name:	P.J. Dick Incorporated
Supplier / Manufacturer:	Stuart-McMunn / Air Systems
Specification Section Number:	233113 - Metal Ducts
Comments: HVAC Ductwork Plans for Floors 1-5 and Roof Opening Plans	

The Omni Associates - Architects
1543 Fairmont Avenue - Suite 201
Fairmont, WV 26554
voice: 304.367.1417
facsimile: 304.367.1418

www.omniassociates.com

(Contractors Review Stamp)

This Document has been reviewed for conformance to Contract Documents and submitted to Architect for approval. An approval does not relieve Supplier/Subcontractor of their responsibility to comply with the Contract Documents.

Date 1/22/2014

Submittal No. 233113-02 - 001

PJ DICK

(Architects Review Stamp)

OMNI ASSOCIATES - ARCHITECTS

SUBMITTAL NUMBER: 233113-02

DATE RECEIVED: 1.22.14

- ☐ NO EXCEPTIONS NOTED
- ☒ IMPLEMENT EXCEPTIONS NOTED
- ☐ REVISE AND RESUBMIT
- ☐ REJECTED - RESUBMIT
- ☐ SUBMIT SPECIFIED ITEM

This conditional review is limited in scope and not detailed and is only for conformance with the design concept and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming quantities, verifying dimensions, selecting fabrication procedures and construction techniques, and coordinating and safely performing the Work. The Architect has not reviewed and is not responsible for substitutions to or deviations from the Contract Documents not clearly noted by the Contractor and specifically accepted by the Architect in writing or by the Architect's issuance of an Information Bulletin.

BY: _____ DATE: 1.30.14

304.367.1417 omniassociates.com

(Consultants Review Stamp)

TOWER ENGINEERING

115 Evergreen Heights Drive, Suite 400
Pittsburgh, Pennsylvania 15229
Phone: (412) 931-8888
Fax: (412) 939-2525

SUBMITTAL REVIEW

PROJECT NO.

- ☐ NO EXCEPTIONS TAKEN
- ☐ NOT ACCEPTABLE
- ☒ MAKE CORRECTIONS NOTED
- ☐ REVISE & RESUBMIT
- ☒ REFER TO SUBMITTAL COVER SHEET FOR COMMENTS

Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

By: CWeiland Date: 01/29/2014

(Comments)

TOWER ENGINEERING

Submittal Cover Sheet

ESTC Project Name:	Fairmont Office Building	Date Received:	01-24-2014
ESTC Project No.:	2011227	Date Sent:	01-29-2014
Client:	Omni Architects		
Client Project No.:	20856	Contractor:	Stuart-McMunn Company

Manufacturer Or Supplier	Item or System	Recommended Action	Comments
Air Systems Sheet Metal	Ductwork Plans – Floors 1 thru 5 and Roof	Make Corrections Noted	See Below

Comments:

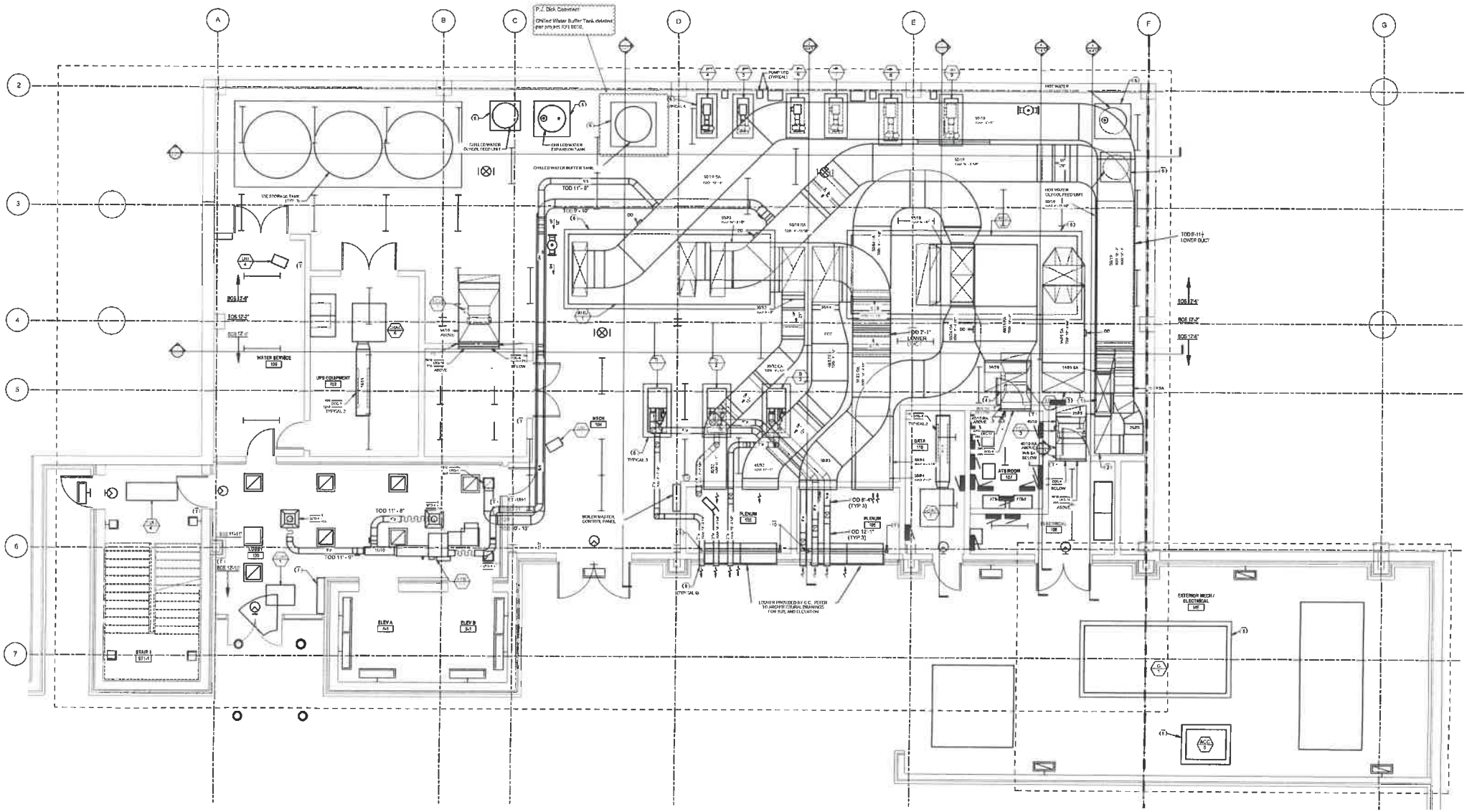
1. Supply fan SF-1 and SF-2 and their associated ductwork are not shown on the roof plan. Verify these items have been coordinated.
2. Air cooled condensing units ACC-1 thru ACC-4 and ACC-4 are not shown on the roof plan. Verify these items have been coordinated.

Reviewed By: Cory Weiland

Cory Weiland
Tower Engineering

Note: Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

115 Evergreen Heights Drive, Suite 400, Pittsburgh, Pennsylvania 15229
Phone 412.931.8888 ■ Fax 412.939.2525 ■ tower@estower.com



FIRST FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

N

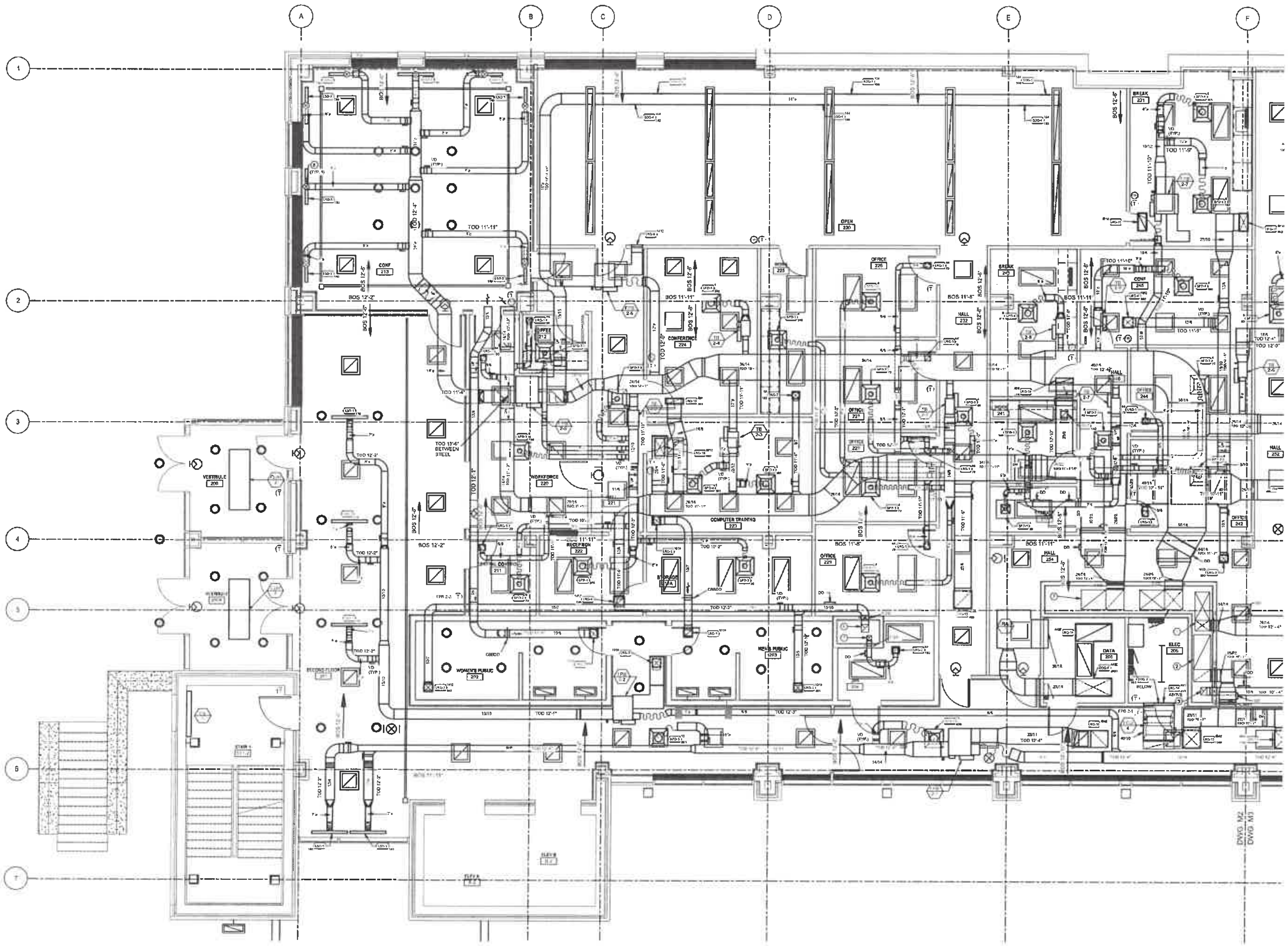
NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DRAWN BY: CFL | DATE: 10-10-13

REVISION: - | DRAWING NO: M1



SECOND FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

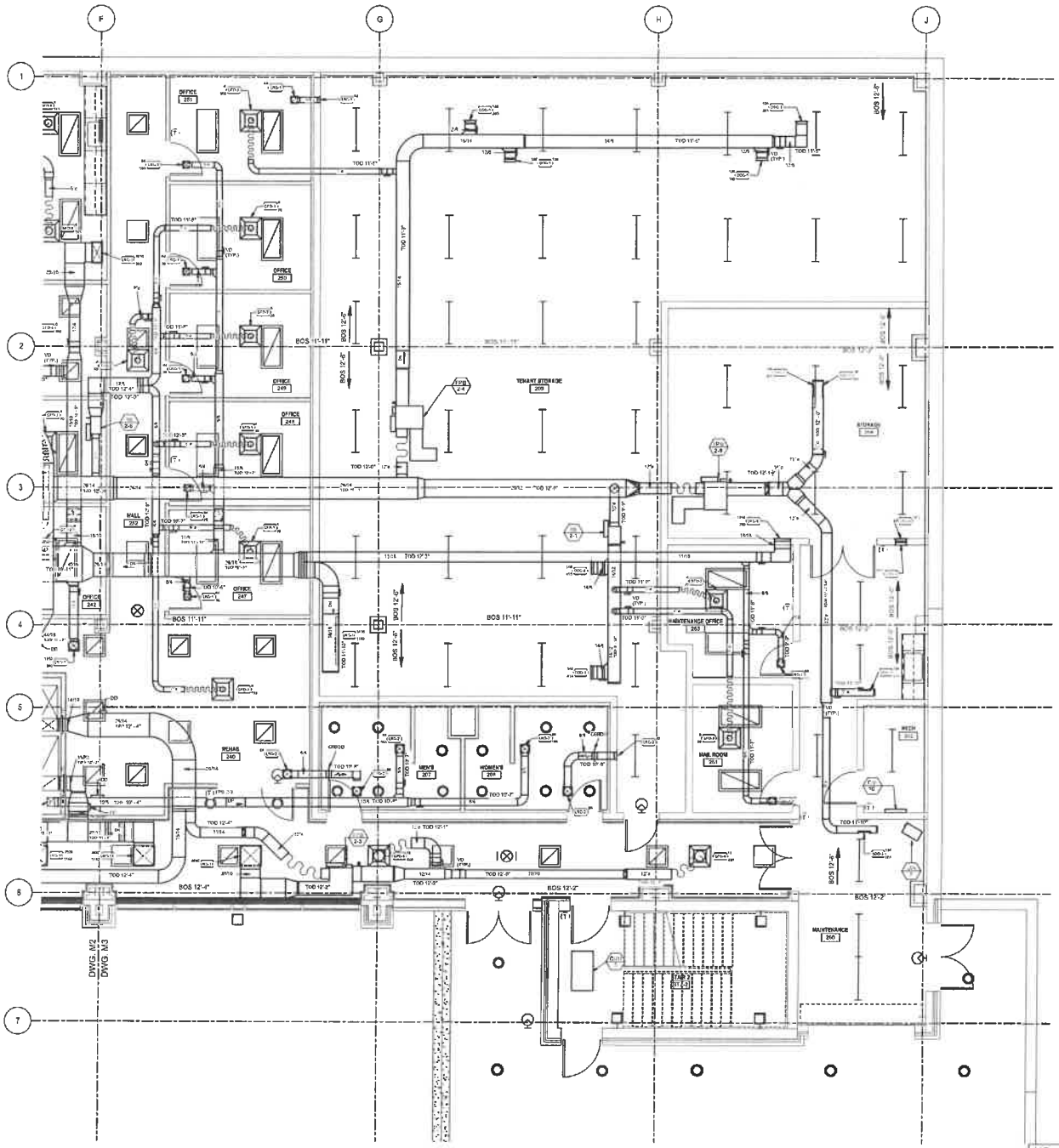
NO	DESCRIPTION	DATE
1	–	–

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

REVISION: —

DRAWING NO: M2



SECOND FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

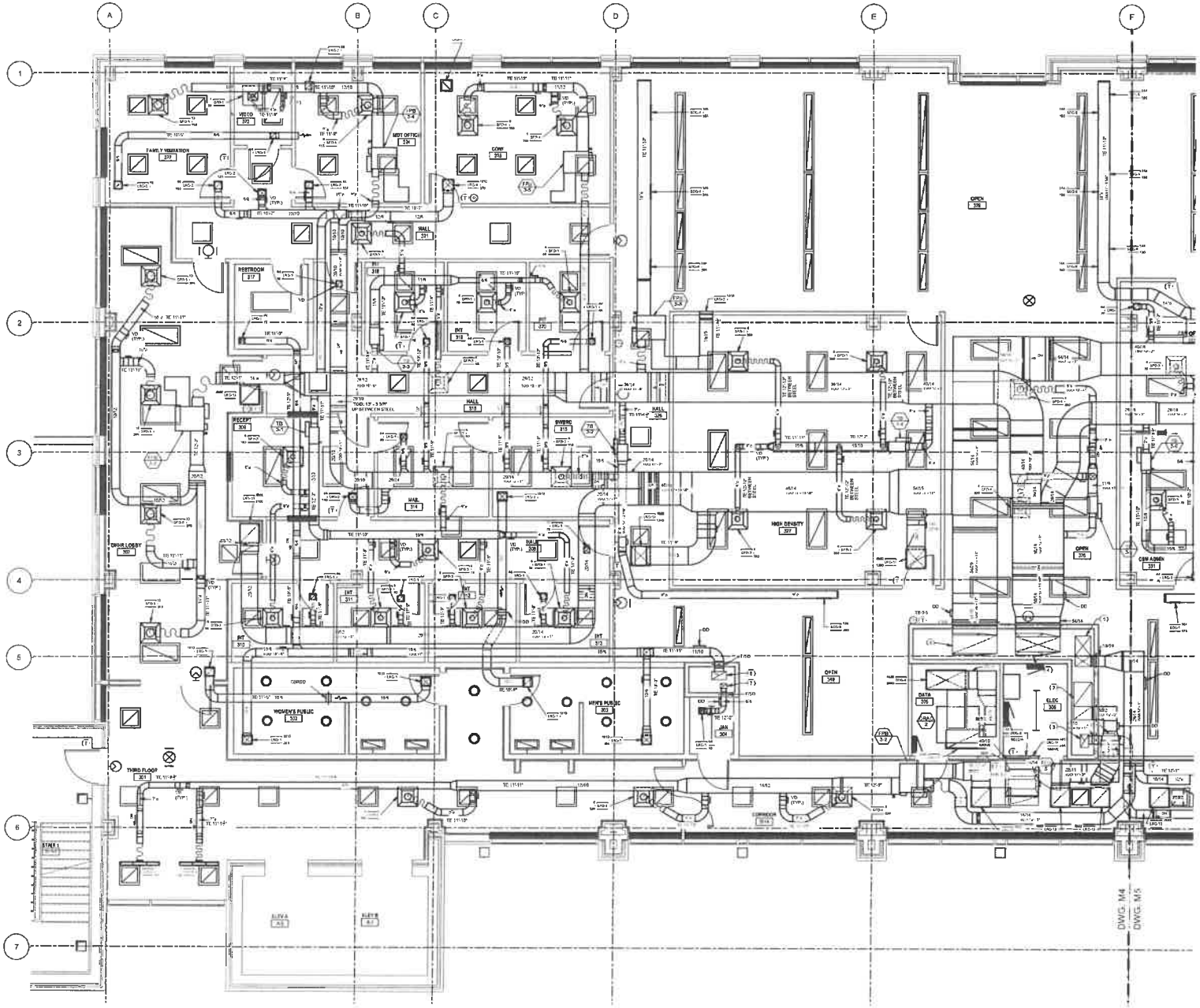
NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DRAWN BY: CPL | DATE: 10-19-13

REVISION: - | DRAWING NO: M3



THIRD FLOOR PLAN HVAC

SCALE 1/4"=1'-0"

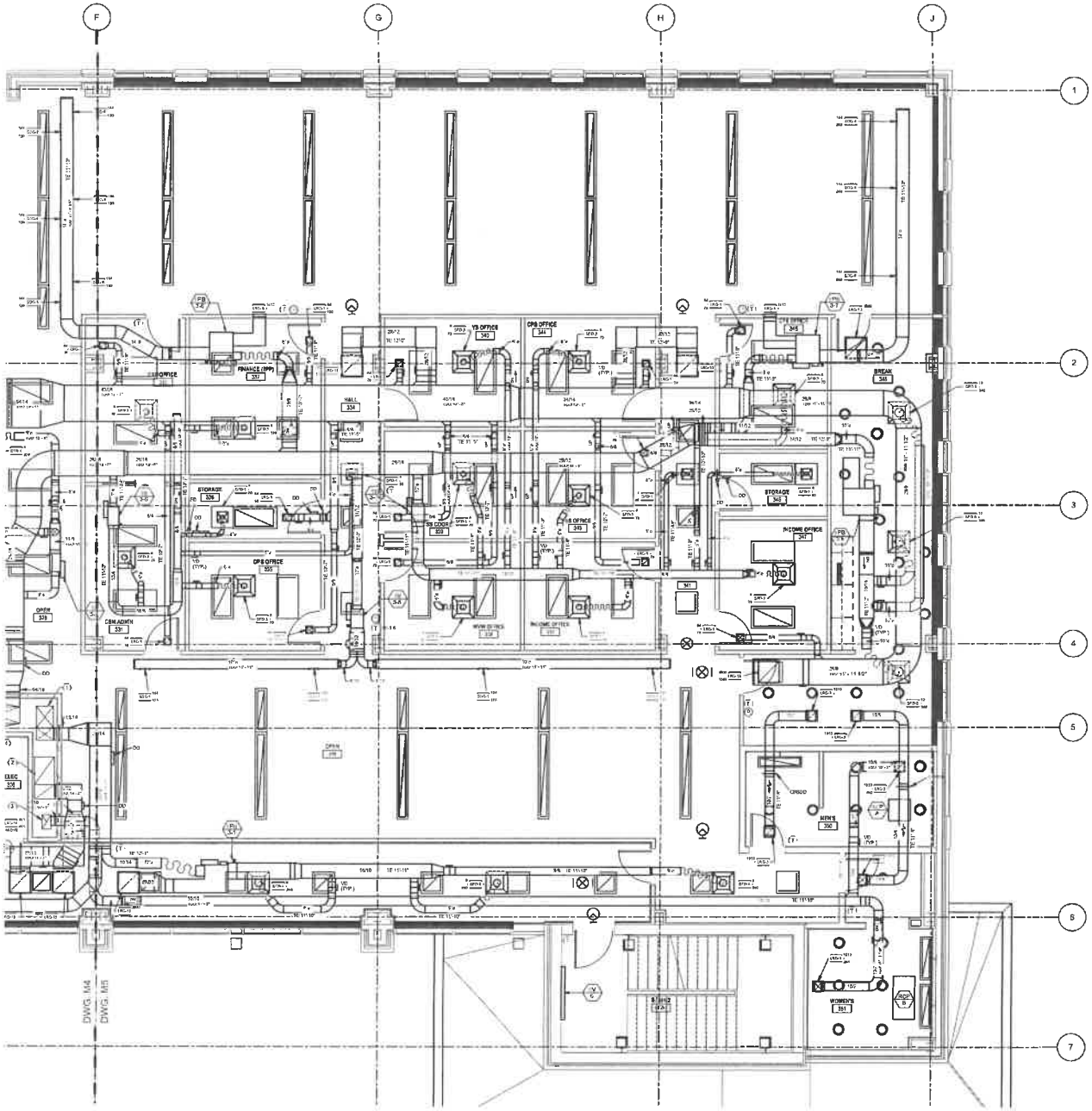
NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMONT, WV

DRAWN BY: GFL | DATE: 10-30-13

DRAWING NO.: M4



THIRD FLOOR PLAN HVAC

SCALE: 1/8"=1'-0"

N

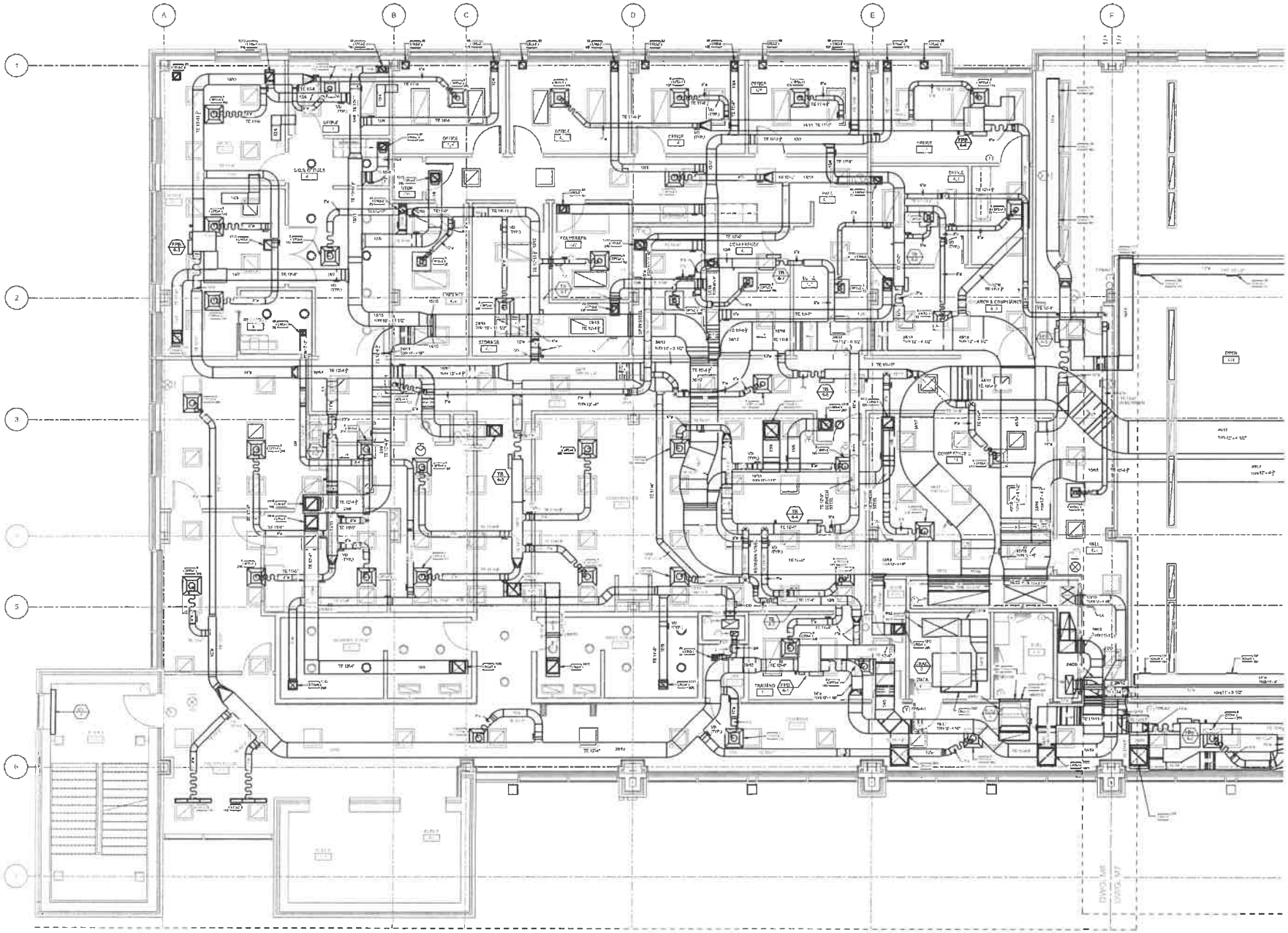
NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DRAWN BY: CFL | DATE: 10-30-13

REVISION: - | DRAWING NO: M5



FOURTH FLOOR PLAN HVAC

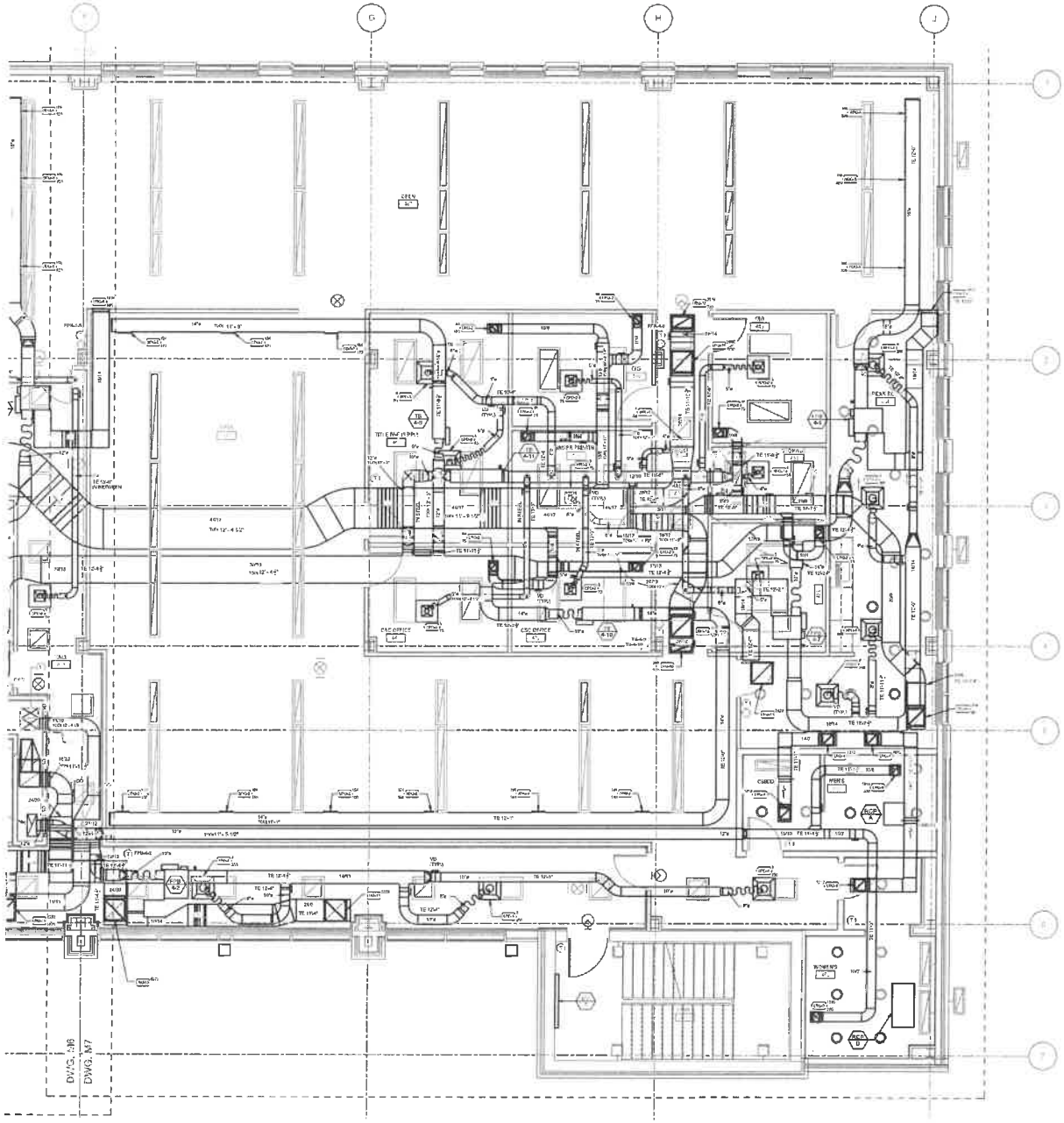
SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M6



FOURTH FLOOR PLAN HVAC

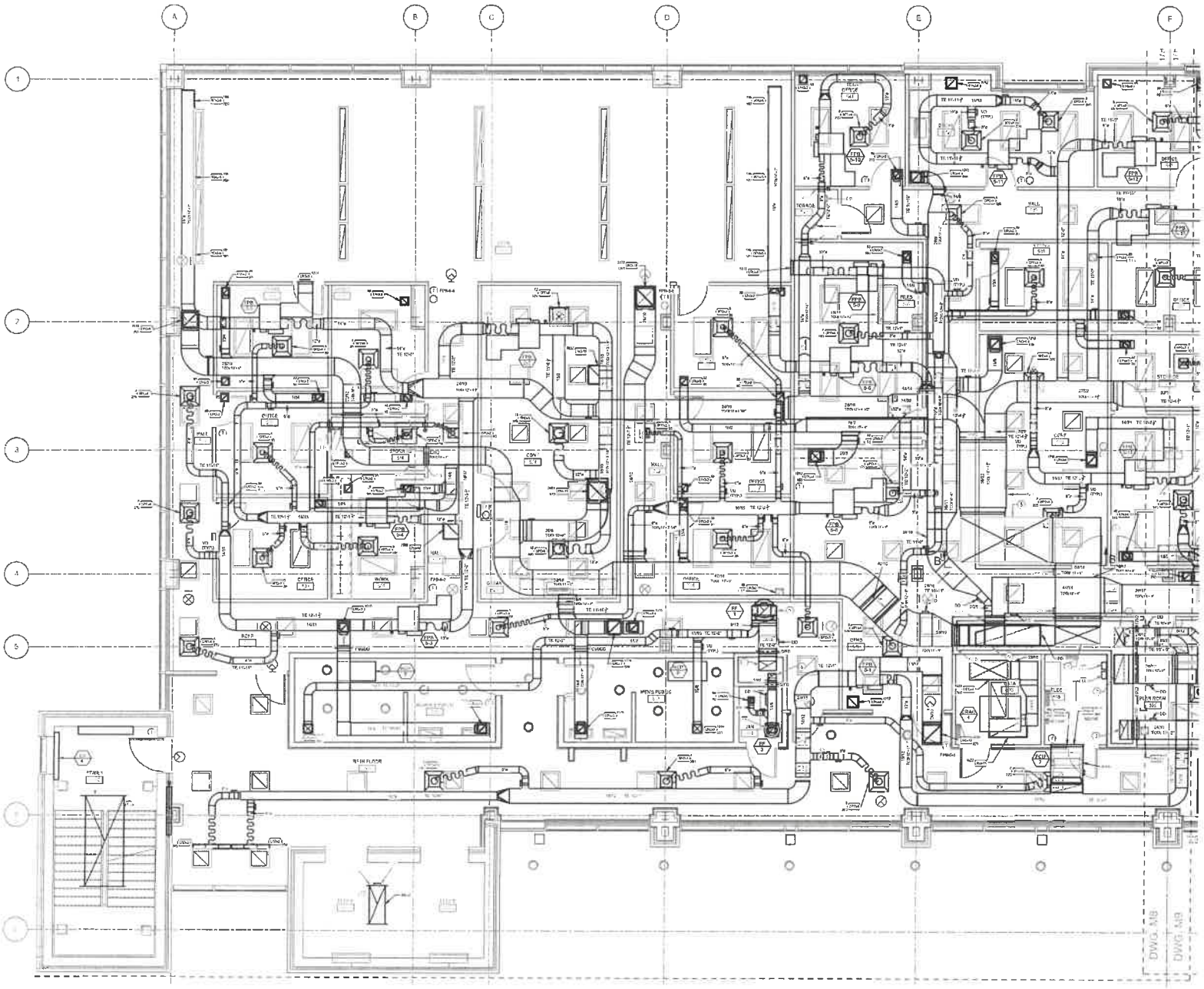
SCALE 1/4"=1'-0"

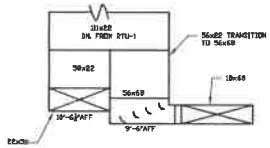
NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DWG. M7





FIFTH FLOOR PLAN HVAC

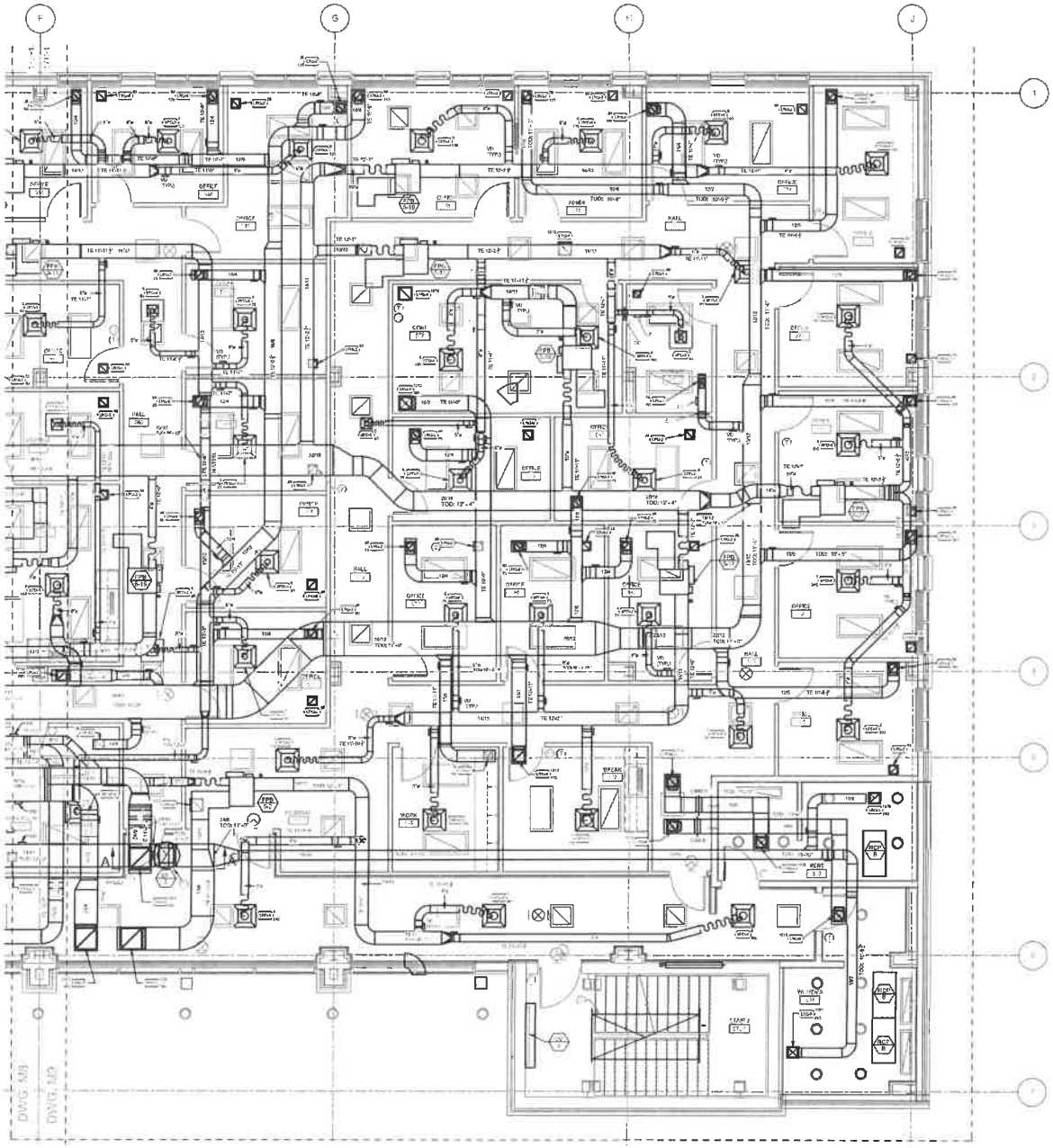
SCALE 1/4"=1'-0"

NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

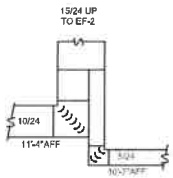
FAIRMOUNT, WV

M8



FIFTH FLOOR PLAN HVAC

SCALE 1/4"=1'-0"



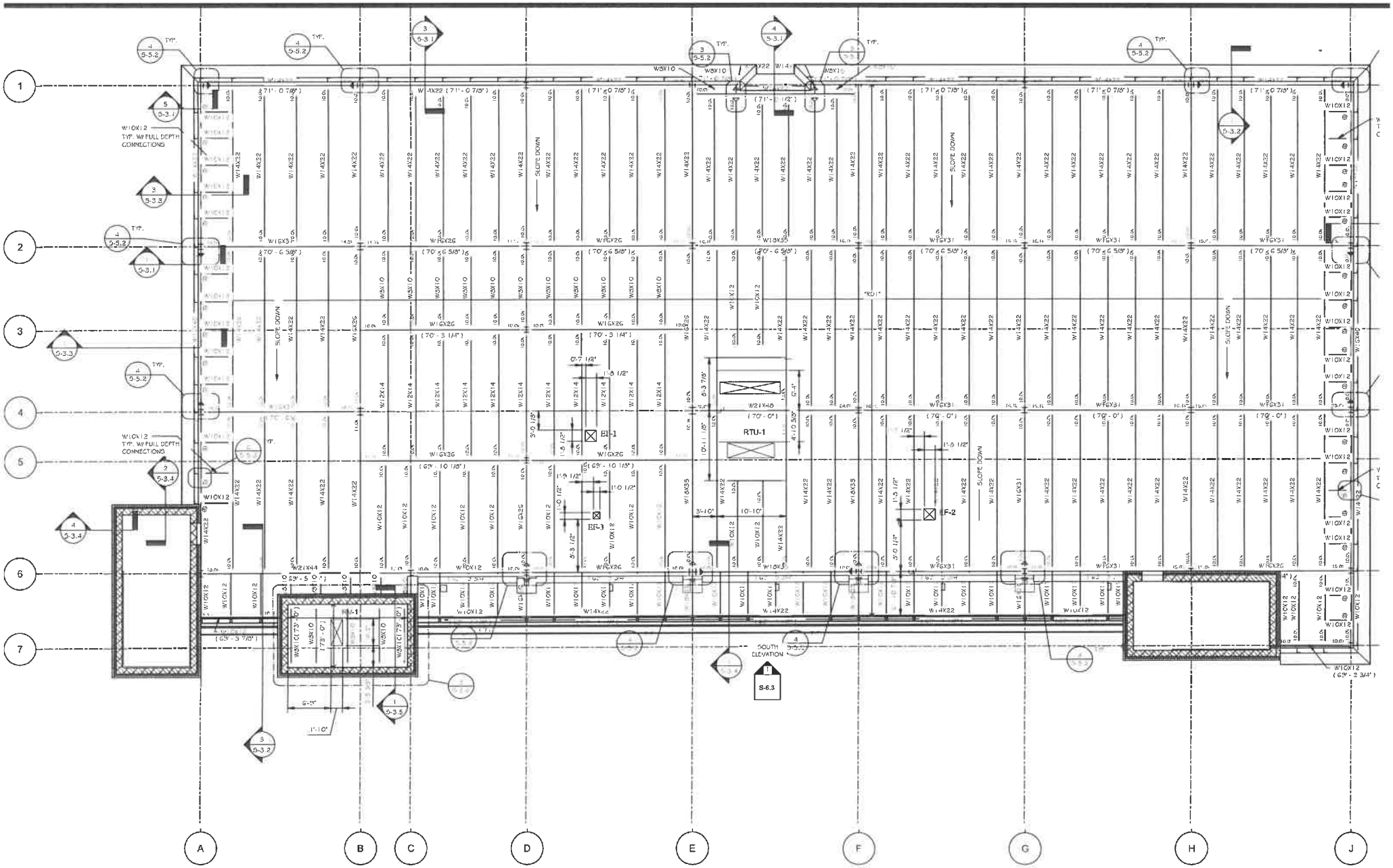
SECTION A-A

NO	DESCRIPTION	DATE
1	-	-

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

M9



ROOF PLAN

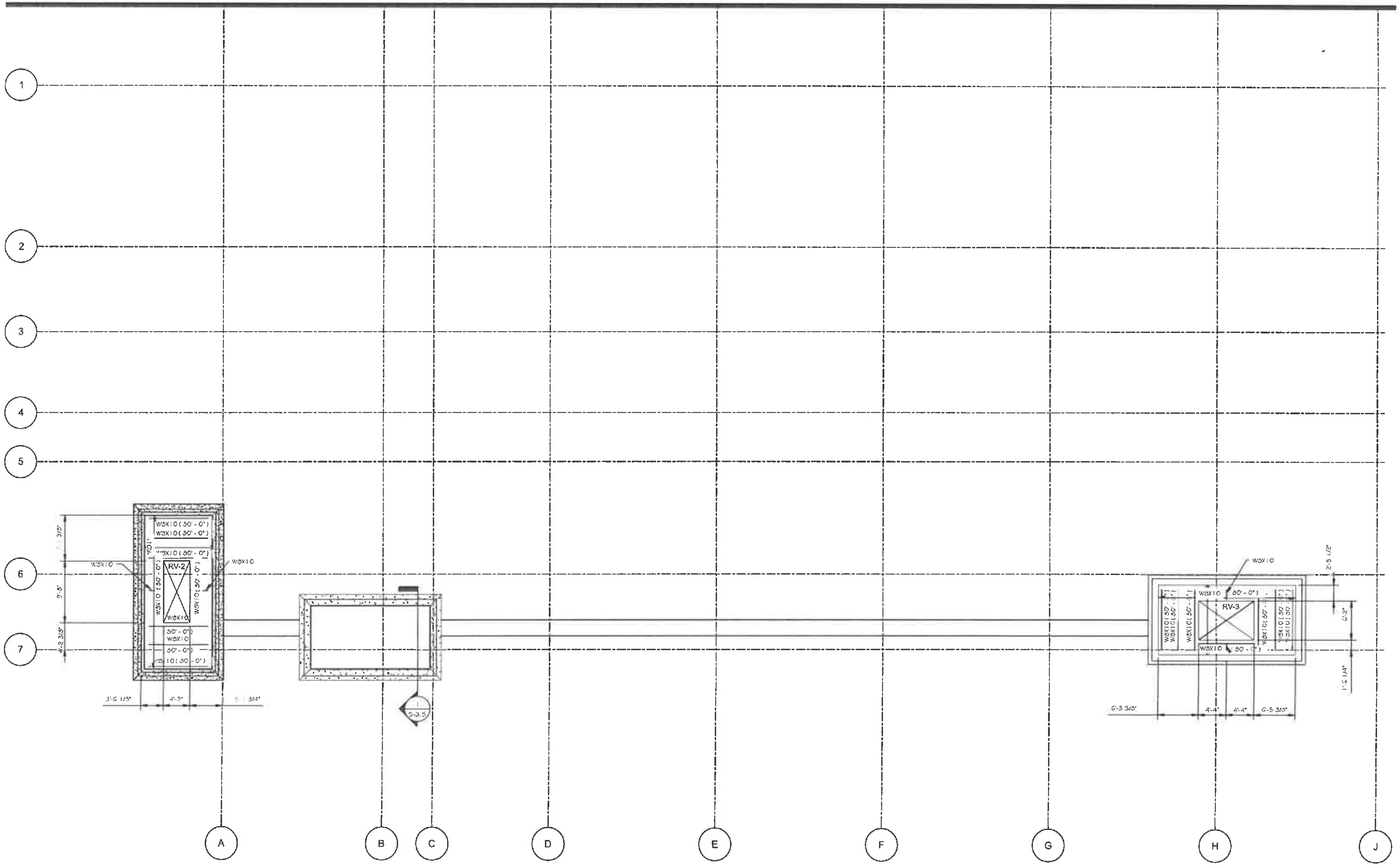
SCALE 1/4"=1'-0"

N

NEW STATE OFFICE BUILDING FAIRMOUNT

FAIRMOUNT, WV

DRAWING NO. RO 1



NOTE
OPENING DIMENSIONS ARE FOR
INSIDE CLEARANCES

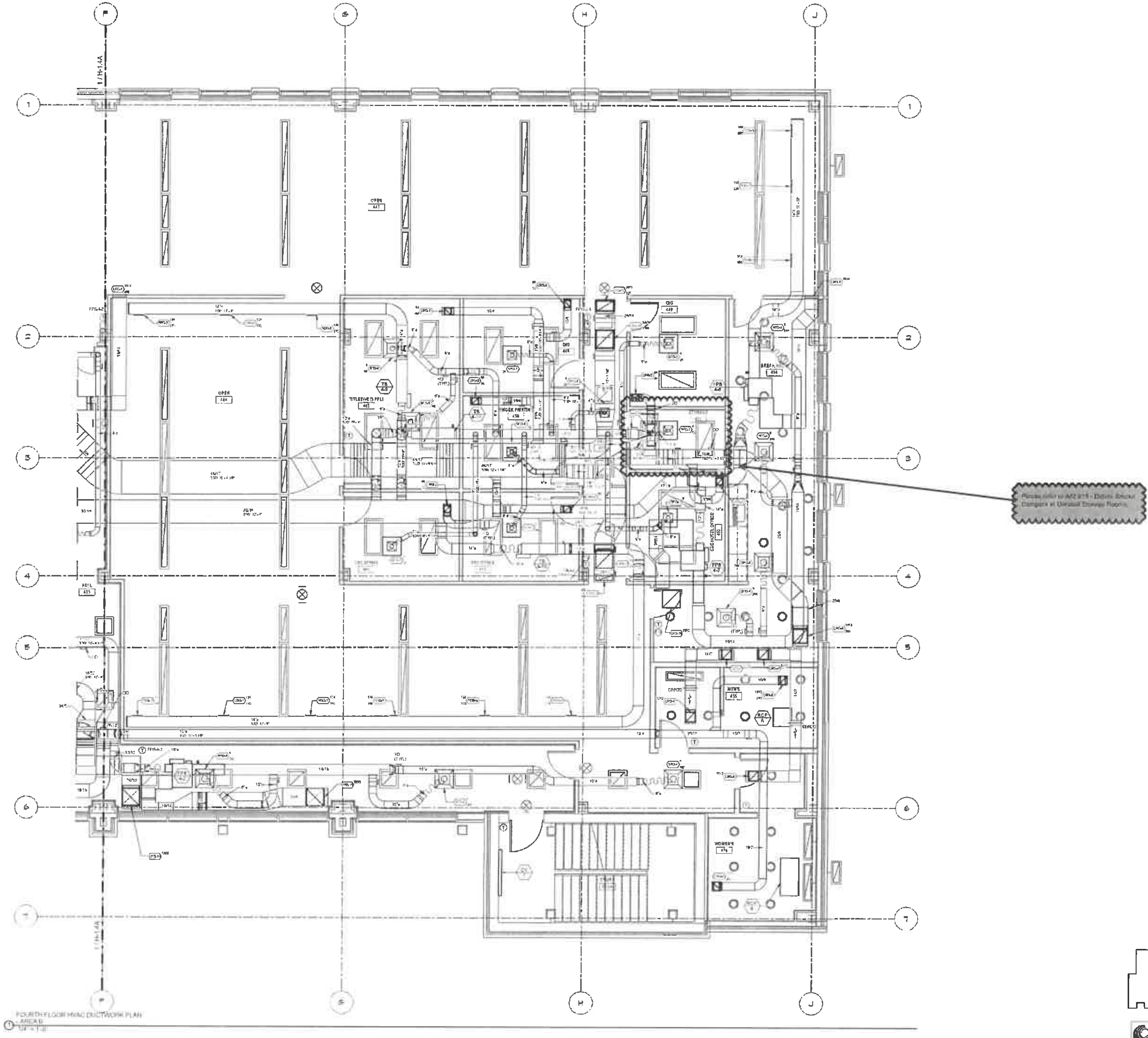
ROOF PLAN

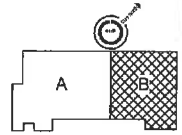
SCALE 1/4"=1'-0"

NEW STATE OFFICE
BUILDING FAIRMOUNT

FAIRMOUNT, WV

RO 2





NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
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03/06/2013

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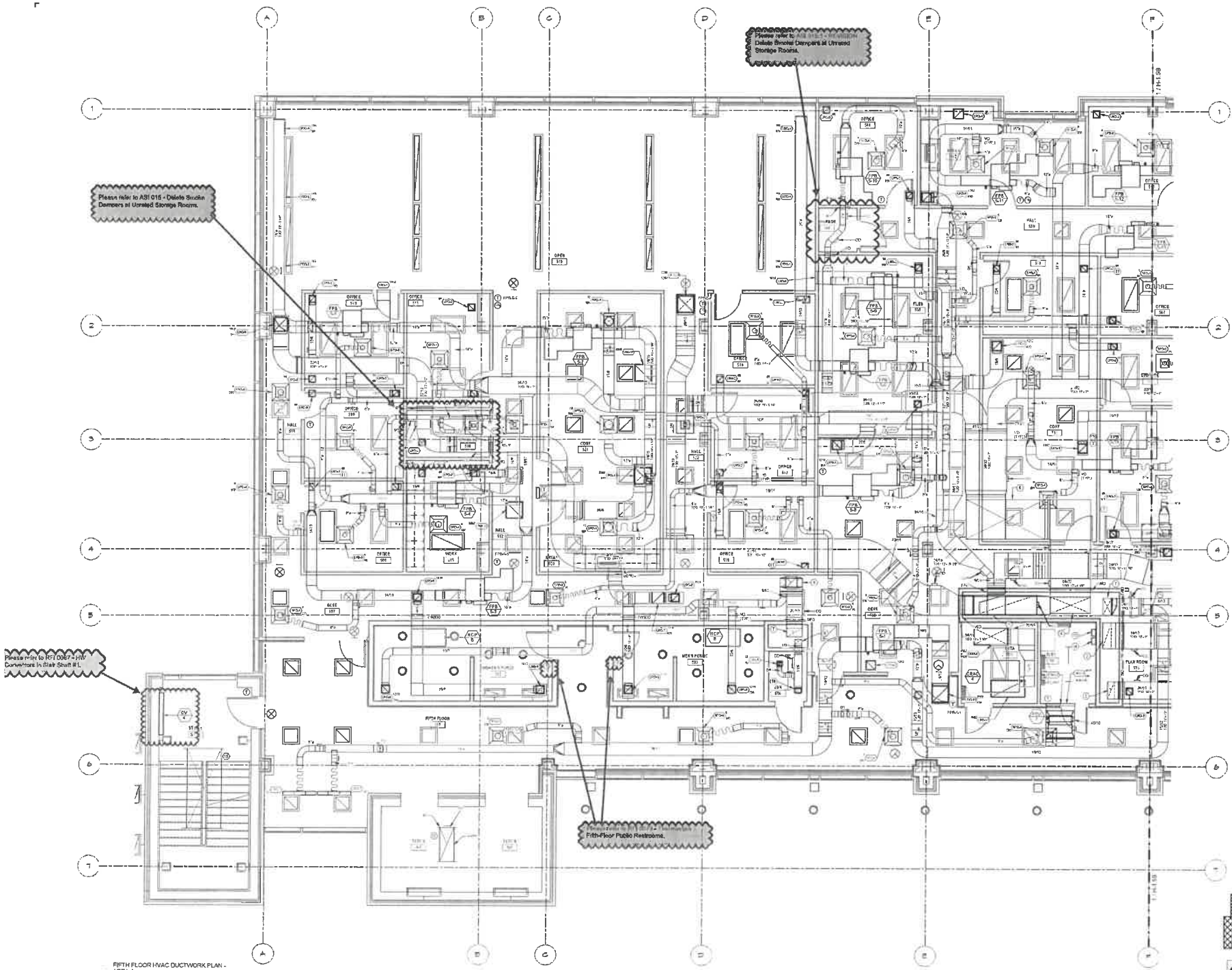
FOURTH FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING
115 Evergreen Heights Drive Suite 400
Pittsburgh, Pennsylvania 15229
Phone: (412) 931-8888
Fax: (412) 939-2525

Project Number
2011227

H-1.4B



FIFTH FLOOR HVAC DUCTWORK PLAN - AREA A
1/4" = 1'-0"

CODED NOTES - SHEET H-1.5A

1. 51/16 SA DUCT UP FROM FLOOR BELOW. TRANSITION DUCT INTO A 34/12 SA DUCT IN RISER AND CONTINUE TO CERVE FIFTH FLOOR. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
2. 25/12 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
3. 34/16 SA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
4. 58/22 SA DUCT DOWN TO FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
5. 60/38 RA DUCT UP FROM FLOOR BELOW. TRANSITION THE 8/0 B RA RISER INTO 4 44/26 RA DUCT, COMBINE THE 44/26 RA DUCT, THE 26/26 RA DUCT, AND THE 26/16 RA DUCT INTO A SINGLE 68/38 RA DUCT USING A DIVIDED FLOW FITTING. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. CONVEY THE 68/38 RA DUCT UP THROUGH ROOF TO ROOFTOP UNIT RTU-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY IN ROOF CURB AND MAKE FINAL CONNECTION TO RTU-1 RETURN AIR OPENING.
6. 111/22 SA DUCT DOWN FROM ROOFTOP UNIT RTU-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY IN ROOF CURB FROM RTU-1 SUPPLY AIR OPENING. SPLIT THE 111/22 SA DUCT INTO A 52/22 SA DUCT AND A 58/22 SA DUCT USING A DIVIDED FLOW FITTING.
7. 23/12 EA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
8. 16/4 EA DUCT UP FROM FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.4A FOR CONTINUATION OF DUCT.
9. COMBINE A 23/12 EA DUCT AND A 9/12 EA DUCT INTO A SINGLE 32/22 EA DUCT USING A DIVIDED FLOW FITTING AND CONTINUE THE 31/22 UP THROUGH ROOF TO EXHAUST FAN EF-1 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-1.
10. 11/8 EA DUCT UP THROUGH ROOF TO EXHAUST FAN EF-2 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-2.
11. PLENUM GRILLE. DO NOT CONNECT TO DUCT ABOVE.
12. 48/20 OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-1 ON ROOF ABOVE. PROVIDE A SMOKE DAMPER AND DUCT MOUNTED SMOKE DETECTOR IN DUCT. DUCT SHALL BE WRAPPED IN 1HR RATED INSULATION.
13. VARIABLE FREQUENCY DRIVE (VFD) FOR SUPPLY FAN SF-1. COORDINATE INSTALLATION WITH THE ELECTRICAL DRAWINGS AND MOUNT VFD TO WALL.
14. VARIABLE FREQUENCY DRIVE (VFD) FOR SUPPLY FAN SF-2. COORDINATE INSTALLATION WITH THE ELECTRICAL DRAWINGS AND MOUNT VFD TO WALL.
15. 48/14 OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-2 ON ROOF ABOVE. PROVIDE AN AUTOMATIC CONTROL DAMPER IN DUCT.

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STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

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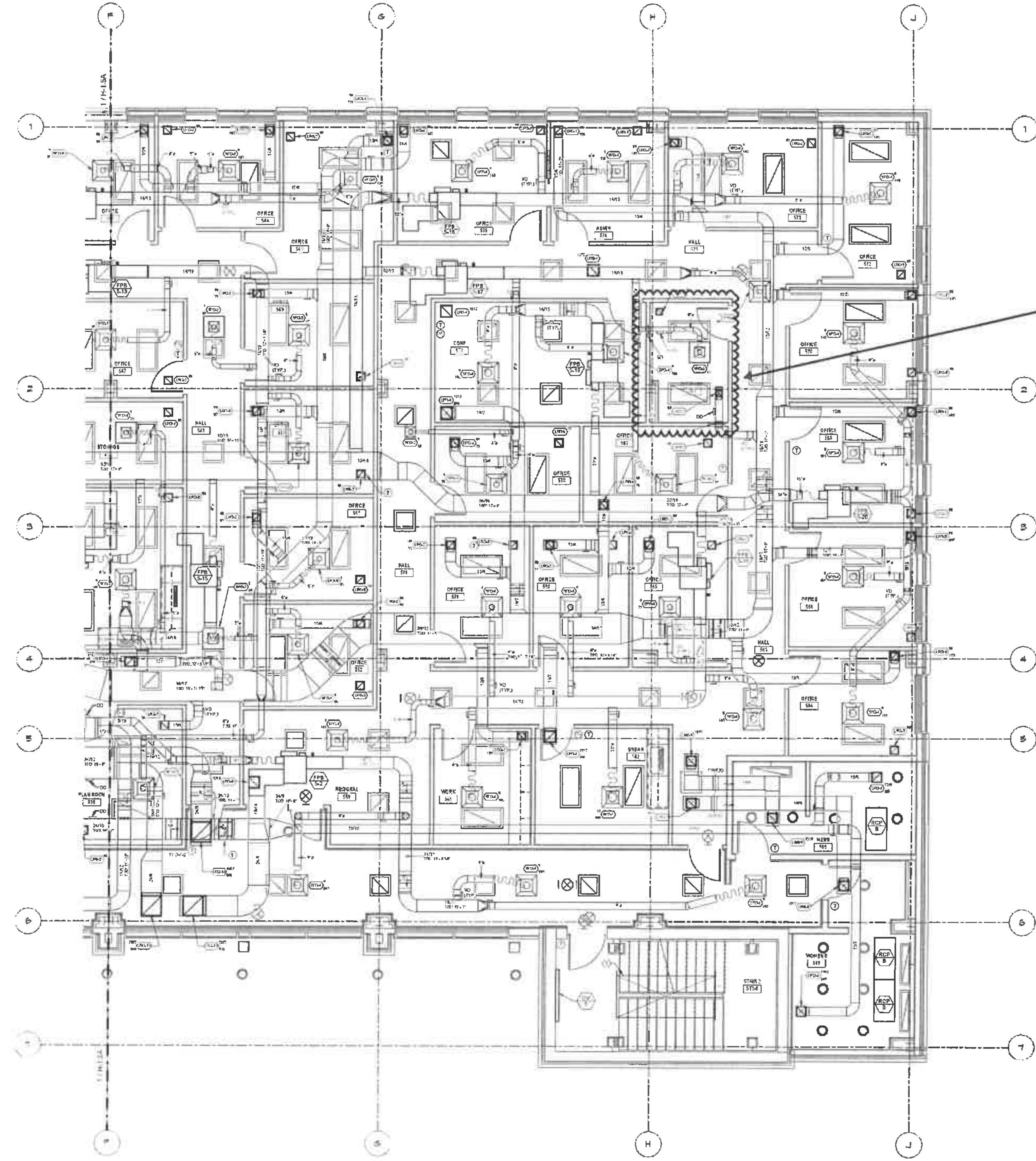
FIFTH FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING

H-1.5A



FIFTH FLOOR HVAC DUCTWORK PLAN - AREA B
1/4" = 1'-0"

Please refer to ASI 018 - Delete Smoke Dampers at Unrated Storage Rooms

CODED NOTES - SHEET H-1.5B

1 COMBINE A 24/10 EA DUCT AND A 24/5 EA DUCT INTO A SINGLE 24/15 EA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 24/15 DUCT UP THROUGH ROOF TO EXHAUST FAN EF-2 ON ROOF ABOVE. TRANSITION DUCT AS NECESSARY AND CONNECT TO EF-2.

2 PLENUM GRILLE. DO NOT CONNECT TO DUCT ABOVE.

3 48/114 OPEN ENDED RELIEF DUCT UP TO ROOF VENTILATOR RV-3 ON ROOF ABOVE. PROVIDE AN AUTOMATIC CONTROL DAMPER IN DUCT.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

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03/06/2013

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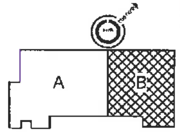

FIFTH FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING
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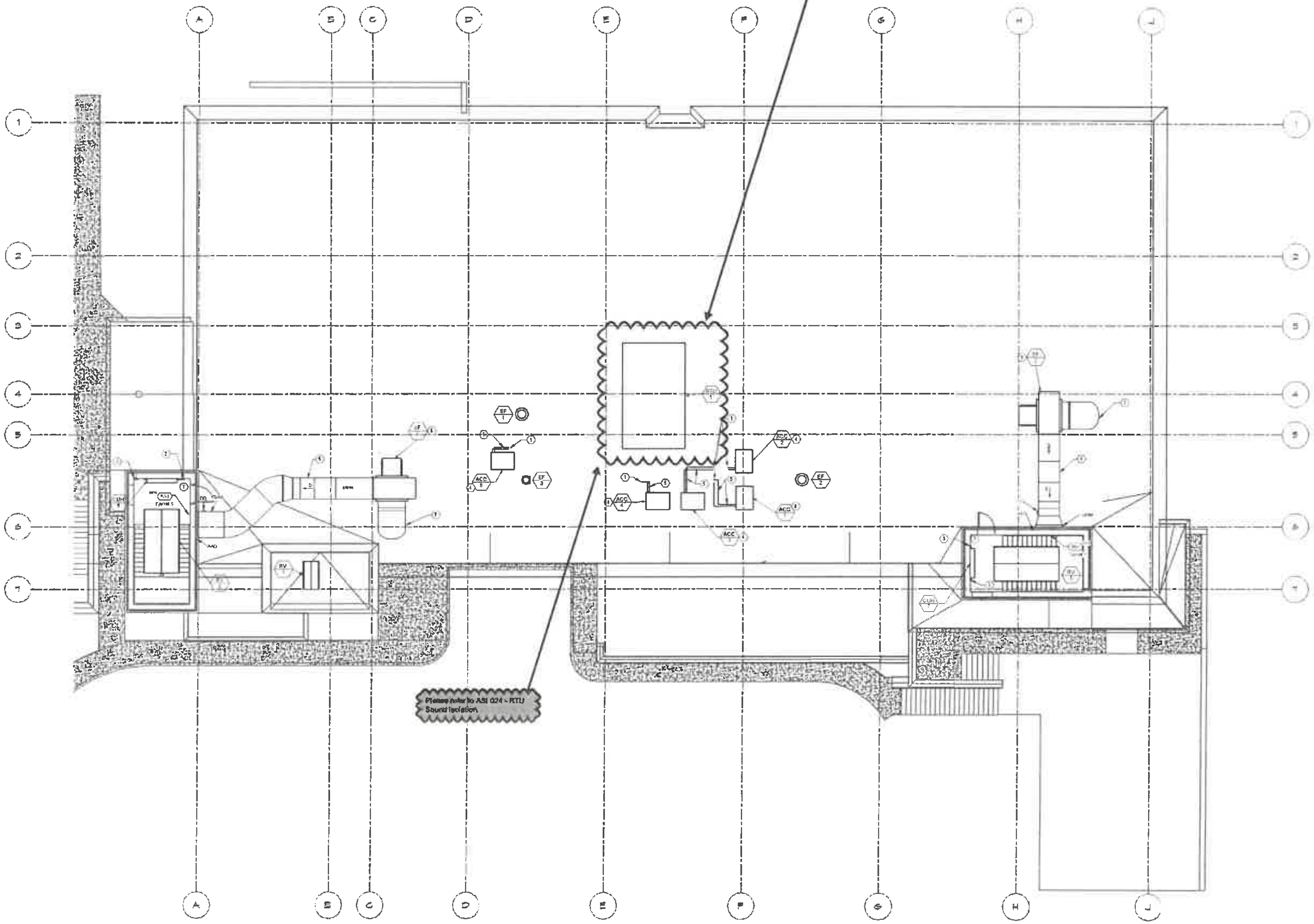
Project Number 2011227

H-1.5B



ROOF HVAC PLAN
1/8" = 1'-0"

CODED NOTES - SHEET H-1.6

1. REFRIGERANT LIQUID AND SUCTION PIPING DOWN THROUGH ROOF TO FLOOR BELOW. PROVIDE PIPE PORTAL AT ROOF PENETRATION. SIZE PIPING IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. REFER TO DRAWING H-2.5A FOR CONTINUATION OF PIPING.
2. 3/4" HWS AND HWR PIPING UP FROM FLOOR BELOW. REFER TO DRAWING H-2.5A FOR CONTINUATION OF PIPING.
3. 3/4" HWS AND HWR PIPING UP FROM FLOOR BELOW. REFER TO DRAWING H-2.5B FOR CONTINUATION OF PIPING.
4. MOUNT AIR COOLED CONDENSING UNIT ON EQUIPMENT RAILS. REFER TO HVAC DETAILS FOR REQUIREMENTS.
5. PROVIDE EQUIPMENT RAIL AND MOUNT PIPING TO RAIL. REFER TO HVAC DETAILS FOR REQUIREMENTS.
6. PROVIDE EQUIPMENT RAIL AND MOUNT DUCTWORK TO RAIL. REFER TO HVAC DETAILS FOR REQUIREMENTS.
7. OPEN-ENDED 62"Ø INTAKE DUCT ELBOWED DOWN AT A 45° ANGLE. PROVIDE BIRDSCREEN IN OPENING. TRANSITION DUCT AS NECESSARY AND CONNECT TO SUPPLY FAN.
8. MOUNT SUPPLY FAN ON EQUIPMENT RAILS. REFER TO HVAC DETAILS FOR REQUIREMENTS.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

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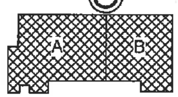

ROOF HVAC PLAN

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Project Number
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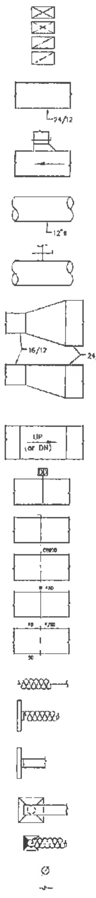
H-1.6

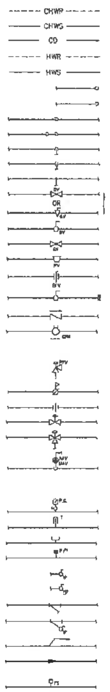
HVAC SYMBOLS & ABBREVIATIONS

SHEET METAL SYMBOLS



- SUPPLY AIR DUCT TURNED UP
- SUPPLY AIR DUCT TURNED DOWN
- RETURN, EXHAUST OR RELIEF AIR DUCT TURNED UP
- RETURN, EXHAUST OR RELIEF AIR DUCT TURNED DOWN
- RECTANGULAR DUCT. DIMENSION IS FREE AREA. FOR LINED DUCT ADD 1-1/2 INCHES TO EACH DIMENSION TO GET OUTSIDE DIMENSION OF SHEET METAL. (1ST FIGURE, SIDE SHOWN; 2ND FIGURE, SIDE NOT SHOWN.)
- RECTANGULAR MAIN DUCT WITH 45° CLINCH COLLAR, AND VOLUME DAMPER IN SUB-DUCT. (PER SMACNA DUCT CONSTRUCTION STANDARDS)
- ROUND DUCT. SINGLE WALL. FOR DOUBLE WALL DUCT REQUIREMENTS, SEE SPECIFICATION AND/OR SEE CODED NOTES ON PLANS.
- ROUND MAIN DUCT WITH 90° TAP OR 90° SADDLE TAP AND VOLUME DAMPER IN SUB-DUCT. (PER SMACNA DUCT CONSTRUCTION STANDARDS)
- TRANSITIONS. GIVE SIZES. NOTE F.O.T. (FLAT ON TOP), OR F.O.B. (FLAT ON BOTTOM) IF APPLICABLE.
- INCLINED RISE (UP) OR DROP (DN). ARROW IN DIRECTION OF AIR FLOW.
- DUCT MOUNTED SMOKE DETECTOR
- VOLUME DAMPER
- COUNTER BALANCED BACKDRAFT DAMPER (CBBD)
- AUTOMATIC AIR DAMPER
- FIRE DAMPER (FD)
FIRE/SMOKE DAMPER (F/SD)
SMOKE DAMPER (SD)
- FLEXIBLE DUCT
- FLEXIBLE DUCT CONNECTION TO LINEAR SLOT DIFFUSER.
- ROUND HARD METAL DUCT CONNECTION TO LINEAR SLOT DIFFUSER.
- FLEXIBLE DUCT OR ROUND HARD METAL DUCT CONNECTION, WITH NO 90° ELBOW, TO SQUARE DIFFUSER.
- DIRECTION DIFFUSER (SLD). DARKENED QUADRANT(S) NO AIR FLOW. 3-WAY BLOW SHOWN
- ROUND DUCT
- DIRECTION OF AIR FLOW IN OR OUT OF EQUIPMENT OR AN AIR TERMINAL DEVICE.

PIPING SYMBOLS



- CHILLED WATER RETURN
- CHILLED WATER SUPPLY
- COIL CONDENSATE DRAIN
- HOT WATER RETURN
- HOT WATER SUPPLY
- PIPING TURNED UP
- PIPING TURNED DOWN
- 90° RISE OR DROP IN PIPE
- 45° RISE OR DROP IN PIPE
- PIPE TAKEOFF FROM TOP OF MAIN
- PIPE TAKEOFF FROM BOTTOM OF MAIN
- PIPE TAKEOFF FROM SIDE OF MAIN
- GATE VALVE
- BALL VALVE
- GLOBE VALVE
- PLUG VALVE
- BUTTERFLY VALVE
- DRAIN VALVE WITH HOSE CONNECTION (HOSE CONNECTION)
- CHECK VALVE
- FLOW CONTROL VALVE WITH GPM INDICATED WHEN LOCATED IN MAINS OR SERVING MULTIPLE UNITS. WHEN SERVING SINGLE-UNIT, REFER TO EQUIPMENT SCHEDULES.
- PRESSURE RELIEF VALVE
- PRESSURE REDUCING VALVE WITH BUILT-IN CHECK VALVE
- UNION
- TWO-WAY CONTROL VALVE
- THREE-WAY CONTROL VALVE
- AIR VENT. INSTALL AT ALL HIGH POINTS IN SYSTEM. AAV-AUTOMATIC. MAV-MANUAL. EXTEND DRAIN LINE FROM ALL AUTOMATIC AIR VENTS TO NEAREST CONDENSATE DRAIN LINE OR SAFEWASTE.
- PRESSURE GAUGE AND COCK
- THERMOMETER
- WELL IN PIPING
- PRESSURE/TEMPERATURE PORT
- HOSE BIBB
- HOSE BIBB W/CAP
- STRAINER
- STRAINER WITH BLOWDOWN AND HOSE CONNECTION (HOSE BIBB)
- DIRECTION OF PIPE SLOPE (DOWN)
- DIRECTION OF FLOW IN PIPE
- FLOW SWITCH

GENERAL DRAWING SYMBOLS

- CODED NOTE
'NO' DENOTES SEQUENTIAL ALPHANUMERIC DESIGNATION
- EQUIPMENT TAG
(REFER TO APPROPRIATE SCHEDULE)
'ID' DENOTES EQUIPMENT TYPE (I.E. EF=EXHAUST FAN)
'FL' DENOTES FLOOR EQUIPMENT IS LOCATED ON
'NO' DENOTES SEQUENTIAL ALPHANUMERIC DESIGNATION
- DIFFUSER, REGISTER, GRILLE TAG
(REFER TO APPROPRIATE SCHEDULE)
'ID' DENOTES DIFFUSER, REGISTER, GRILLE TYPE
(I.E. SCD=SQUARE CONE DIFFUSER)
'SB' DENOTES NECK SIZE AND BLOW PATTERN
(I.E. 123=12"ø OR 12"x12" NECK WITH 3-WAY BLOW PATTERN)
'CFM' INDICATES AIR FLOW RATE IN CFM
OBD INDICATES THAT AN OPPOSED BLADE DAMPER SHALL BE PROVIDED
(I.E. WHEN OBD NOT SHOWN, NO OPPOSED BLADE DAMPER SHALL BE PROVIDED.
- SECTION INDICATOR
'NO' DENOTES SEQUENTIAL ALPHABETIC DESIGNATION
'D1' DENOTES DRAWING ON WHICH SECTION CUT
'D2' DENOTES DRAWING ON WHICH SECTION IS LOCATED
- REVISION INDICATOR
'NO' DENOTES REVISION LEVEL

CONTROL SYMBOLS

- HUMIDISTAT OR HUMIDITY SENSOR
- THERMOSTAT OR TEMPERATURE SENSOR
- CARBON MONOXIDE SENSOR
- CARBON DIOXIDE SENSOR

GENERAL NOTES: (ALL DRAWINGS)

A. UNLESS CONDITIONS DO NOT PERMIT, ALL RADIUSED ELBOWS SHOWN ON THE DRAWINGS SHALL BE PROVIDED. WHERE CONDITIONS DO NOT PERMIT, MITERED RECTANGULAR ELBOWS WITH TURNING VANES MAY BE PROVIDED IN LIEU OF RADIUSED ELBOWS. THE RADIUSED RECTANGULAR ELBOWS SHALL HAVE A RADIUSED HEEL AND A RADIUSED THROAT, AND SHALL HAVE A CENTERLINE RADIUS NOT LESS THAN 1.5 TIMES THE DUCT WIDTH.

B. ALL MITERED RECTANGULAR DUCT ELBOWS HAVING AN ANGLE GREATER THAN 45° SHALL BE PROVIDED WITH TURNING VANES

C. DUCTWORK SHALL NOT BE INSTALLED ABOVE ELECTRICAL PANELS. COORDINATE DUCTWORK WITH ELECTRICAL CONTRACTOR.

D. FINAL THERMOSTAT, SENSOR, AND EXHAUST FAN SWITCH LOCATIONS MUST BE APPROVED BY THE ARCHITECT AND OWNER PRIOR TO INSTALLATION.

E. DUCT DETECTORS SHALL BE PROVIDED BY THE E.C. AND MOUNTED BY THE H.C. THE E.C. SHALL PROVIDE ALL POWER WIRING AND FIRE ALARM CONTROL WIRING FOR THE DETECTOR. THE H.C. SHALL PROVIDE ALL FAN SHUTDOWN CONTROL WIRING.

F. THE HVAC CONTRACTOR SHALL PROVIDE ACCESS PANELS FOR ALL EQUIPMENT INSTALLED ABOVE A DRYWALL CEILING AND INSTALLED WITHIN DRYWALL BULKHEADS, WALLS, ETC. THAT REQUIRES ACCESS SUCH AS BALANCING VALVES, EQUIPMENT, SWITCHES, ETC. THE CONTRACTOR SHALL COORDINATE THE LOCATION OF ACCESS PANELS WITH ALL OTHER TRADES AND THE ARCHITECT.

ABBREVIATIONS

ACC	AIR COOLED CONDENSER
AAD	AUTOMATIC AIR DAMPER
AD	ACCESS DOOR
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
AP	ACCESS PANEL
AS	AIR SEPARATOR
ATC	AUTOMATIC TEMPERATURE CONTROL
B	BOILER
BDD	BACK-DRAFT DAMPER
BFP	BACK-FLOW PREVENTER
BFV	BUTTERFLY VALVE
BJ	BETWEEN JOISTS / BEAMS
BL STL	BLACK STEEL
BTUH	BRITISH THERMAL UNITS/HOUR
BV	BALL VALVE
C	CHILLER
CC	COOLING COIL
CD	COIL CONDENSATE DRAIN
CFM	CUBIC FEET PER MINUTE
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CLG	CEILING
CO	CLEAN OUT
CUH	CABINET UNIT HEATER
CV	CONVECTOR
DB	DRY BULB
DD	DUCT MOUNTED SMOKE DETECTOR
DN	DOWN
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE (°F)
EF	EXHAUST FAN
ESP	EXTERNAL STATIC PRESSURE
ET	EXPANSION TANK
FD	FIRE DAMPER
F/S D	FIRE AND SMOKE DAMPER
FCU	FAN COIL UNIT
FPB	FAN POWERED BOX
GC	GENERAL CONTRACTOR
GFU	GLYCOL FEED UNIT
GPM	GALLONS PER MINUTE
GV	GATE VALVE
H	HUMIDISTAT OR HUMIDITY SENSOR
HB	DRAIN VALVE WITH HOSE CONNECTION (HOSE BIBB)
HC	HVAC CONTRACTOR
HVAC	HEATING, VENTILATING & AIR CONDITIONING
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
KW	KILOWATT
L	LOUVER OR LIQUID (REFRIGERANT)
LAT	LEAVING AIR TEMPERATURE (°F)
LSD	LINEAR SLOT DIFFUSER
LSR	LINEAR SLOT RETURN
MAX	MAXIMUM
MBH	1000 BTUH
MANUF	MANUFACTURER
MIN	MINIMUM
OA	OUTDOOR AIR
OBD	OPPOSED BLADE DAMPER
P	PUMP
PC	PLUMBING CONTRACTOR
PD	PRESSURE DROP
PG	PRESSURE GAUGE
PRV	PRESSURE RELIEF VALVE
PV	PLUG VALVE
RA	RETURN AIR
RCD	ROUND CONE DIFFUSER
RCP	RADIANT CEILING PANEL (HOT WATER)
RL	REFRIGERANT LIQUID
RPM	REVOLUTIONS PER MINUTE
RS	REFRIGERANT SUCTION
SA	SUPPLY AIR
SCD	SQUARE CONE DIFFUSER (4-WAY BLOW PATTERN)
SD	SMOKE DAMPER
SF	SUPPLY FAN
SLD	SQUARE DIRECTIONAL DIFFUSER
SPD	SQUARE PLAQUE DIFFUSER
ST STL (SS)	STAINLESS STEEL
T	THERMOSTAT OR TEMPERATURE SENSOR
TB	TERMINAL BOX
TDV	TRIPLE DUTY VALVE
TJ	THRU JOISTS
UH	UNIT HEATER
VEL	VELOCITY
VFD	VARIABLE FREQUENCY DRIVE
VOL D (VD)	VOLUME DAMPER
WB	WET BULB

REVISIONS ▲

NEW STATE OFFICE BUILDING - FAIRMO
STATE OF WEST VIRGINIA
418 ADAMS STREET
FAIRMONT, WV

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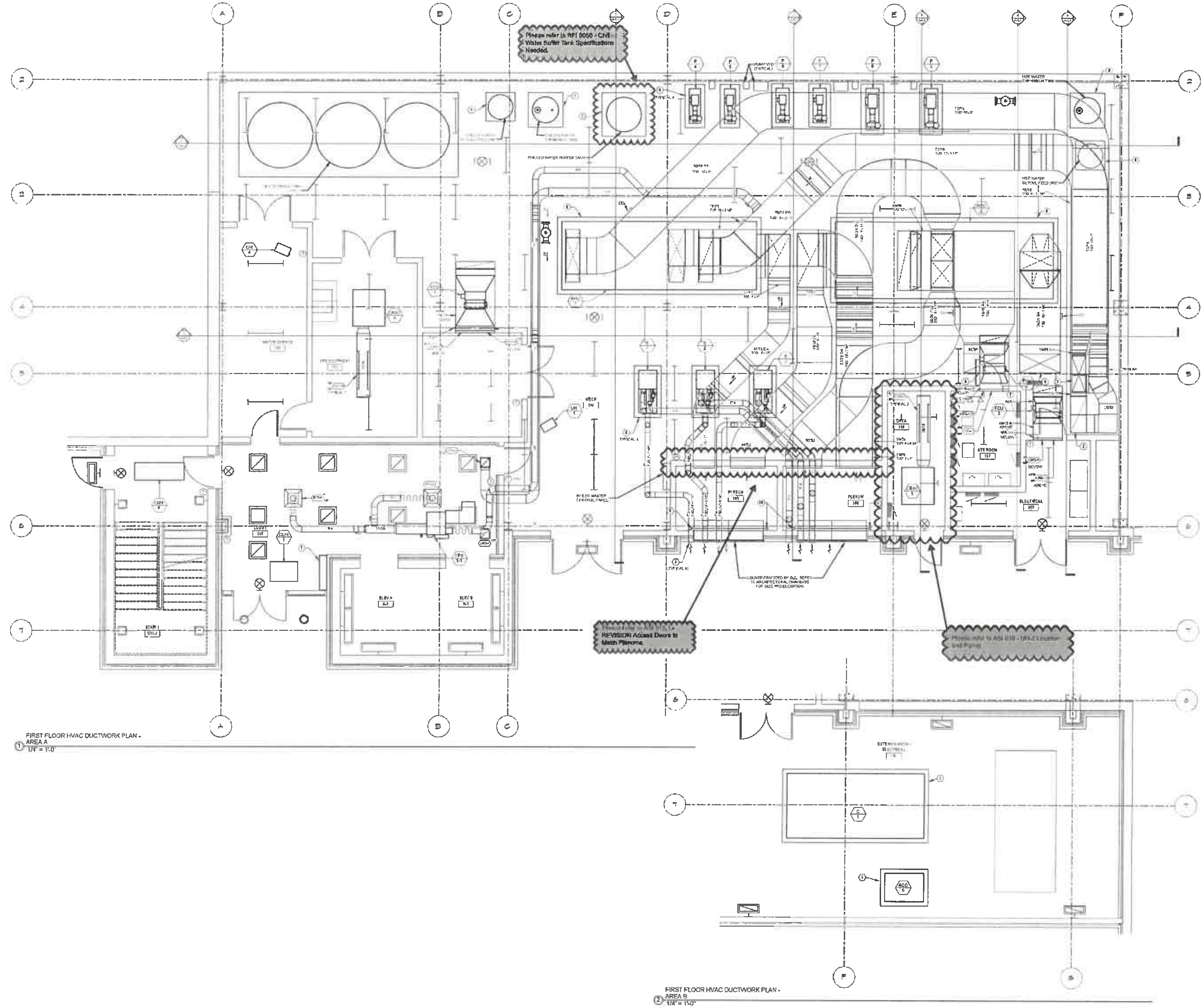
HVAC SYMBOLS AND ABBREVIATIO

H-1.0



FIRST FLOOR HVAC DUCTWORK PLAN - AREA A
1/4" = 1'-0"

FIRST FLOOR HVAC DUCTWORK PLAN - AREA B
1/4" = 1'-0"

CODED NOTES - SHEET H-1.1

1 COMBINE A 19/25 SA DUCT RISER AND A 28/19 SA DUCT RISER INTO A SINGLE 51/19 SA DUCT RISER USING A DIVIDED FLOW FITTING. CONTINUE DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.

2 50/22 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. SPLIT THE 50/22 RA DUCT INTO A 25/22 RA DUCT AND A 25/22 RA DUCT USING A DIVIDED FLOW FITTING. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.

3 58/26 SA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.

4 56/26 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.

5 6" CONCRETE EQUIPMENT PAD. EXTEND PAD 6" BEYOND ALL FOUR SIDES OF EQUIPMENT. REFER TO CONCRETE PAD (ON GRADE) DETAIL ON DRAWING H-4.1.

6 4" CONCRETE EQUIPMENT PAD. EXTEND PAD 6" BEYOND ALL FOUR SIDES OF EQUIPMENT. REFER TO CONCRETE PAD DETAIL ON DRAWING H-4.1.

7 FIRE FIGHTERS' SMOKE-CONTROL STATION. MOUNT BOTTOM OF STATION TO WALL 18" AFF.

8 BOILER FLUE AND COMBUSTION AIR DUCTS SHALL TERMINATE THROUGH SIDEWALL ABOVE LOUVERS. TERMINATE DUCTS WITH AN APPROVED WALL CAP AND THIMBLE FURNISHED BY THE BOILER MANUFACTURER. REFER TO ARCHITECTURAL DRAWINGS FOR ELEVATIONS.

9 PROVIDE A 48" x 96" AUTOMATIC AIR DAMPER ASSOCIATED WITH AHU-1. MOUNT DAMPER IN DUCT SLEEVE ATTACHED TO LOUVER.

10 PROVIDE A 48" x 96" AUTOMATIC AIR DAMPER ASSOCIATED WITH AHU-2. MOUNT DAMPER IN DUCT SLEEVE ATTACHED TO LOUVER.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
416 ADAMS STREET
FAIRMONT, WV

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03/06/2013

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FIRST FLOOR HVAC DUCTWORK PLAN

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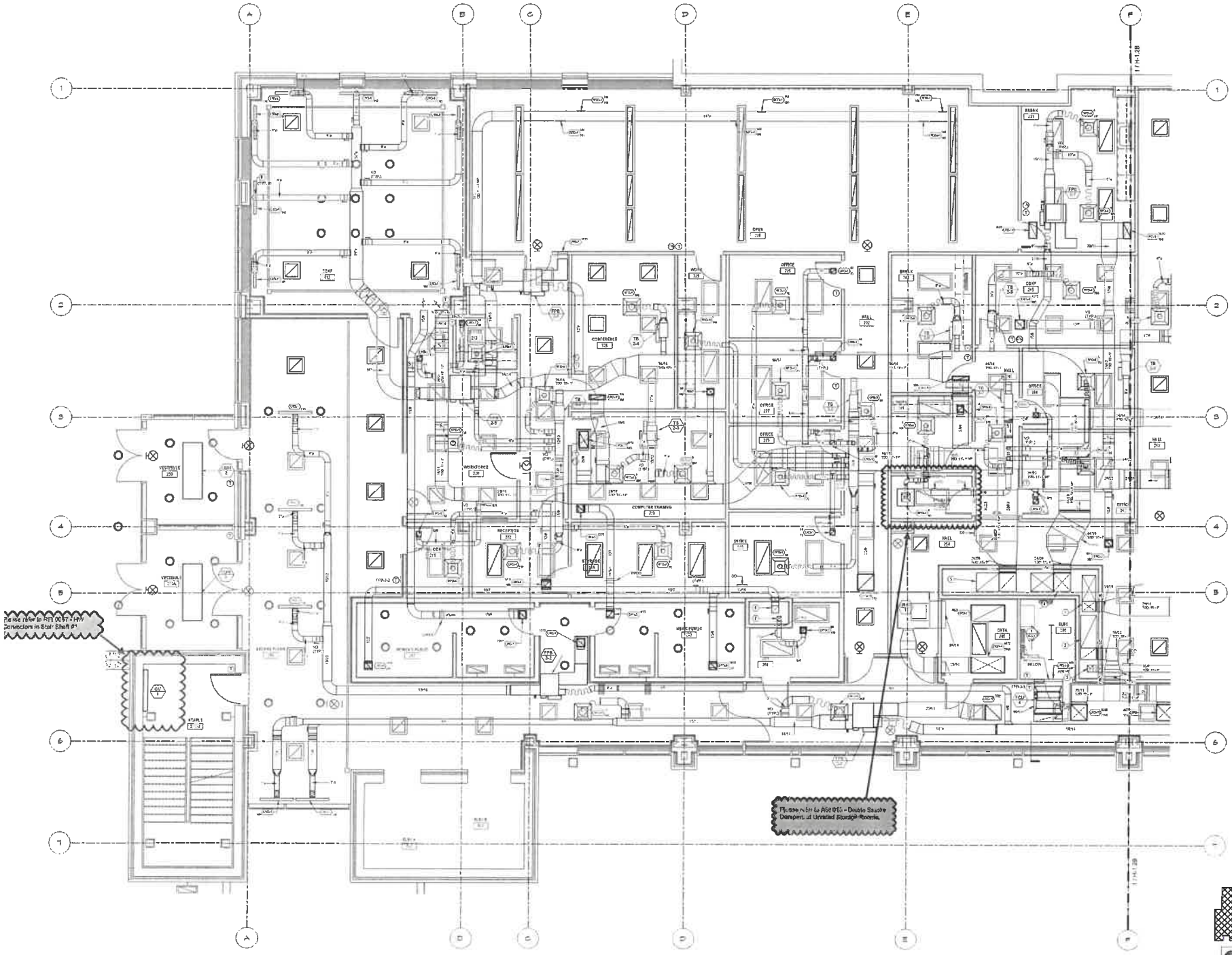
H-1.1



SECOND FLOOR HVAC DUCTWORK PLAN
1 AREA A
1/4" = 1'-0"

CODED NOTES - SHEET H-1.2A

1. 51/18 SA DUCT UP FROM FLOOR BELOW, SPLIT THE 51/18 SA DUCT INTO A 34/18 SA DUCT AND A 17/18 SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 17/18 SA DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS H-1.1 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
2. 46/22 RA DUCT DOWN FROM FLOOR ABOVE. COMBINE THE 46/22 RA DUCT AND THE 18/12 RA DUCT INTO A SINGLE 62/22 RA DUCT USING A DIVIDED FLOW FITTING. TRANSITION THE 62/22 RA DUCT INTO A 58/22 RA DUCT IN RISER AND CONTINUE THE 58/22 RA DUCT DOWN TO FLOOR BELOW. REFER TO DRAWINGS H-1.1 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
3. 10/6 EA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DWG. H-1.3A FOR CONTINUATION OF DUCT.
4. 56/26 SA DUCT UP FROM FLOOR BELOW, SPLIT THE 56/26 SA DUCT INTO A 32/26 SA DUCT AND A 24/26 SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 32/26 SA DUCT UP TO FLOOR ABOVE. PROVIDE COMBINATION FIRE/SMOKE DAMPERS AT SHAFT PENETRATIONS. REFER TO DRAWINGS H-1.1 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
5. 32/26 RA DUCT DOWN FROM FLOOR ABOVE. COMBINE THE 32/26 RA DUCT AND THE 24/26 RA DUCT INTO A SINGLE 56/26 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 56/26 RA DUCT DOWN TO FLOOR BELOW. PROVIDE COMBINATION FIRE/SMOKE DAMPERS AT SHAFT PENETRATIONS. REFER TO DRAWINGS H-1.1 AND H-1.3A FOR CONTINUATION OF DUCTWORK.
6. 10/10 ER DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.3A FOR CONTINUATION OF DUCT.
7. 6/6 EA DUCT UP IN SHAFT TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.3A FOR CONTINUATION OF DUCT.
8. 7"Ø SUPPLY DUCT DOWN TO LINEAR SLOT DIFFUSER. PROVIDE CUSTOM PLENUM BOX AND ATTACH TO DIFFUSER. PLENUM BOX SHALL BE A MINIMUM 10 INCHES HIGH AND SHALL BE INSULATED. TRANSITION SUPPLY DUCT AS NECESSARY AND CONNECT TO TOP OF PLENUM BOX.

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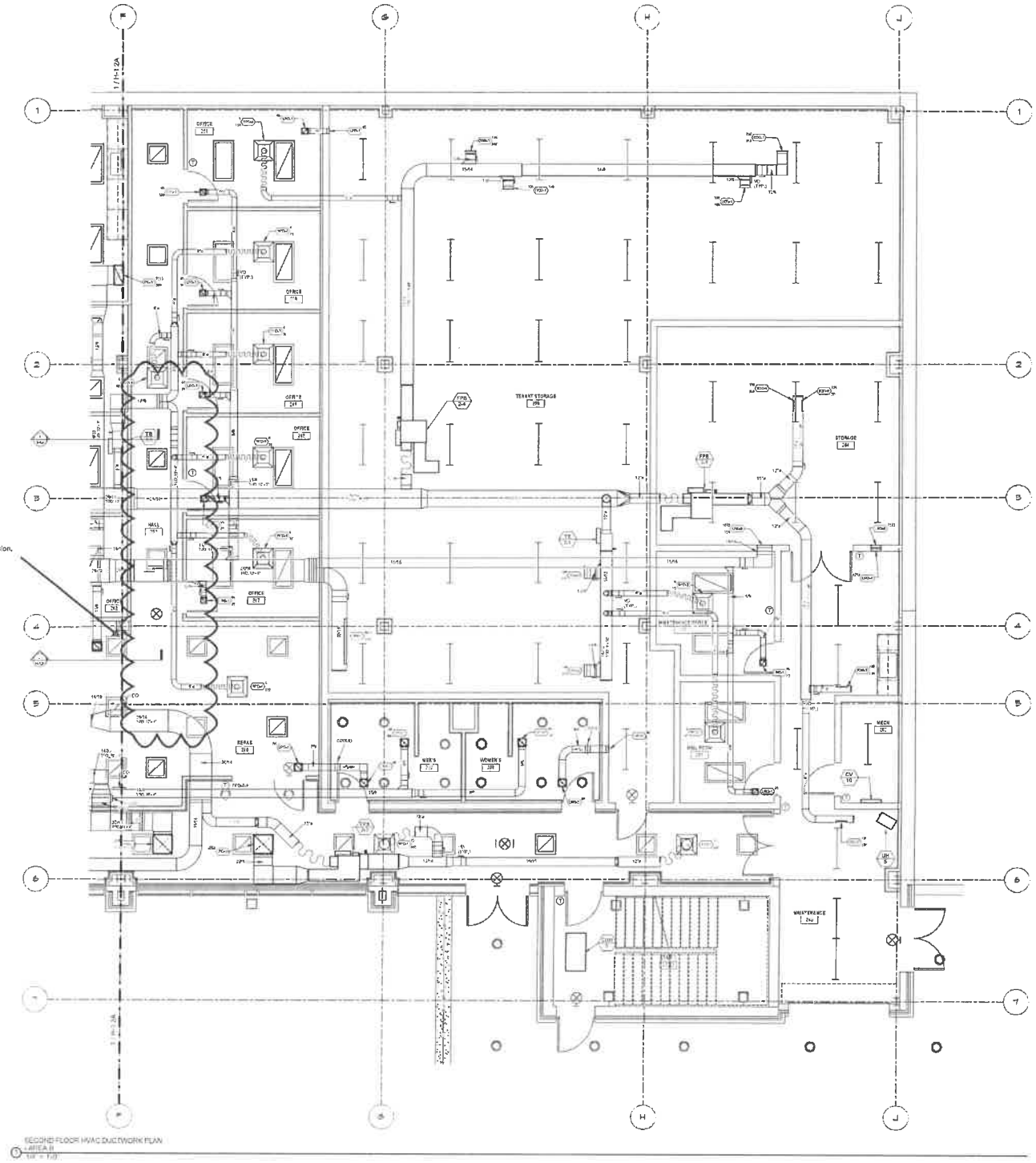
SECOND FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING

Project Number: 2011227

H-1.2A



SECOND FLOOR HVAC DUCTWORK PLAN - AREA B

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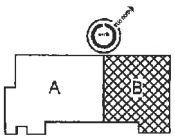

SECOND FLOOR HVAC DUCTWORK PLAN - AREA

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Project Number
2013127

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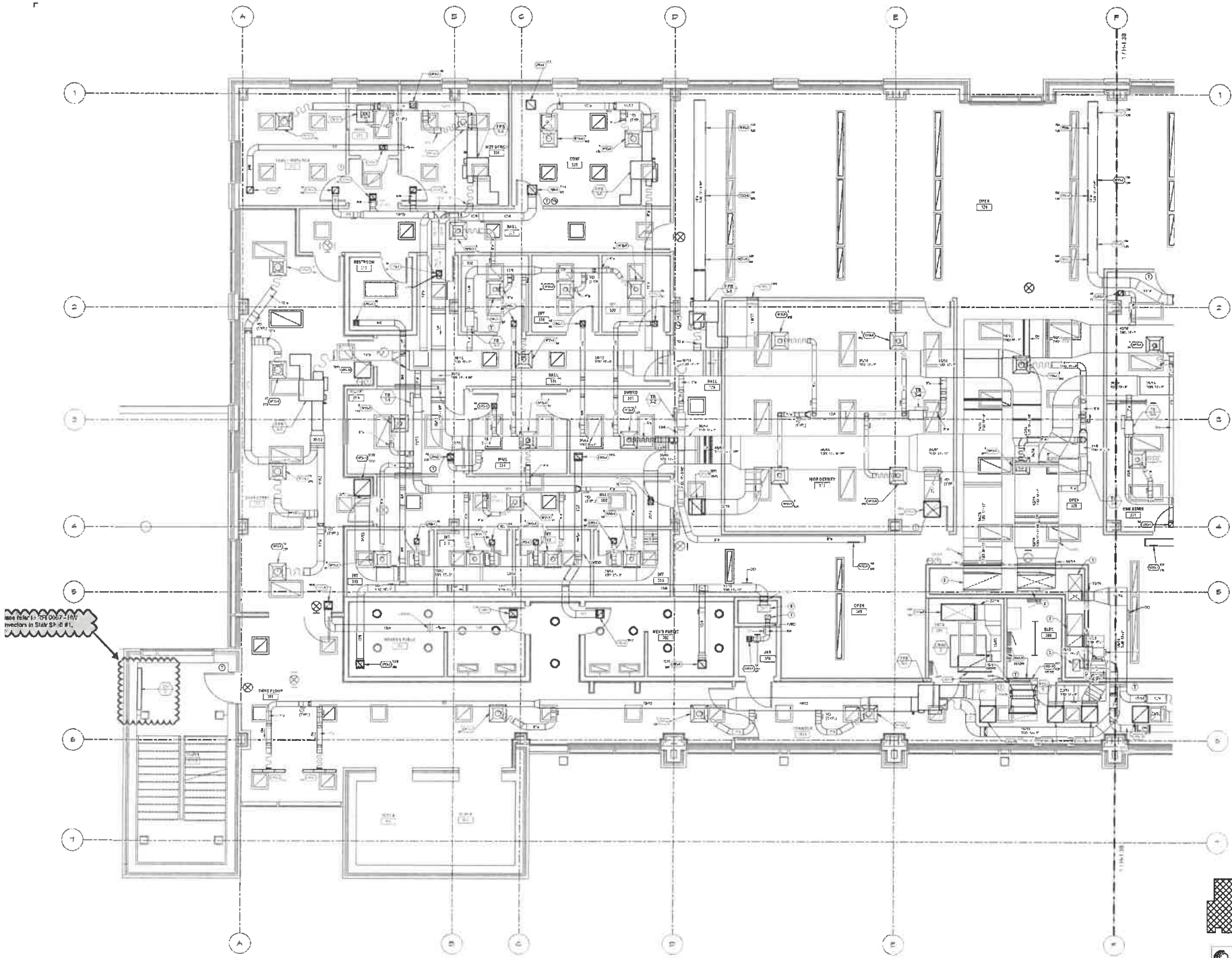

CODED NOTES - SHEET H-1.3A

1. 37/19 SA DUCT UP IN SHAFT FROM BELOW. SPLIT THE 37/19 DUCT INTO A 24/16 SA DUCT AND A 13/16 SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 24/16 SA DUCT UP TO FLOOR ABOVE. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
2. 36/22 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. COMBINE THE 36/22 RA DUCT AND THE 16/22 RA DUCT INTO A SINGLE 48/22 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 48/22 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
3. 10/8 EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 18/10 EA DUCT IN RISER UPSTREAM OF THE 10/10 BRANCH DUCT CONNECTION. CONTINUE THE 18/10 DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS H-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
4. 32/26 SA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 54/18 SA DUCT IN RISE AND CONTINUE ON THIRD FLOOR AS SHOWN. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
5. 54/32 RA DUCT DOWN IN SHAFT. TRANSITION TO A 32/28 RA DUCT IN RISE AND EXTEND DOWN TO FLOOR BELOW. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.2A FOR CONTINUATION OF DUCT.
6. 10/10 RA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 18/10 EA DUCT IN RISER UPSTREAM OF THE 10/10 BRANCH DUCT CONNECTION. CONTINUE THE 18/10 DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS H-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.
7. 6/6 EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 6/6 EA DUCT IN RISER UPSTREAM OF THE 6/6 BRANCH DUCT CONNECTION. CONTINUE THE 6/6 DUCT UP TO FLOOR ABOVE. REFER TO DRAWINGS H-1.2A AND H-1.4A FOR CONTINUATION OF DUCTWORK.

NEW STATE OFFICE BUILDING - FAIRMONT
213/15 OF WEST VIRGINIA
416 ADAMS STREET
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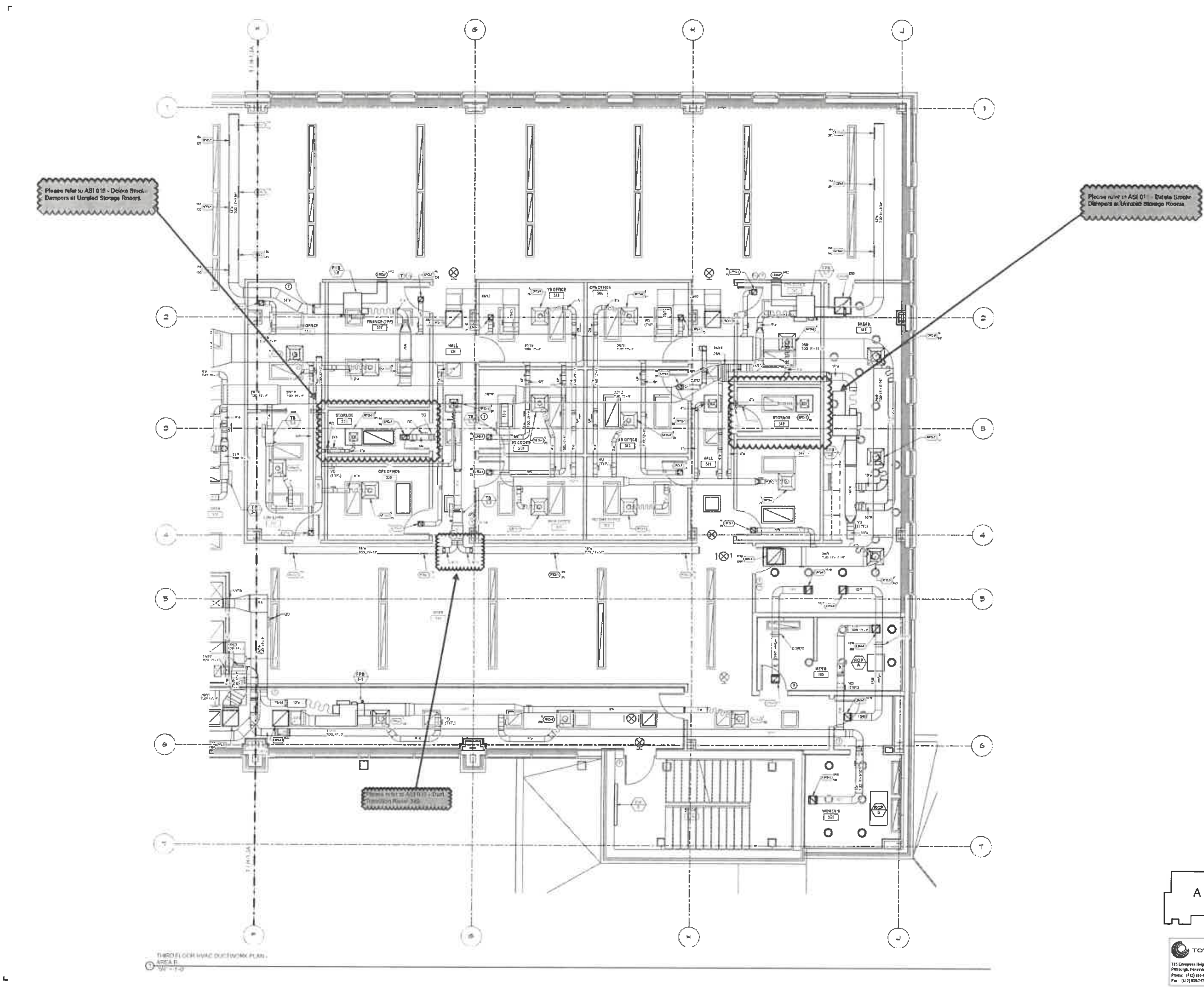
THIRD FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING

H-1.3A



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THIRD FLOOR HVAC DUCTWORK PLAN - AREA

H-1.3B

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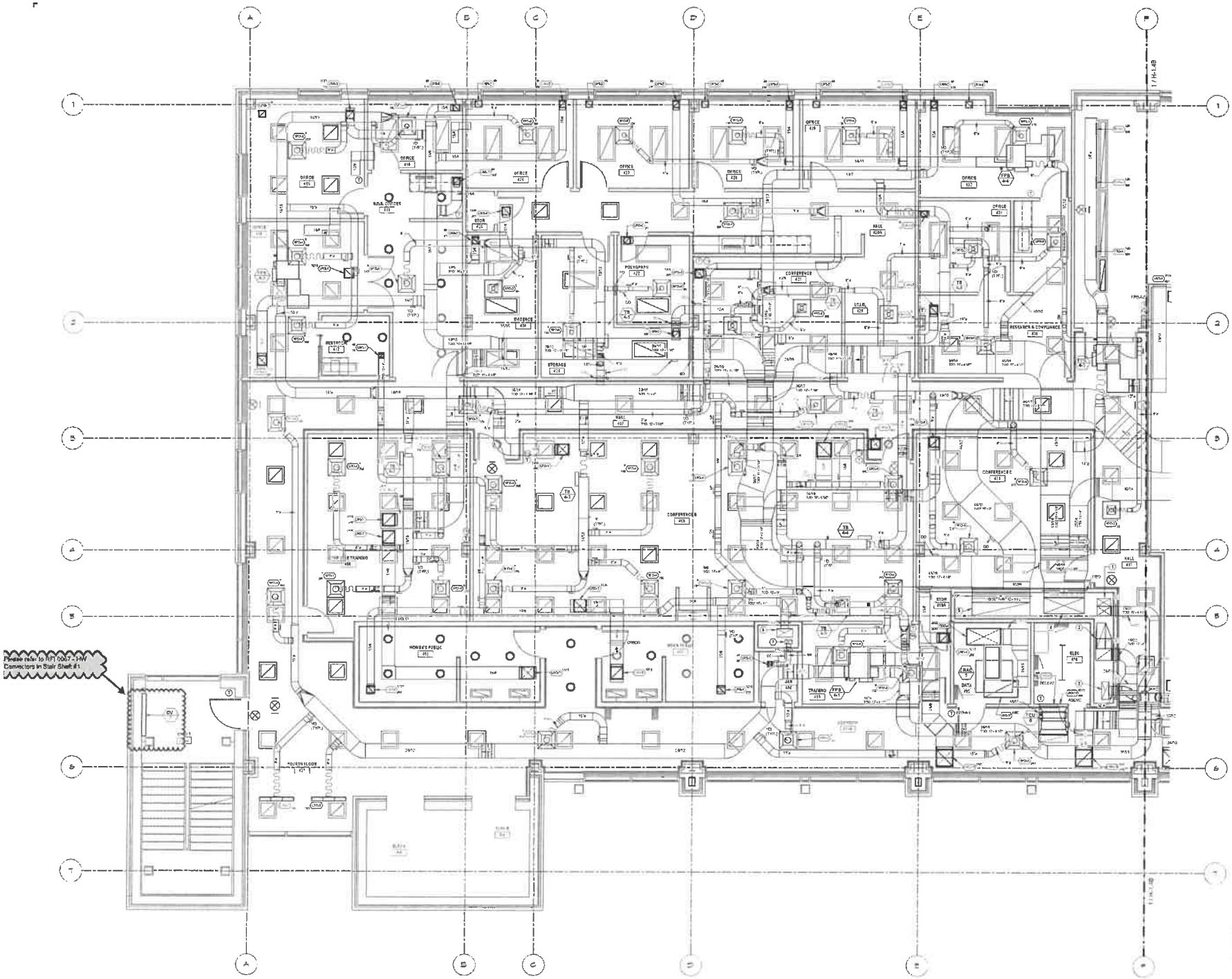


CODED NOTES - SHEET H-1.4A

1. 24/18 SA DUCT UP IN SHAFT FROM BELOW. SPLIT THE 24/18 SA DUCT INTO A 12/18 SA DUCT AND A 12/18 SA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 12/18 DUCT UP TO FLOOR ABOVE. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.3A AND H-1.5A FOR CONTINUATION OF DUCTWORK.
2. 36/12 RA DUCT DOWN IN SHAFT FROM FLOOR ABOVE. TRANSITION THE 36/12 DUCT TO A 14/22 DUCT AND COMBINE WITH A 16/22 RA DUCT INTO A SINGLE 30/22 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 30/22 RA DUCT DOWN TO FLOOR BELOW. PROVIDE A SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.3A AND H-1.5A FOR CONTINUATION OF DUCTWORK.
3. 18/18 EA DUCT UP IN SHAFT FROM FLOOR BELOW. TRANSITION TO A 24/18 EA DUCT UPSTREAM OF THE 12"Ø BRANCH DUCT. CONTINUE THE 24/18 EXHAUST DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.3A AND H-1.5A FOR CONTINUATION OF DUCTWORK.
4. 55/22 SA DUCT DOWN FROM FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.5A FOR CONTINUATION OF DUCT.
5. COMBINE THE 43/18 RA DUCT AND THE 33/18 RA DUCT INTO A SINGLE 60/18 RA DUCT USING A DIVIDED FLOW FITTING. CONTINUE THE 60/18 DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWING H-1.5A FOR CONTINUATION OF DUCT.
6. 18/18 EA DUCT UP FROM FLOOR BELOW. TRANSITION TO A 22/12 DUCT IN RISER UPSTREAM OF THE 8"Ø BRANCH DUCT CONNECTION. CONTINUE THE 22/12 DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.3A AND H-1.5A FOR CONTINUATION OF DUCTWORK.
7. 8/8 EA DUCT UP FROM FLOOR BELOW. TRANSITION TO A 10/6 DUCT IN RISER UPSTREAM OF THE 6"Ø BRANCH DUCT CONNECTION. CONTINUE THE 10/6 DUCT UP TO FLOOR ABOVE. PROVIDE A COMBINATION FIRE/SMOKE DAMPER AT SHAFT PENETRATION. REFER TO DRAWINGS H-1.3A AND H-1.5A FOR CONTINUATION OF DUCTWORK.

NEW STATE OFFICE BUILDING - FAIRMONT
STATE OF WEST VIRGINIA
4TH AVENUE & FIRST STREET
FAIRMONT, WV

BID DOCUMENTS
03/06/2013

omi associates

A B

FOURTH FLOOR HVAC DUCTWORK PLAN - AREA

TOWER ENGINEERING

H-1.4A

ADDENDUM ACKNOWLEDGEMENT FORM
SOLICITATION NO.: CRFQ GSD2300000029

Instructions: Please acknowledge receipt of all addenda issued with this solicitation by completing this addendum acknowledgment form. Check the box next to each addendum received and sign below. Failure to acknowledge addenda may result in bid disqualification.

Acknowledgment: I hereby acknowledge receipt of the following addenda and have made the necessary revisions to my proposal, plans and/or specification, etc.

Addendum Numbers Received:
(Check the box next to each addendum received)

☑ Addendum No. 1	☐ Addendum No. 6
☑ Addendum No. 2	☐ Addendum No. 7
☐ Addendum No. 3	☐ Addendum No. 8
☐ Addendum No. 4	☐ Addendum No. 9
☐ Addendum No. 5	☐ Addendum No. 10

I understand that failure to confirm the receipt of addenda may be cause for rejection of this bid. I further understand that any verbal representation made or assumed to be made during any oral discussion held between Vendor's representatives and any state personnel is not binding. Only the information issued in writing and added to the specifications by an official addendum is binding.

CP&H INC (CITY PLUMBING & HEATING)
Company

Authorized Signature

3/1/2023
Date

NOTE: This addendum acknowledgement should be submitted with the bid to expedite document processing.

Department of Administration
Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Centralized Request for Quote
Construction

Proc Folder: 1165141
Doc Description: Building 54 HVAC Modifications Project
Proc Type: Central Purchase Order

Reason for Modification:
Addendum No. 2

Date Issued	Solicitation Closes	Solicitation No	Version
2023-02-17	2023-03-01 13:30	CRFQ 0211 GSD2300000029	3

BID RECEIVING LOCATION

BID CLERK
DEPARTMENT OF ADMINISTRATION
PURCHASING DIVISION
2019 WASHINGTON ST E
CHARLESTON WV 25305
US

VENDOR

Vendor Customer Code: 000000206308
Vendor Name : CP&H, Inc. dba City Plumbing & Heating
Address : 1500 Morgantown Industrial Park
Street :
City : Morgantown
State : WV **Country :** United States **Zip :** 26501
Principal Contact : Jay Wade
Vendor Contact Phone: 304-296-7135 **Extension:**

FOR INFORMATION CONTACT THE BUYER
Melissa Pettrey
(304) 558-0094
melissa.k.pettrey@wv.gov

Vendor Signature X **FEIN#** 55-0683597 **DATE** 3/1/23

All offers subject to all terms and conditions contained in this solicitation

ADDITIONAL INFORMATION

Addendum No. 2 is issued to publish and distribute the attached information to the vendor community.

****

Request for Quotation
*CONSTRUCTION**

The West Virginia Purchasing Division is soliciting bids on behalf of the WV Department of Administration, General Services Division ("Agency" and "Owner") to establish a contract for HVAC Modifications for Building 54 in Fairmont, WV., per the bid requirements, specifications and terms and conditions as attached hereto.

PROJECT MANUALS AND DRAWINGS ARE NOT ATTACHED TO THIS SOLICITATION. SEE SECTION 12 OF THE GENERAL CONSTRUCTION SPECIFICATIONS FOR MORE INFORMATION*

INVOICE TO		SHIP TO	
DEPARTMENT OF ADMINISTRATION		DEPARTMENT OF ADMINISTRATION	
GENERAL SERVICES DIVISION		GENERAL SERVICES DIVISION - BLDG 54	
103 MICHIGAN AVENUE		400 ADAMS ST	
CHARLESTON	WV	FAIRMONT	WV
US		US	

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Base Bid				

Comm Code	Manufacturer	Specification	Model #
72151201			

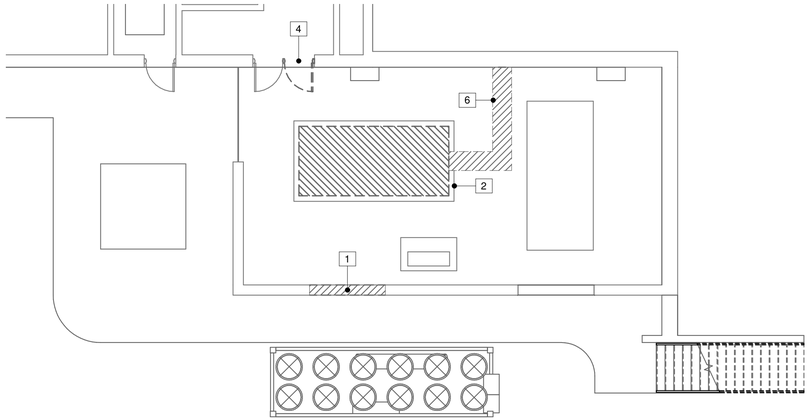
Extended Description:
Building 54 HVAC Modifications Project - per specifications

BUILDING 54 HVAC RENOVATIONS - REBID

WEST VIRGINIA OFFICE
54 WEST RUN ROAD
MORGANTOWN, WV 26508
PHONE: (304) 291 - 2234

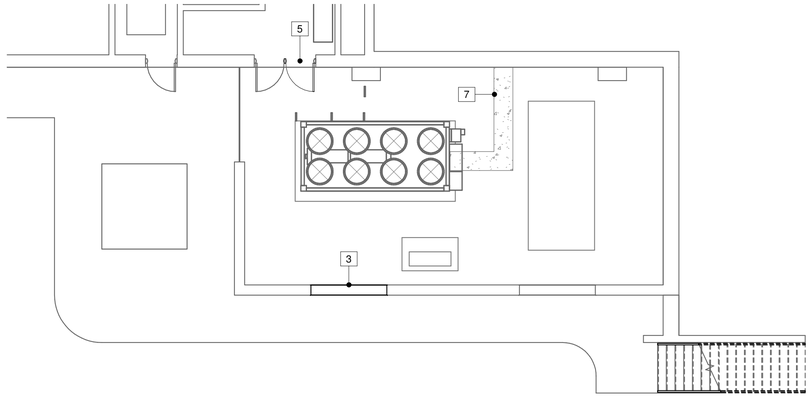
PENNSYLVANIA OFFICE
429 LAUREL RUN ROAD
CARMICHAELS, PA 15320
PHONE: (724) 966 - 5655

MEI PROJECT #21013	
DWG	**TITLE**
GENERAL	
G000	COVER PAGE
G101	GENERAL TRADES DEMOLITION & NEW FIRST FLOOR PLANS
MECHANICAL	
M000	MECHANICAL ABBREVIATIONS
M001	MECHANICAL DEMOLITION FIRST FLOOR PLAN
M002	MECHANICAL DEMOLITION SECOND & THIRD FLOORS
M003	MECHANICAL DEMOLITION FOURTH & FIFTH FLOORS
M004	MECHANICAL DEMOLITION ROOF PLAN
M101	MECHANICAL FIRST FLOOR PLAN
M102	MECHANICAL SECOND & THIRD FLOOR PLANS
M103	MECHANICAL FOURTH & FIFTH FLOOR PLANS
M104	MECHANICAL ROOF PLAN
M501	MECHANICAL DETAILS
M502	MECHANICAL DETAILS
M503	MECHANICAL DETAILS
M601	MECHANICAL SCHEDULE
ELECTRICAL	
E000	ELECTRICAL ABBREVIATIONS
E001	ELECTRICAL DEMOLITION FIRST FLOOR PLAN
E101	ELECTRICAL FIRST FLOOR PLAN
E102	ELECTRICAL SECOND AND THIRD FLOOR PLANS
E103	ELECTRICAL FOURTH AND FIFTH FLOOR PLANS



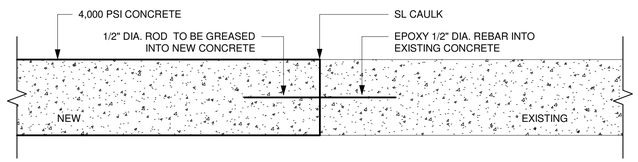
1 FIRST FLOOR GENERAL TRADES DEMOLITION PLAN

1/8" = 1'-0"



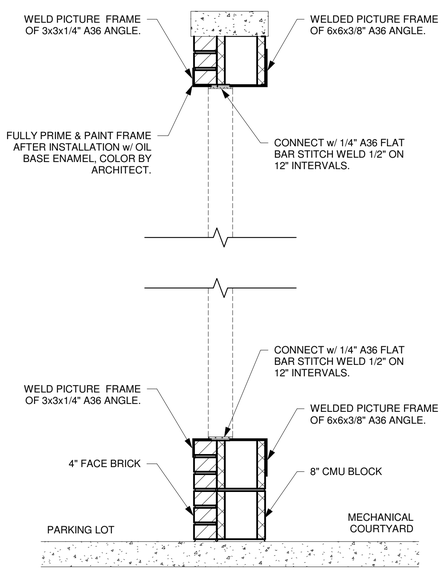
2 FIRST FLOOR GENERAL TRADES PLAN

1/8" = 1'-0"



3 FLOOR SLAB CONNECTION DETAIL

DRAWING NOT SCALABLE



4 LOUVER SUPPORT DETAIL

DRAWING NOT SCALABLE

SHEET NOTES

1. CAREFULLY DEMO WALL FOR INSTALLATION OF NEW 8'x8' LOUVER. OFFSET FROM TOP OF WALL TO MATCH EXISTING LOUVER.
2. EXISTING CHILLER PAD TO REMAIN.
3. SEE LOUVER SUPPORT DETAIL (THIS SHEET) FOR ADDITIONAL INFORMATION.
4. DEMO EXISTING DOOR. SAVE EXISTING HARDWARE FOR RE-INSTALLATION.
5. INSTALL NEW FIRE RATED DOOR TO MATCH EXISTING. PAINT TO MATCH EXISTING. RE-INSTALL EXISTING HARDWARE FROM DEMOED DOOR.
6. SAWCUT SLAB AND EQUIPMENT PAD AND EXCAVATE FOR NEW UNDERGROUND CONDUIT TO CHILLER.
7. REPLACE DEMOED CONCRETE WITH NEW PER DETAIL 3 SHEET G101.

MILLER ENGINEERING, INC.

WV OFFICE:
54 WEST RUN ROAD
MORGANTOWN, WV 26508
PH: (304) 291-2234

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429 LAUREL RUN ROAD
CARMICHAELS, PA 15320
PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

CONSTRUCTION DOCUMENTS

NO.	DESCRIPTION	DATE

PROJECT NUMBER:	21013
ORIGINAL PAGE SIZE:	22x34
DESIGNED BY:	BCM
DRAWN BY:	JMM
CHECKED BY:	BCM

SHEET NAME:

GENERAL TRADES DEMOLITION & NEW FIRST FLOOR PLANS

G101

MECHANICAL ABBREVIATIONS

SYMBOLS	
#	NUMBER
&	AND
°	DEGREES
ºF	DEGREES FAHRENHEIT
A	
AAV	AUTOMATIC AIR VENT
ABV	ABOVE
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
ALT	ALTERNATE
ALUM	ALUMINUM
APPROX	APPROXIMATELY
AUX	AUXILIARY
AVG	AVERAGE
B	
BFV	BUTTERFLY VALVE
BH	BASEBOARD HEATER
BHP	BRAKE HORESPOWER
BLR	BOILER
BTUH	BRITISH THERMAL UNIT PER HOUR
BV	BALL VALVE
C	
CA	COMPRESSED AIR
CAP	CAPACITY
CFM	CUBIC FEET PER MINUTE
CHKV	CHECK VALVE
CIRC	CIRCULATING
CI	CAST IRON
CKT	CIRCUIT
CMU	CONCRETE MASONARY UNIT
C/O	CLEAN OUT
CON	CONDENSATE
CONT	CONTINUATION
CT	COOLING TOWER
CU	CONDENSING UNIT
D	
DIA	DIAMETER
DWG	DRAWING
DWH	DOMESTIC WATER HEATER
E	
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE(ºF)
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
EFF	EFFICIENCY
ELEC	ELECTRIC
ELEV	ELEVATION
EQUIP	EQUIPMENT
ESP	EXTERNAL STATIC PRESSURE
EXH	EXHAUST
EXIST	EXISTING
EWT	ENTERING WATER TEMPERATUR(ºF)
F	
ºF	FAHRENHEIT
FCU	FAN COIL UNIT
FD	FIRE DAMPER/FLOOR DRAIN
FLA	FULL LOAD AMPS
FLR	FLOOR
FO	FLAT OVAL
FPM	FEET PER MINUTE
FPS	FEET PER SECOND
FT	FEET
G	
GAS	NATURAL GAS
GALV	GALVANIZED
GA	GAUGE
GC	GENERAL CONTRACTOR
GLV	GLOBE VALVE
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GV	GATE VALVE
H	
HCWL	HYDRONIC CHILLED WATER LOOP
HCWR	HYDRONIC CHILLED WATER RETURN
HCWS	HYDRONIC CHILLED WATER SUPPLY
HHWL	HYDRONIC HOT WATER LOOP
HHWR	HYDRONIC HOT WATER RETURN
HHWS	HYDRONIC HOT WATER SUPPLY
HORIZ	HORIZONTAL
HP	HORSEPOWER/HEAT PUMP
HR	HOUR
HTG	HEATING
HVAC	HEATING, VENTILATING, AND AIR CONDITIONING
HZ	HERTZ
I	
ID	INSIDE DIAMETER
IN	INCHES
INV	INVERT
J	
JB	JUNCTION BOX
K	
KW	KILOWATT
KWH	KILOWATT HOUR
L	
LAT	LEAVING AIR TEMPERATURE(ºF)
LBS	POUNDS
LBS/HR	POUNDS PER HOUR
LF	LINEAR FEET
LP	LIQUID PROPANE
LV	LOUVER
LVG	LEAVING
LWT	LEAVING WATER TEMPERATURE(ºF)
M	
MAU	MAKE-UP AIR UNIT
MAV	MANUAL AIR VENT
MAX	MAXIUM
MBH	THOUSAND BTUH
MC	MECHANICAL CONTRACTOR
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MFG	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MS	MINI-SPLIT SYSTEM
N	
N/A	NOT APPLICABLE
NC	NORMALLY CLOSED; NOISE CRITERIA
NEC	NATIONAL ELECTRICAL CODE
NEG	NEGATIVE
NFC	NATIONAL FIRE CODE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NO	NORMALLY OPEN
NTS	NOT TO SCALE
O	
OA	OUTSIDE AIR
OC	ON CENTER
OCC	OCCUPANCY
OD	OUTSIDE DIAMETER
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
OSV	OIL SAFETY VALVE
OZ	OUNCE
P	
P	PUMP
PC	PLUMBING CONTRACTOR
PNL	PANEL
PRV	PRESSURE REDUCING VALVE
PSI	POUNDS PER SQUARE INCH
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAGE
PTAC	PACKAGED TERMINAL AIR CONDITIONER
Q	
QTY	QUANTITY
R	
RA	RETURN AIR
RAD	RADIATOR
RCP	RADIANT CEILING PANEL
REFRIG	REFRIGERANT
REQD	REQUIRED
REV	REVISION
RH	RELATIVE HUMIDITY
RPM	REVOLUTIONS PER MINUTE
RV	RELIEF VALVE
S	
SA	SUPPLY AIR
SCH	SCHEDULE
SD	SMOKE DAMPER
SENS	SENSIBLE
SP	STATIC PRESSURE (INCHES OF WATER)
SPEC	SPECIFICATION
SQ	SQUARE
SQFT	SQUARE FOOT
SS	STAINLESS STEEL
STD	STANDARD
STRUCT	STRUCTURAL
T	
T	THERMOSTATE
TA	TRANSFER AIR
TCV	TEMPERATURE CONTROL VALVE
TDV	TRIPLE DUTY VALVE
TEMP	TEMPERATURE
TOT	TOTAL
TRANS	TRANSITION
TSTAT	THERMOSTAT
TV	TURNING VANES
TYP	TYPICAL
U	
UH	UNIT HEATER
UV	UNIT VENTILATOR
V	
VOLTS	VOLTAGE
VA	VOLT AMPERES
VAC	VACUUM
VAV	VARIABLE AIR VOLUME
VEL	VELOCITY
VERT	VERTICAL
VFD	VARIABLE FREQUENCY DRIVE
VOL	VOLUME
VOLTS	VOLTAGE
VRF	VARIABLE REFRIGERANT FLOW
VVT	VARIABLE VOLUME AND TEMPERATURE
W	
W/	WITH
W/O	WITHOUT
WP	WEATHERPROOF
WT	WEIGHT
Z	
Z	ZONE
ZCV	ZONE CONTROL VALVE

MECHANICAL NOTES

1. PROVIDE ALL MATERIALS AND EQUIPMENT AND PERFORM ALL LABOR REQUIRED TO INSTALL, COMPLETE, AND OPERATE AS INDICATED ON THE DRAWINGS, SPECIFICATIONS, AND REQUIRED BY CODE.
2. PROVIDE AIR LOUVERS w/ GRAVITY BACKDRAFT DAMPERS. ALL EXTERIOR LOUVERS WILL HAVE 60% MIN. OPEN AREA INSTALL ALL w/ BIRD SCREEN. COLORS BY OWNER/ARCHITECT. COORDINATE LOCATIONS w/ GENERAL CONTRACTOR.
3. UNLESS OTHERWISE SHOWN, LOCATE ALL ROOM THERMOSTATS AND HUMIDISTATS AT 5'-0" ABOVE FINISHED FLOOR. FINAL THERMOSTAT LOCATION BY OWNER/ARCHITECT.
4. LOCATE ALL MECHANICAL EQUIPMENT FOR UN-OBSTRUCTED ACCESS TO UNIT ACCESS PANELS, CONTROL, AND VALVING.
5. PERFORM WORK IN ACCORDANCE w/ CURRENT INTERNATIONAL MECHANICAL CODE, FUEL GAS CODE, ASHRAE, SMACNA, STATE, AND LOCAL CODES AND REQUIREMENTS.
6. VERIFY ALL FIELD CONDITIONS AND MEASUREMENTS PRIOR TO BIDDING. COORDINATE ALL WORK w/ OTHER TRADES. COORDINATE ALL CEILING MOUNTED DEVICES w/ ALL OTHER TRADES PRIOR TO INSTALLATION. FINAL COORDINATION OF SCOPE OF WORK, DIMENSIONS, FIXTURE PLACEMENT, ROUTING ETC. IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR AND ALL SUB-CONTRACTORS PRIOR TO BIDDING.

PIPING NOTES

1. PROVIDE ALL MATERIALS AND EQUIPMENT AND PERFORM ALL LABOR REQUIRED TO INSTALL COMPLETE AND OPERABLE PIPING SYSTEMS AS INDICATED ON THE DRAWINGS, SPECIFICATIONS, AND REQUIRED BY CODE.
2. PROVIDE BALL VALVE STOPS AT ALL FIXTURES. PROVIDE UNIONS, DIRT LEGS, AND REGULATORS ON ALL EQUIPMENT.
3. COORDINATE ALL STUB-UPS AND FIELD ADJUST LOCATIONS FOR COORDINATION AS NECESSARY. AVOID EXCESSIVE ADDITIONAL PIPE FITTINGS.
4. PROVIDE AN AIR VENT AT THE HIGH POINT OF EACH DROP IN THE HEATING WATER, CHILLED WATER, AND OTHER CLOSED WATER PIPING SYSTEMS. ALL PIPING SHALL GRADE TO LOW POINTS. PROVIDE HOSE END DRAIN VALVES AT BOTTOM OF RISERS AND LOW POINTS.
5. UNLESS OTHERWISE NOTED, ALL PIPING IS TO BE OVERHEAD, TIGHT TO UNDERSIDE OF STRUCTURE OR DECK w/ SPACE FOR INSULATION.
6. INSTALL PIPING SO THAT ALL VALVES, STRAINERS, UNIONS, TRAPS, FLANGES, ETC. ARE ACCESSIBLE.
7. ALL BALANCING VALVES AND BUTTERFLY VALVES SHALL BE PROVIDED w/ POSITION INDICATORS AND MANUAL ADJUSTABLE STOPS.
8. ALL VALVES (EXCEPT CONTROL VALVES) AND STRAINERS SHALL BE FULL SIZE OF PIPE BEFORE REDUCING SIZE TO MAKE CONNECTIONS TO EQUIPMENT AND CONTROLS.
9. UNIONS AND/OR FLANGES SHALL BE INSTALLED AT EACH PIECE OF EQUIPMENT, IN BYPASSES, AND IN LONG PIPING RUNS TO PERMIT DISASSEMBLY FOR ALTERATIONS AND REPAIRS.
10. ALL PIPING SHALL CLEAR DOORS AND WINDOWS. ALL VALVES SHALL BE ADJUSTED FOR SMOOTH AND EASY OPERATION.
11. ALL PIPING WORK SHALL BE COORDINATED w/ ALL TRADES INVOLVED. OFFSETS IN PIPING AROUND OBSTRUCTIONS SHALL BE PROVIDED AT NO ADDITIONAL COST TO THE OWNER.
12. PROVIDED FLEXIBLE CONNECTIONS IN ALL PIPING SYSTEMS CONNECTED TO PUMPS, CHILLERS, COOLING TOWERS, AND OTHER EQUIPMENT WHICH REQUIRE VIBRATION ISOLATION EXCEPT WATER COILS.
13. ALL WORK TO MEET REQUIREMENTS OF CURRENT INTERNATIONAL PLUMBING CODE, INTERNATIONAL MECHANICAL CODE, APPLICABLE LOCAL CODES, LOCAL UTILITY REQUIREMENTS, AND THE INTERNATIONAL FUEL GAS CODE.
14. FINAL COORDINATION OF SCOPE OF WORK, DIMENSIONS, FIXTURE PLACEMENT, ROUTING, ECT. IS THE RESPONSIBILITY OF THE PRIME CONTRACTOR AND ALL SUB-CONTRACTORS PRIOR TO BIDDING.

HVAC BASIS OF EQUIPMENT

A. SPACE SET POINTS:
   1. GENERAL SPACES SETPOINTS
      a. COOLING: 72°F, 55% RH
      b. HEATING: 70°F
B. OUTSIDE AIR CONDITIONS
   1. SUMMER: 91°F WB, 72°F DB
   2. WINTER: 2°F DB, 0°F WB

MILLER ENGINEERING, INC.

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PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

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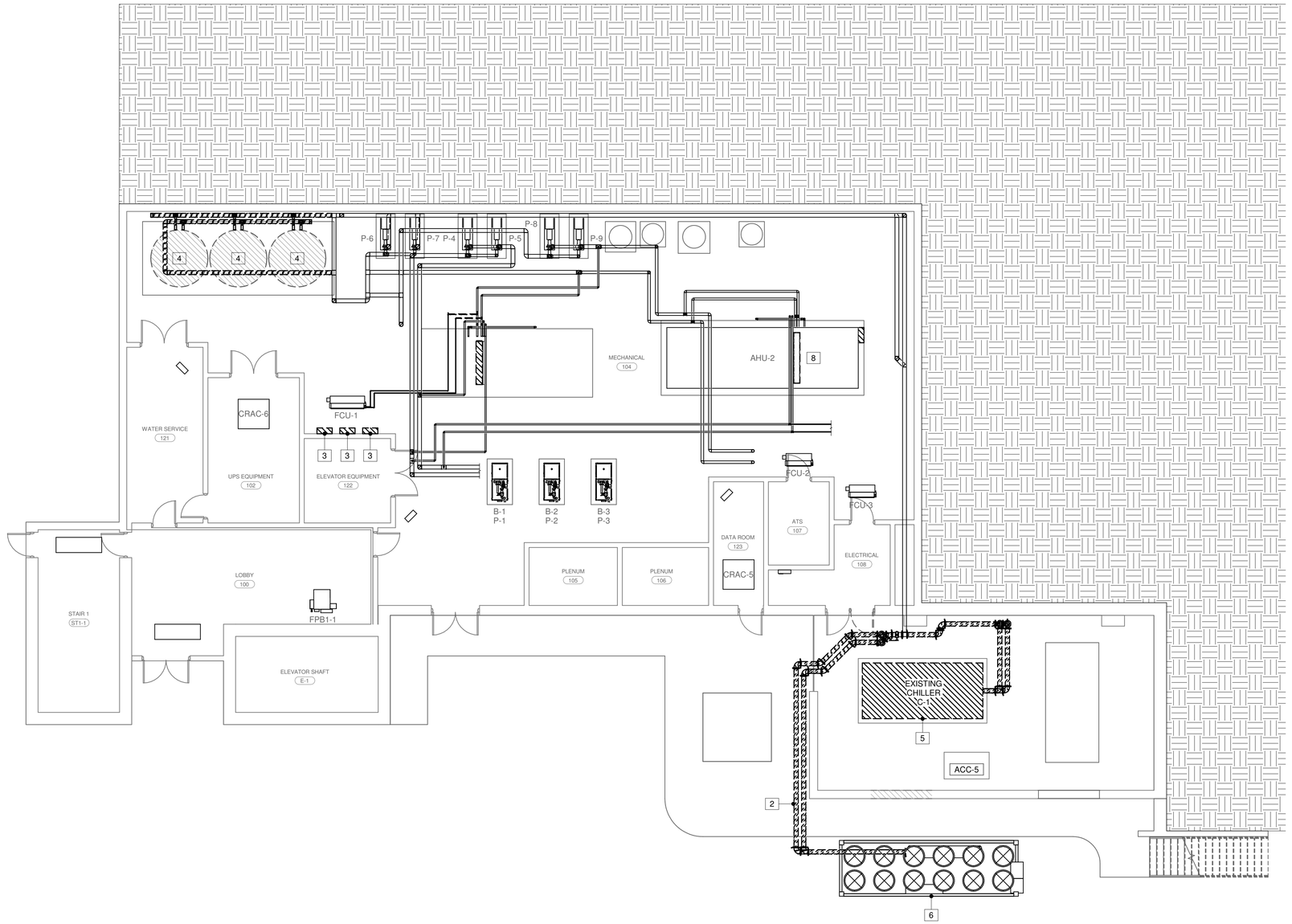
MECHANICAL ABBREVIATIONS

M000



1 FIRST FLOOR MECHANICAL DEMOLITION PLAN

1/8" = 1'-0"

SHEET NOTES

1. SELECTIVELY DEMO CONTROLS TO ALL DEVICES AND SYSTEMS CONTROLLED AND MONITORED BY BAS, FOR REPLACEMENT. ICE STORAGE CONTROLS WILL NOT BE REPLACED. AS ICE SYSTEM IS DEMOED , DEMO ALL ICE RELATED CONTROLS.
2. FLEXIBLE PIPING BY OTHERS.
3. SELECTIVELY DEMO BAS PANELS FOR REPLACEMENT IN SAME LOCATION.
4. DEMO ICE STORAGE AND ALL ASSOCIATED PIPING, WIRING, ETC. CONCRETE PAD TO REMAIN.
5. DEMO EXISTING CHILLER AND ASSOCIATED PIPING, WIRING, ETC.
6. TEMPORARY RENTAL CHILLER TO REMAIN IN PLACE UNTIL NEW CHILLER IS IN SERVICE. RENTAL CHILLER AND TEMPORARY PIPING / POWER BY OTHERS.
7. SELECTIVELY DEMO COOLING COIL IN AHU-1, ALONG WITH CONNECTION PIPING, ETC. FOR INSTALLATION OF NEW COIL. REMOVE COOLING AS TO NOT TO DAMAGE HEATING COIL.
8. SELECTIVELY DEMO HEATING AND COOLING COILS IN AHU-2, ALONG WITH CONNECTION PIPING, ETC. FOR INSTALLATION OF NEW COILS.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

MILLER ENGINEERING, INC.

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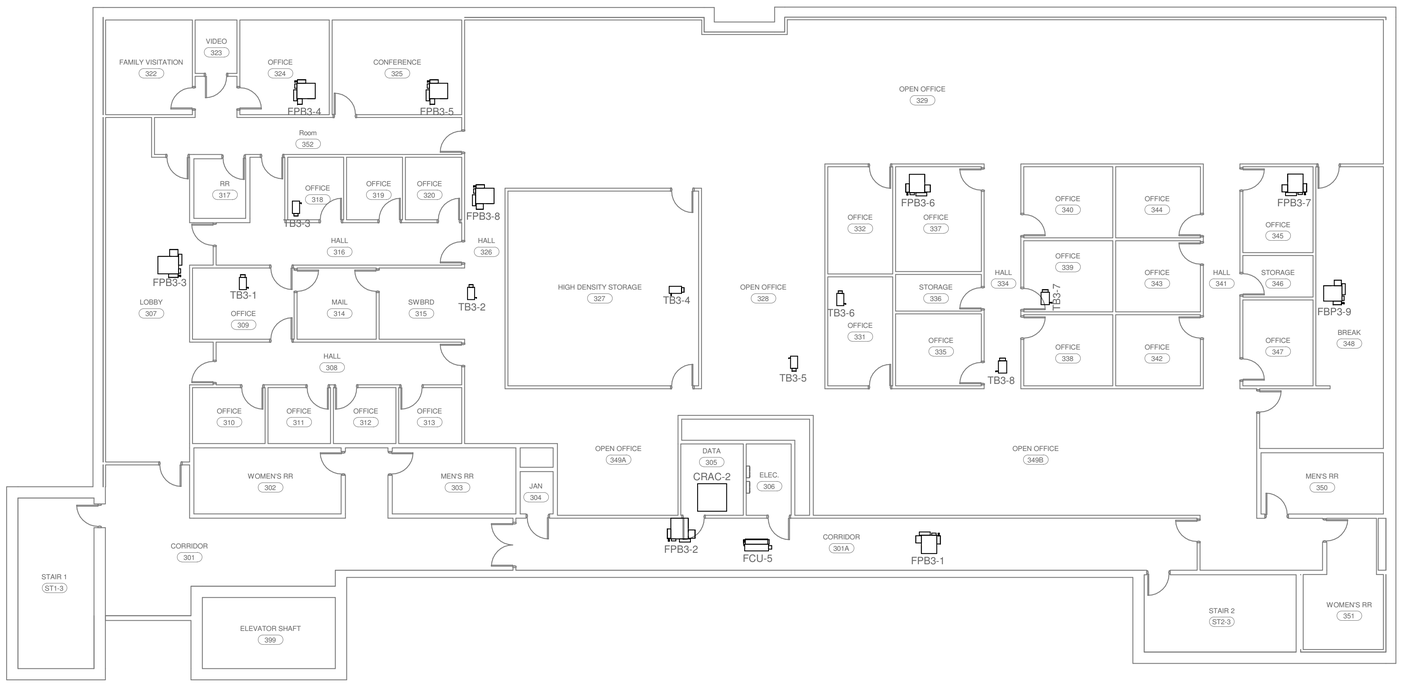
MECHANICAL DEMOLITION FIRST FLOOR PLAN

M001

1 SECOND FLOOR MECHANICAL DEMOLITION PLAN

3/32" = 1'-0"



2 THIRD FLOOR MECHANICAL DEMOLITION PLAN

3/32" = 1'-0"

SHEET NOTES

1. SELECTIVELY DEMO CONTROLS TO ALL DEVICES AND SYSTEMS CONTROLLED AND MONITORED BY BAS, FOR REPLACEMENT.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

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PROJECT STATUS:

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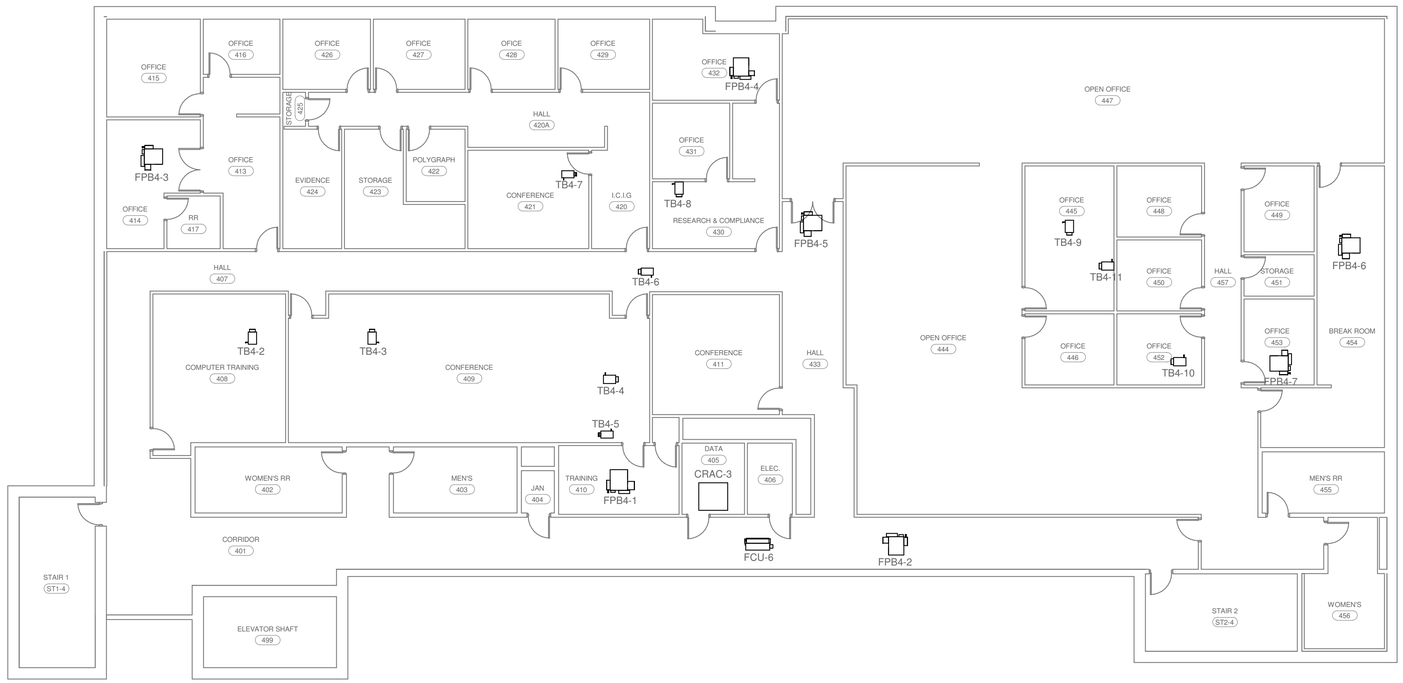
SHEET NAME:

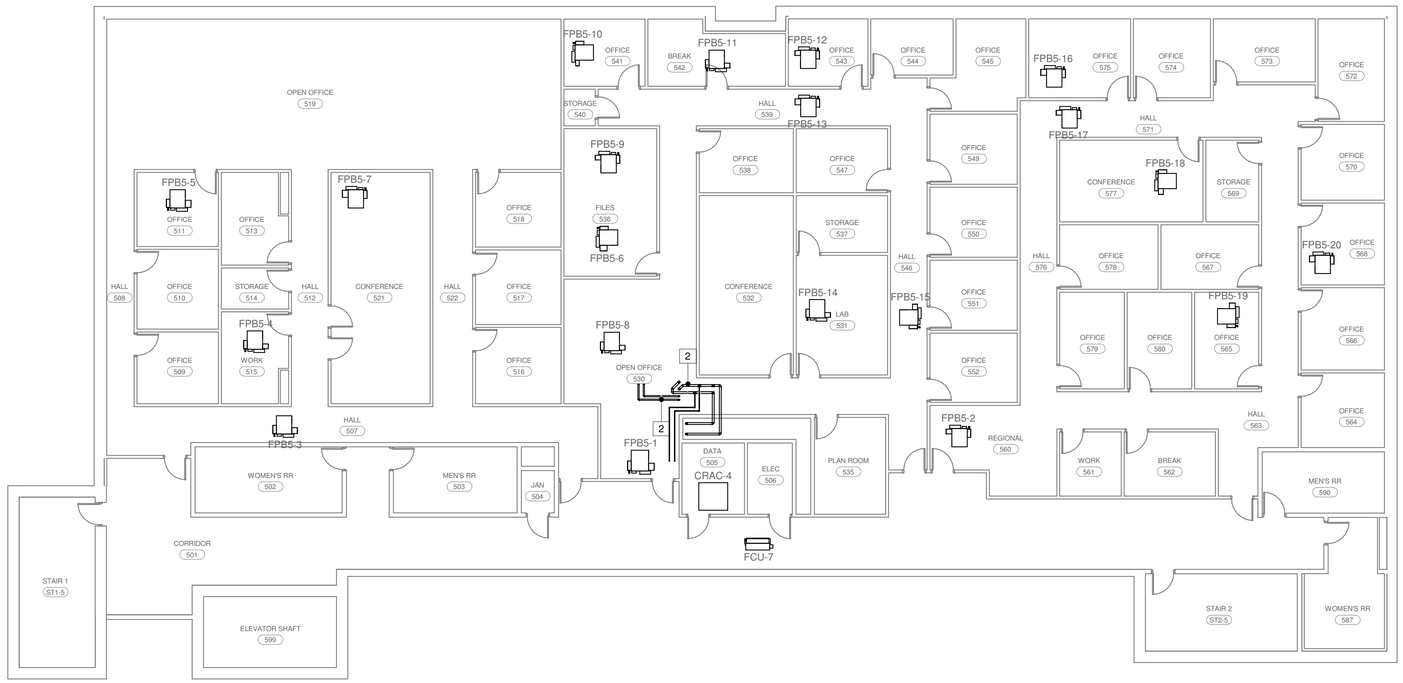
MECHANICAL DEMOLITION SECOND & THIRD FLOORS

M002



1 FOURTH FLOOR MECHANICAL DEMOLITION PLAN

3/32" = 1'-0"



2 FIFTH FLOOR MECHANICAL DEMOLITION PLAN

3/32" = 1'-0"

SHEET NOTES

1. SELECTIVELY DEMO CONTROLS TO ALL DEVICES AND SYSTEMS CONTROLLED AND MONITORED BY BAS, FOR REPLACEMENT.
2. SELECTIVELY DEMO PIPING FOR INSTALLATION OF NEW VALVES. SEE SHEET M103 FOR ADDITIONAL INFORMATION.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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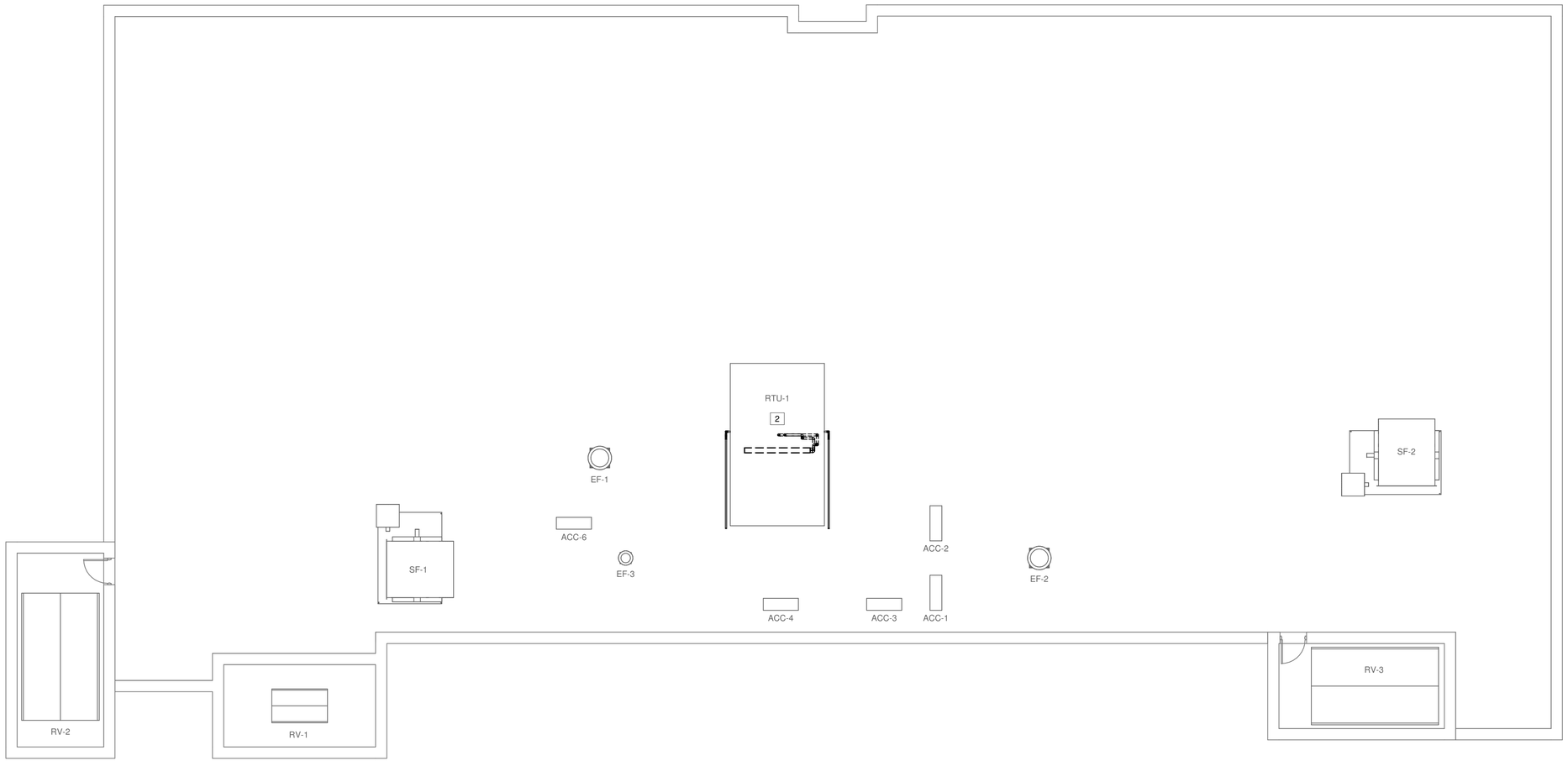
SHEET NAME:

MECHANICAL DEMOLITION FOURTH & FIFTH FLOORS

M003



1 ROOF MECHANICAL DEMOLITION PLAN

1/8" = 1'-0"

SHEET NOTES

1. SELECTIVELY DEMO CONTROLS TO ALL DEVICES AND SYSTEMS CONTROLLED AND MONITORED BY BAS, FOR REPLACEMENT.
2. SELECTIVELY DEMO COOLING COILS IN RTU-1, ALONG WITH CONNECTION PIPING, ETC. FOR INSTALLATION OF NEW COILS.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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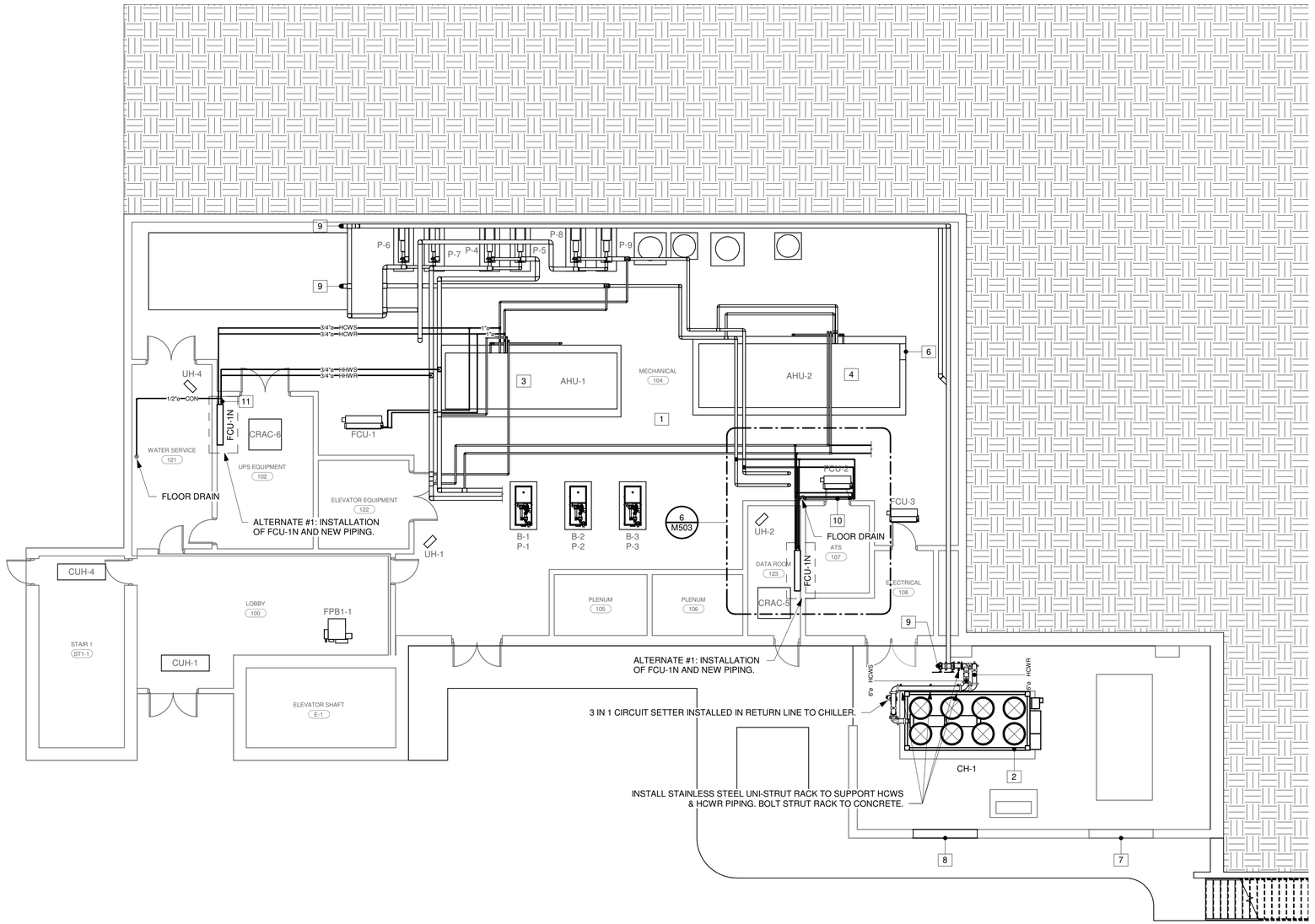
MECHANICAL DEMOLITION ROOF PLAN

M004



FIRST FLOOR MECHANICAL PLAN

1 1/8" = 1'-0"

SHEET NOTES

1. PROVIDE NEW CONTROLS FOR ALL DEVICES AND SYSTEMS CURRENTLY CONTROLLED OR MONITORED BY BAS. REFER TO PROJECT MANUAL PRIOR TO BIDDING FOR BAS REQUIREMENTS.
2. INSTALL NEW CHILLER AND ASSOCIATED PIPING, CONTROLS, WIRING, ETC.
3. INSTALL NEW COOLING COILS WITH CONNECTION PIPING, CONTROLS, ETC. IN AHU-1. RECONFIGURE COIL PIPING TO INSTALL NEW COIL.
4. INSTALL NEW HEATING AND COOLING COILS WITH CONNECTION PIPING, CONTROLS, ETC. IN AHU-2. RECONFIGURE COIL PIPING TO INSTALL NEW COILS.
5. NEW BAS PANELS WITH NEW ENCLOSURES.
6. NEW BAS PANEL FOR AHU-2
7. EXISTING LOUVER. APPROXIMATE 96"x144".
8. NEW LOUVER TO MATCH EXISTING. VERIFY DIMENSIONS ON EXISTING LOUVER PRIOR TO ORDERING NEW LOUVER. REFER TO SHEET G101 FOR INSTALLATION OF LOUVER.
9. CAP OPEN TEE's, VALVES TO REMAIN. SET EXISTING 3 WAY VALVES FOR FULL FLOW THROUGH LOOP.
10. EXTEND CONDENSATE RISER OVERHEAD AND DOWN TO FLOOR DRAIN.
11. ALTERNATE #1: LITTLE GIANT CONDENSATE PUMP (VCL-45ULS SERIES)

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

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SHEET NAME:

MECHANICAL FIRST FLOOR PLAN

M101

SECOND FLOOR MECHANICAL PLAN

1 3/32" = 1'-0"

THIRD FLOOR MECHANICAL PLAN

2 3/32" = 1'-0"

SHEET NOTES

1. PROVIDE NEW CONTROLS FOR ALL DEVICES AND SYSTEMS CURRENTLY CONTROLLED OR MONITORED BY BAS. REFER TO PROJECT MANUAL PRIOR TO BIDDING FOR BAS REQUIREMENTS.
2. ALTERNATE #1: NEW FAN COIL UNIT PER DETAILS SHEET M501.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC - * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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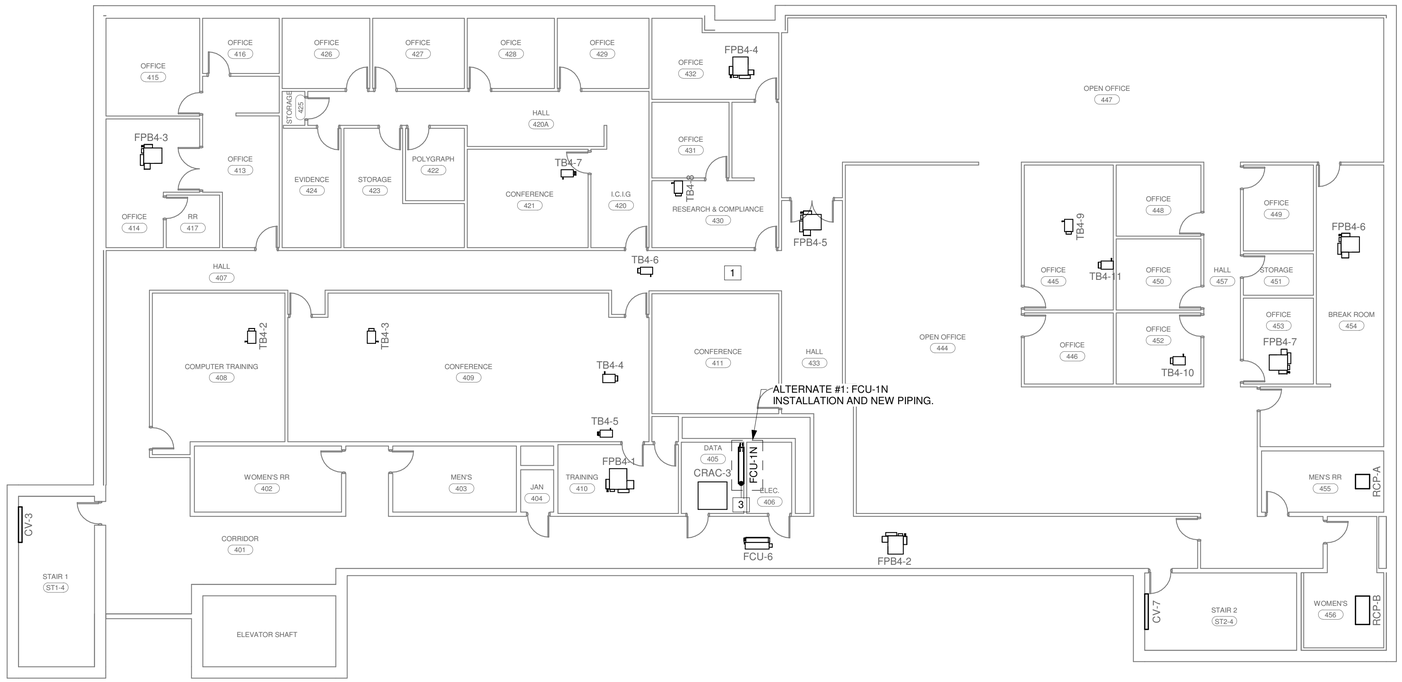
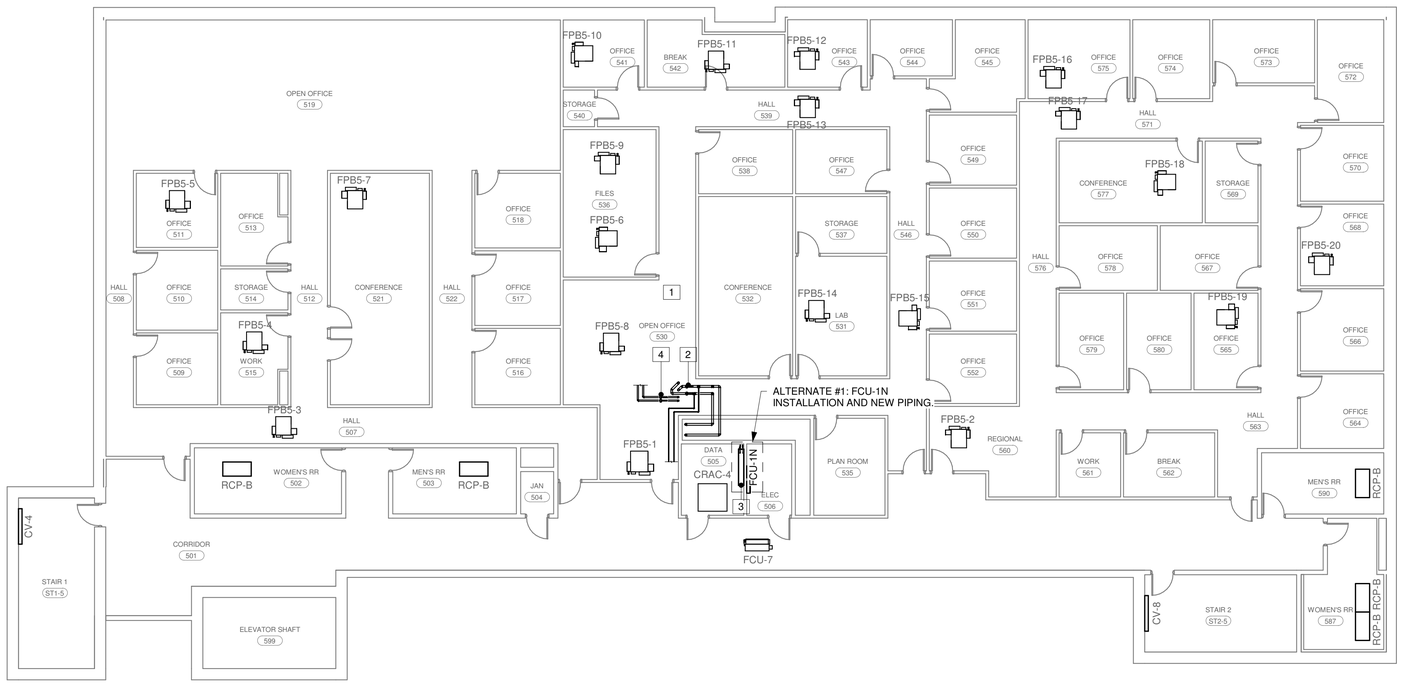
MECHANICAL SECOND & THIRD FLOOR PLANS

M102



FOURTH FLOOR MECHANICAL PLAN

1 3/32" = 1'-0"



FIFTH FLOOR MECHANICAL PLAN

2 3/32" = 1'-0"

SHEET NOTES

1. PROVIDE NEW CONTROLS FOR ALL DEVICES CURRENTLY CONTROLLED OR MONITORED BY BAS. REFER TO PROJECT MANUAL PRIOR TO BIDDING FOR BAS REQUIREMENTS.
2. INSTALL NEW 3" WAFER BUTTERY VALVE FOR RTU-1 ON THE CHILLED WATER SUPPLY AND RETURN PIPING. PROVIDE VENTS AND DRAINS ON BOTH SIDES OF EACH VALVE.
3. ALTERNATER #1: NEW FAN COIL UNIT PER DETAILS ON SHEET M501.
4. INSTALL NEW 2" WAFER BUTTERY VALVE FOR RTU-1 ON THE HOT WATER SUPPLY AND RETURN PIPING. PROVIDE VENTS AND DRAINS ON BOTH SIDES OF EACH VALVE.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV - * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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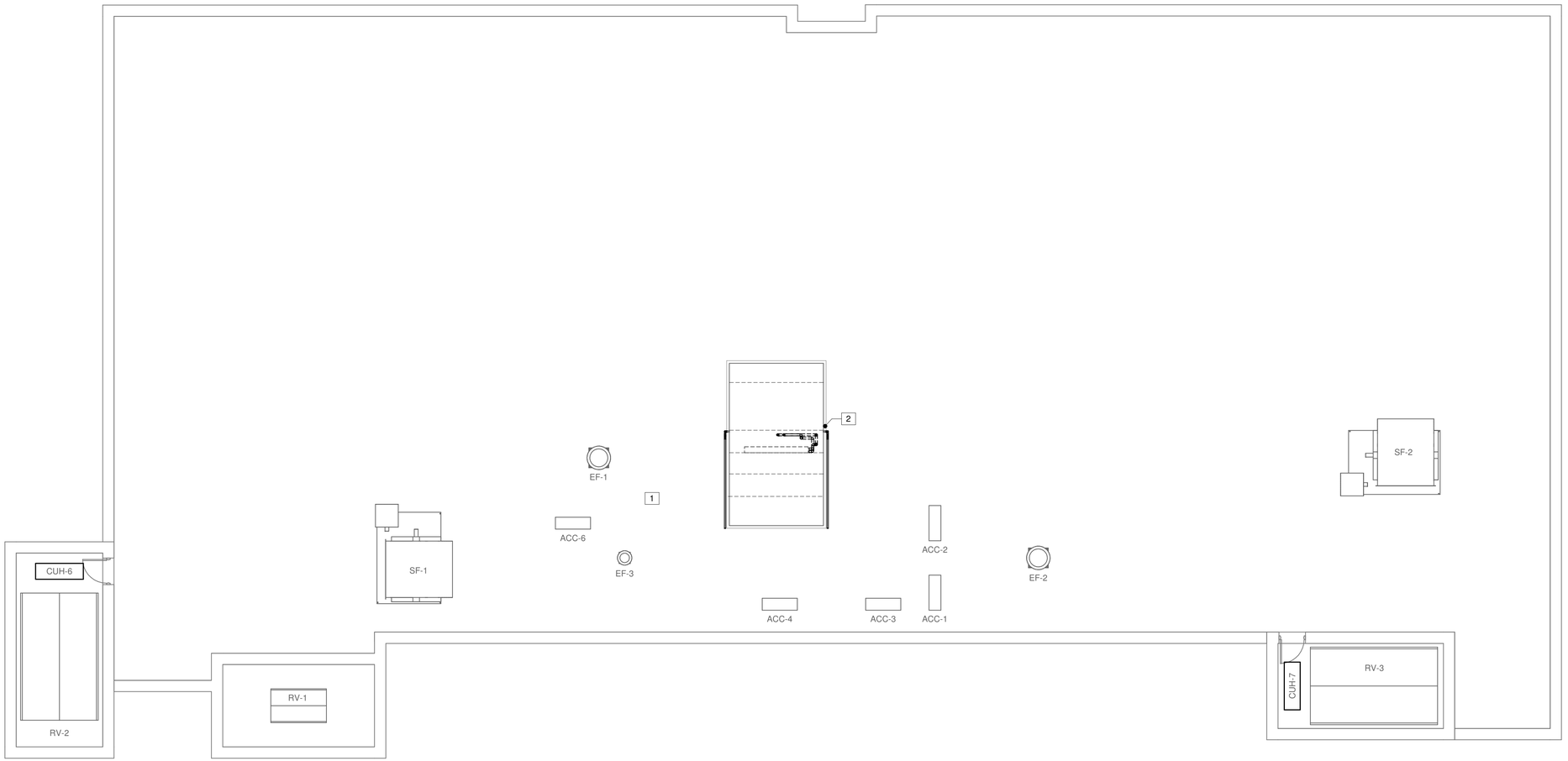
MECHANICAL FOURTH & FIFTH FLOOR PLANS

M103



1 ROOF MECHANICAL PLAN

1/8" = 1'-0"

SHEET NOTES

1. PROVIDE NEW CONTROLS FOR ALL DEVICES AND SYSTEMS CURRENTLY CONTROLLED OR MONITORED BY BAS, INCLUDING ALL ROOF TOP EQUIPMENT. REFER TO PROJECT MANUAL PRIOR TO BIDDING FOR BAS REQUIREMENTS.
2. INSTALL NEW HEATING AND COOLING COILS WITH CONNECTION PIPING, CONTROLS, ETC. IN RTU-1. RECONFIGURE COIL PIPING TO INSTALL NEW COIL.

MECHANICAL EQUIPMENT LEGEND

= FAN POWER BOXES (FPB) [CONTROLS ONLY]

= TERMINAL BOX (TB) [CONTROLS ONLY]

CRAC- * = COMPUTER ROOM AIR CONDITIONING UNIT (CRAC) (* DENOTES UNIT NUMBER)

ACC- * = AIR CONDITIONING CONDENSER (ACC) (* DENOTES UNIT NUMBER)

= EXISTING FAN COIL UNIT (FCU - *) [CONTROLS ONLY] (* DENOTES UNIT NUMBER)

= ALTERNATE #1: NEW FAN COIL UNIT (FCU - *N) (* DENOTES UNIT NUMBER)

RCP-A = 2x2 HOT WATER RADIANT CEILING PANEL (RCP-A)

RCP-B = 2x4 HOT WATER RADIANT CEILING PANEL (RCP-B)

CV- * = HOT WATER CONVECTOR (CV) (* DENOTES UNIT NUMBER)

CUH - * = CABINET UNIT HEATER (CUH - *) (* DENOTES UNIT NUMBER)

UH - * = UNIT HEATER (UH - *) (* DENOTES UNIT NUMBER)

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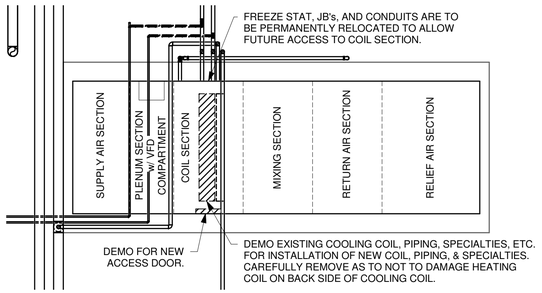
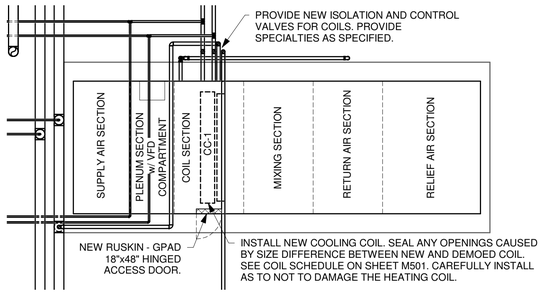
SHEET NAME:

MECHANICAL ROOF PLAN

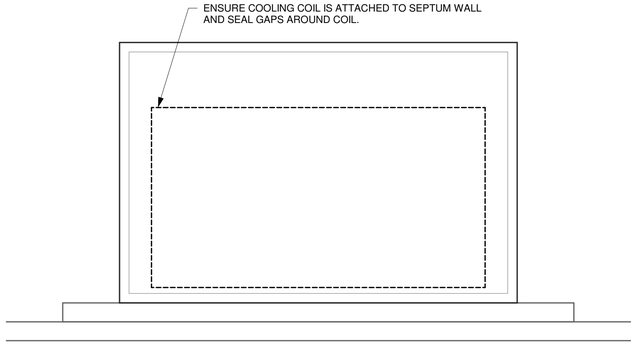
M104



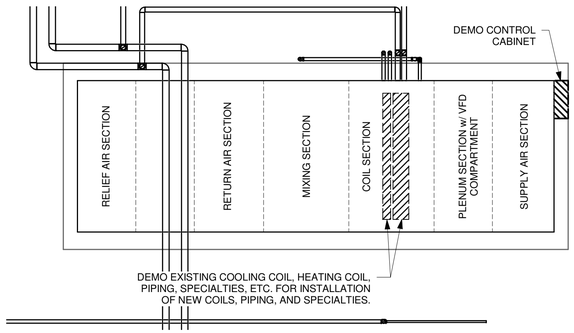
1 AHU-1 DEMOLITION LAYOUT
1/4" = 1'-0"



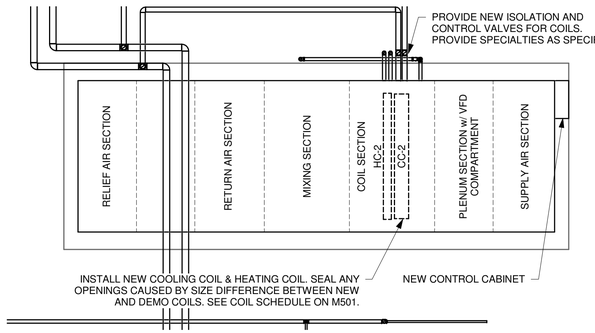
2 AHU-1 LAYOUT
1/4" = 1'-0"



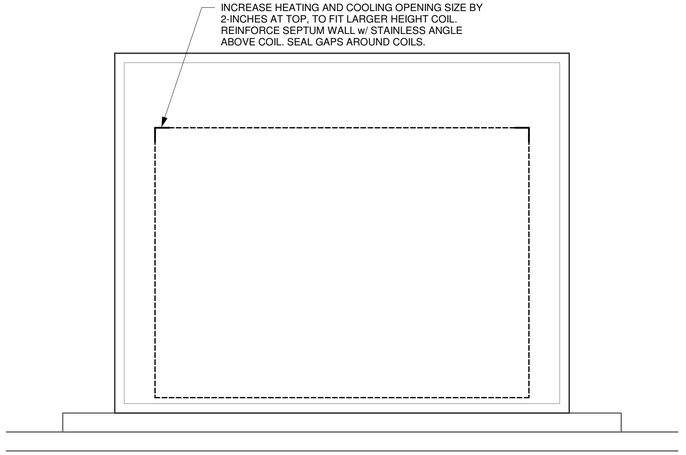
7 AHU-1 COIL SECTION
3/4" = 1'-0"



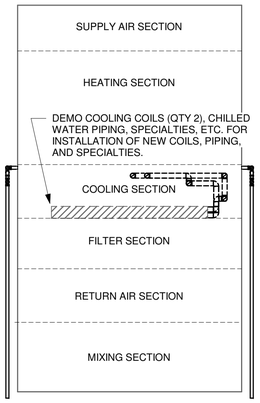
3 AHU-2 DEMOLITION LAYOUT
1/4" = 1'-0"



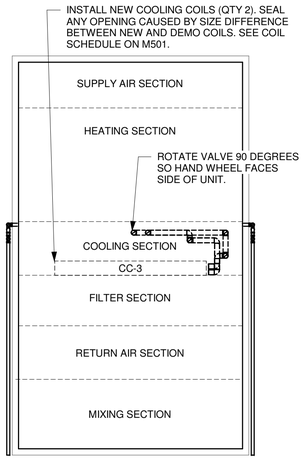
4 AHU-2 LAYOUT
1/4" = 1'-0"



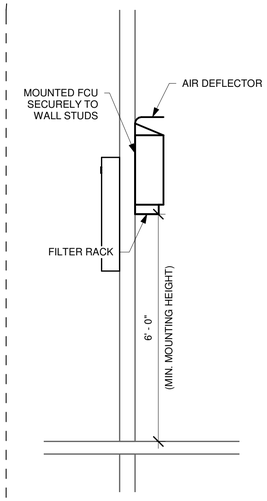
8 AHU-2 COIL SECTION
3/4" = 1'-0"



5 RTU-1 DEMOLITION LAYOUT
1/4" = 1'-0"



6 RTU-1 LAYOUT
1/4" = 1'-0"



9 NEW FCU MOUNTING DETAIL (ALT #1)
DRAWING NOT SCALABLE

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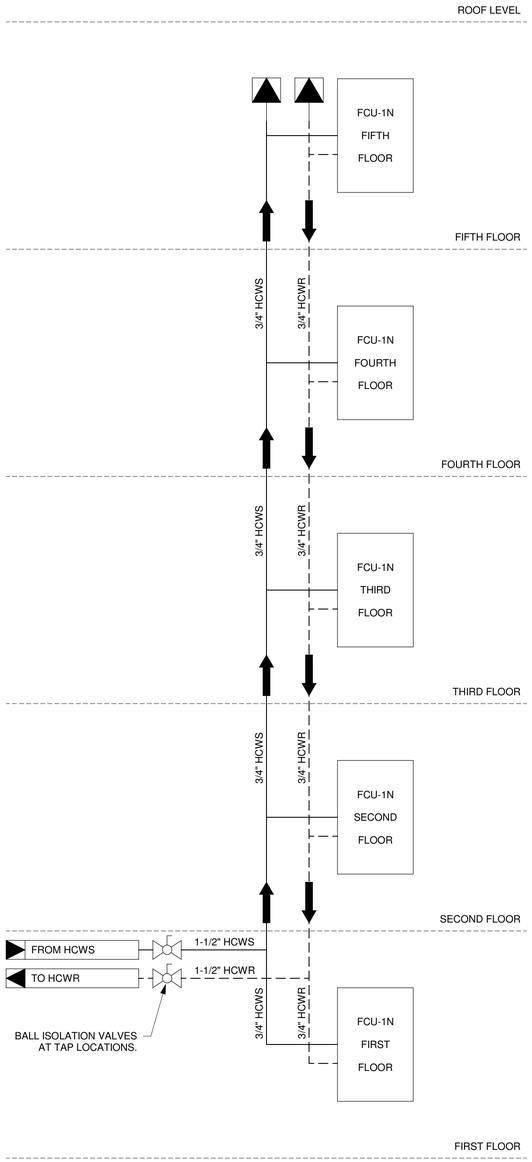
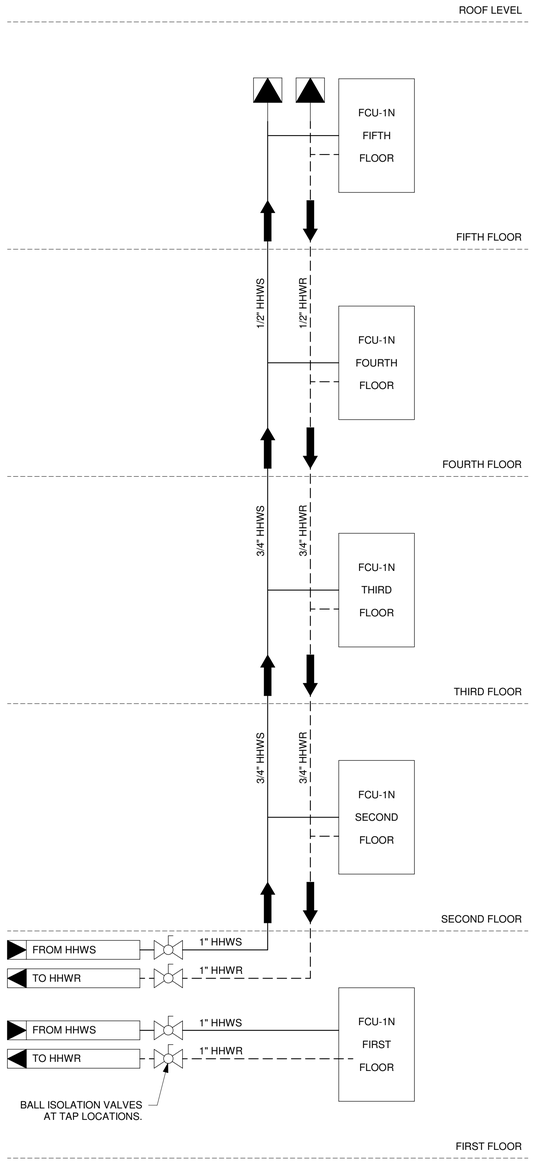
MECHANICAL DETAILS

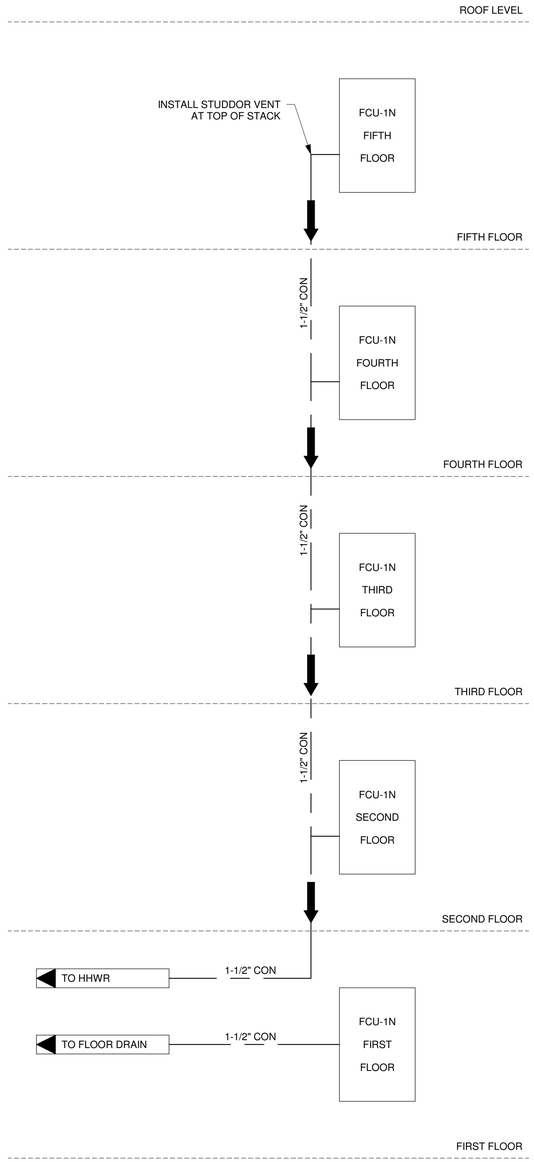
M501



1 FCU-1N HCW PIPING ONE-LINE
DRAWING NOT SCALABLE



2 FCU-1N HHW PIPING ONE-LINE
DRAWING NOT SCALABLE



3 FCU-1N CONDENSATE PIPING ONE-LINE
DRAWING NOT SCALABLE

FCU-1N ARE PART OF ALTERNATE #1

MILLER ENGINEERING, INC.

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CONSULTANT:

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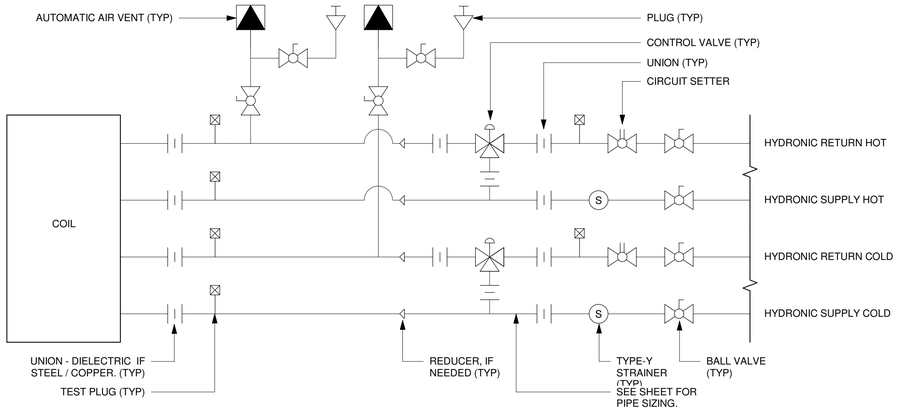
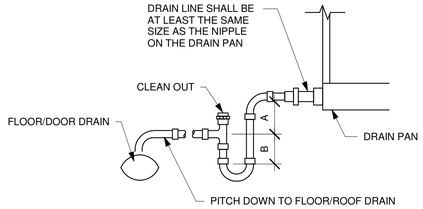
M502



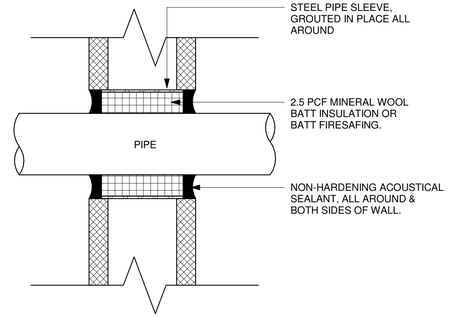
1 4-PIPE COIL CONNECTION DETAIL
DRAWING NOT SCALABLE



UNIT TYPE	A	B
DRAW THROUGH	P+1"	P
BLOW THROUGH	2" MIN.	2P

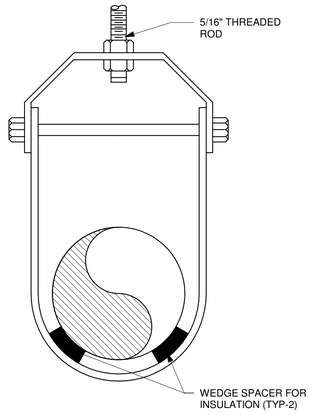
P = STATIC PRESSURE OF UNITS IN INCHES OF H20

2 CONDENSATE DRAIN DETAIL
DRAWING NOT SCALABLE

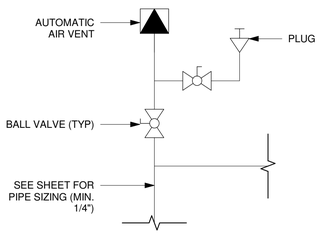


GENERAL NOTES:
1. WHERE EXPOSED TO ROOM, PROVIDE ESCUTCHEON TRIM.
2. NO MORTAR BRIDGING BETWEEN PIPE & CMU.
3. SUPPORT PIPE TO PREVENT CONTACT w/ SLEEVE.

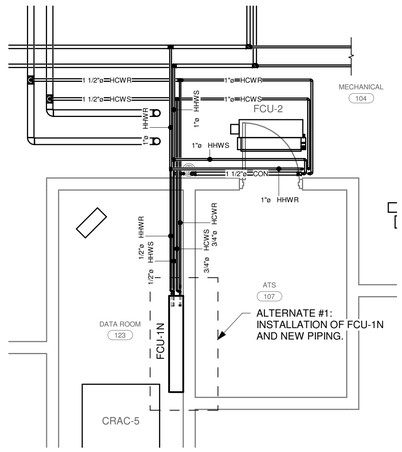
3 INTERIOR WALL CMU PIPE PENETRATION
DRAWING NOT SCALABLE



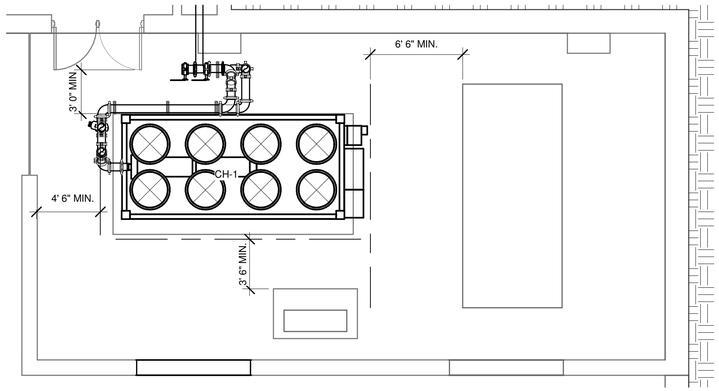
4 PIPE HANGER DETAIL
DRAWING NOT SCALABLE



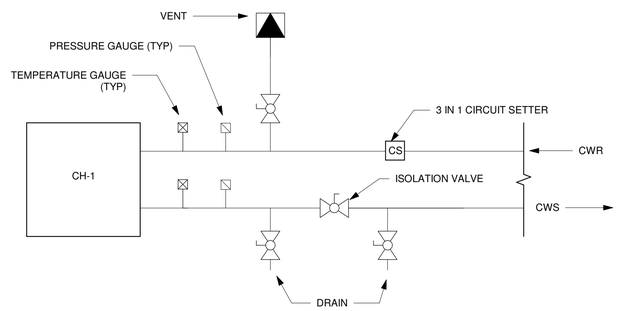
5 AIR VENT DETAIL
DRAWING NOT SCALABLE



6 ENLARGED PIPING PLAN
1/4" = 1'-0"



7 CHILLER CLEARANCE DETAILS
3/16" = 1'-0"



8 CHILLER CONNECTION DETAIL
3/4" = 1'-0"

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CHILLER SCHEDULE

MARK	MFR	MODEL	NOMINAL CAPACITY	DESIGN CAPACITY	COMPRESSOR TYPE	CONDENSER INFORMATION			EVAPORATOR INFORMATION					ELECTRICAL INFORMATION				NOTES
						TYPE	AIR FLOW	EAT	FLUID TYPE	FLUID FLOW	EWT	LWT	PD	VOLTAGE	PHASE	MCA	MOCP	
CH-1	CARRIER	30XV-1806S400-3C0	177 ton	165 ton	VFD SCREW	AIR COOLED	116,000 CFM	95.0 °F	30% PG	423.4 GPM	54.0 °F	44.0 °F	19.30 ftH2O	460 V	3	357.2 A	450 A	PROVIDE w/ CONTROL TRANSFORMER, 2-PASS FLOODED EVAPORATOR w/ HEATER, VARIABLE SPEED CONDENSER FANS, COIL TRIM PANELS

COOLING COIL SCHEDULE

MARK	MFR	SYSTEM	QTY	FACE DIMENSIONS			LOADS		AIR INFORMATION					WATER INFORMATION								NOTES
				LENGTH	HEIGHT	DEPTH	TOTAL	SENSIBLE	AIR FLOW	PRESSURE DROP	TEMPERATURES				FLUID TYPE	MATERIALS		FPI	FLOW	PRESSURE DROP	TEMPERATURES		
											ENTERING		LEAVING			FINS	TUBING				ENTERING	LEAVING	
											DB	WB	DB	WB								
CC-1	SFI COILS	AHU-1	1	70 1/2"	36"	9"	294,600 Btu/h	229,900 Btu/h	8,950 CFM	0.80 in-wg	76.4 °F	63.5 °F	53.0 °F	52.1 °F	30% PG	ALUMINUM	COPPER	11.5	62.4 GPM	20.60 ftH2O	44.0 °F	54.0 °F	
CC-2	SFI COILS	AHU-2	1	79"	59"	9"	662,100 Btu/h	499,700 Btu/h	18,350 CFM	1.11 in-wg	78.0 °F	64.5 °F	53.2 °F	52.2 °F	30% PG	ALUMINUM	COPPER	9	139.3 GPM	26.19 ftH2O	44.0 °F	54.0 °F	
CC-3	SFI COILS	RTU-1	2	96"	43 1/2"	9"	734,600 Btu/h	579,100 Btu/h	21,770 CFM	0.52 in-wg	77.2 °F	64.0 °F	53.0 °F	52.4 °F	30% PG	ALUMINUM	COPPER	12.5	154.0 GPM	14.08 ftH2O	44.0 °F	54.1 °F	TOP COIL TO HAVE INTERMEDIATE PAN AND DRAIN TO LOWER INTEGRAL PAN
CC-3 INFORMATION IS BASED FOR BOTH COILS COMBINED; FLANGES ON COILS - TOP & BOTTOM ARE 1-1/4" & SIDES ARE 1"; VERIFY FINAL DIMENSIONS IN FIELD PRIOR TO ORDERING																						

HEATING COIL SCHEDULE

MARK	MFR	MODEL	SYSTEM	QTY	FACE DIMENSIONS			TOTAL HEATING	AIR INFORMATION				FLUID TYPE	WATER INFORMATION						
					LENGTH	HEIGHT	DEPTH		AIR FLOW	PRESSURE DROP	TEMPERATURES			MATERIALS		FPI	FLOW	PRESSURE DROP	TEMPERATURES	
											EDB	LDB		FINS	TUBING				ENTERING	LEAVING
HC-2	CARRIER	SFI COILS	AHU-2	1	79"	59"	5"	269,000 Btu/h	18,350 CFM	0.09 in-wg	42.0 °F	55.5 °F	30% PG	ALUMINUM	COPPER	6	27.3 GPM	3.21 ftH2O	140.0 °F	120.2 °F
HC-1 NOT BEING REPLACED; FLANGES ON COILS - TOP & BOTTOM ARE 1-1/4" & SIDES ARE 1"; VERIFY FINAL DIMENSIONS IN FIELD PRIOR TO ORDERING																				

FAN COIL UNIT SCHEDULE (ALTERNATE #1)

MARK	MFR	MODEL	AIR FLOW	COOLING COIL INFORMATION											HEATING LOAD	HEATING COIL INFORMATION								ELECTRICAL INFORMATION				NOTES
				COOLING LOADS		AIR TEMPERATURES				FLUID INFORMATION						AIR TEMPERATURES		FLUID INFORMATION									
				SENSIBLE	TOTAL	ENTERING		LEAVING		FLOW RATE	FLUID TYPE	PRESSURE DROP	# OF ROWS	FLUID TEMPERATURES				ENTERING	LEAVING	FLOW RATE	FLUID TYPE	PRESSURE DROP	# OF COILS	FLUID TEMPERATURE		VOLTAGE	PHASE	MCA	MOCP	
						DB	WB	DB	WB					ENTERING	LEAVING									ENTERING	LEAVING					
FCU-1N	CARRIER	42VF06B6	600 CFM	13,509 Btu/h	15,799 Btu/h	78.0 °F	65.0 °F	57.7 °F	56.5 °F	3.4 GPM	30% PG	5.500 ftH2O	4	45.0 °F	55.0 °F	18,372 Btu/h	60 °F	87.6 °F	2.0 GPM	30% PG	22.900 ftH2O	1	140.0 °F	120.0 °F	115 V	1	3.1 A	20 A	VERIFY COIL HAND SELECTION PRIOR TO ORDERING: HEATING COIL TO BE PLACED IN REHEAT POSITION FOR HUMIDITY CONTROL

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ELECTRICAL ABBREVIATIONS

1P	SINGLE POLE
1PH	SINGLE-PHASE
2/C	TWO-CONDUCTOR
2WAY	TWO-WAY
3/C	THREE-CONDUCTOR
3PH	THREE-PHASE
3WAY	THREE-WAY
4/C	FOUR-WIRE
4PDT	FOUR-POLE DOUBLE THROW
4PST	FOUR-POLE SINGLE THROW
4WAY	FOUR-WAY
4W	FOUR-WIRE
ø	PHASE
A	
A	AMPERE
AC	ALTERNATING CURRENT; ARMORED CABLE
ACT	ACOUSTIC CEILING TILE
ADA	AMERICANS WITH DISABILITIES ACT
A/E	ARCHITECT/ENGINEER
AFC	ABOVE FINISHED COUNTER
AFCI	ARC FAULT CIRCUIT INTERUPTER
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AHJ	AUTHORITY HAVING JURISDICTION
AHU	AIR HANDLING UNIT
AIC	AMPERE INTERRUPTING CAPACITY
ALT	ALTERNATE
AMP	AMPERE
AMT	AMOUNT
ANN	ANNUNCIATOR
APPD	APPROVED
APPROX	APPROXIMATELY; APPROXIMATE
ARCH	ARCHITECT
ASC	ABOVE SUSPENDED CEILING; AMPS SHORT CIRCUIT
ATS	AUTOMATIC TRANSFER SWITCH
ATTN	ATTENTION
AUTO	AUTOMATIC
AUX	AUXILIARY
A/V	AUDIO VISUAL
AVG	AVERAGE
AWG	AMERICAN WRE GAUGE
B	
BAS	BUILDING AUTOMATION SYSTEM
BAT	BATTERY
BFF	BELOW FINISHED FLOOR
BG	BELOW GRADE
BKBD	BACKBOARD
BLDG	BUILDING
BLT	BUILT
BLW	BELOW
BOT	BOTTOM
BPS	BOLTED PRESSURE SWITCH
BRKR	BREAKER
BSMT	BASEMENT
BTWN	BETWEEN
BX	INTERLOCKED ARMORED CABLE
BYP	BYPASS
C	
C	CELSIUS
CAT	CATALOG
CATV	COMMUNITY ANTENNA TELEVISION SYSTEM
CB	CIRCUIT BREAKER
CCTV	CLOSED CIRCUIT TV
CD	CANDELA; CONSTRUCTION DOCUMENTS;
CF	CONTRACTOR FURNISHED
CF/CI	CONTRACTOR FURNISHED/CONTRACTOR INSTALLED
CIR	CIRCLE
CKT	CIRCUIT
C	CENTERLINE
CL	CURRENT LIMITING; CENTER LINE; CLASS; CLOSE
CLG	CEILING
CLR	CLEAR
CND	CONDUIT
COAX	COAXIAL
COL	COLUMN
COMB	COMBINATION; COMBINED
COMM	COMMUNICATION
COMPR	COMPRESSOR
CONC	CONCRETE
CONN	CONNECT
CORR	CORRIDOR; CORRECT
CP	CONTROL PANEL
CR	CONTROL RELAY
CS	CONTROL SWITCH
CT	CURRENT TRANSFORMER
CTR	CENTER
CTRL	CONTROL
CU	COPPER; COEFFICIENT OF UTILIZATION; CUBIC
CU FT	CUBIC FEET
CUR	CURRENT
D	
D	DEPTH
DB	DIRECT BURIAL / DECIBEL
DBL	DOUBLE
DC	DIRECT CURRENT
DDC	DIRECT DIGITAL CONTROL
DEL	DELETE; DELIVER
DEMO	DEMOLITION; DEMONSTRATION
DEPT	DEPARTMENT
DIA	DIAMETER
DIAG	DIAGRAM; DIAGONAL
DIFF	DIFFERENCE
DIM	DIMENSION
DISC	DISCONNECT
DIST	DISTANCE; DISTRICT
DISTR PNL	DISTRIBUTION PANEL
DIV	DIVISION; DIVIDE
DN	DOWN
DOC	DOCUMENT
DPDT	DOUBLE POLE; DOUBLE THROW
DPST	DOUBLE POLE; SINGLE THROW
DS	DISCONNECT SWITCH
DWG	DRAWING
E	
E	EAST
EA	EACH
EC	ELECTRICAL CONTRACTOR
EL	ELEVATION
ELEC	ELECTRIC
ELEV	ELEVATOR
ELR	END OF LINE RESISTOR
EM	EMERGENCY
EMI	ELECTROMAGNETIC INTERFERENCE
EMT	ELECTRICAL METALLIC TUBING
ENCL	ENCLOSURE
ENGR	ENGINEER
ENGY	ENERGY
ENT	ELECTRICAL NONMETALLIC TUBING
ENTR	ENTRANCE
EO	ELECTRICAL OUTLET
EP	ELECTRICAL PANEL
EQ	EQUAL
EQUIP	EQUIPMENT
EQUIV	EQUIVALENT
EST	ESTIMATE
ESTB	ESTABLISH
EX	EXISTING
EXH	EXHAUST
EXP	EXPANSION; EXPOSED; EXPAND
EXT	EXTERIOR; EXTERNAL
EXTN	EXTENSION
F	
F	FAHRENHEIT; FEMALE
FA	FIRE ALARM
FAAP	FIRE ALARM ANNUNCIATOR PANEL
FACP	FIRE ALARM CONTROL PANEL
FBO	FURNISHED BY OWNER
FC	FOOT-CANDLE
FCU	FAN COIL UNIT
FDR	FEEDER
FIN	FINISH
FIN GR	FINISH GRADE
FIXT	FIXTURE
FL MT	FLUSH MOUNT
FLEX	FLEXIBLE
FLG	FLOORING
FLR	FLOOR
FLUOR	FLUORESCENT
FM	FREQUENCY MODULATION
FP	FIREPROOF
FR	FIRE RESISTANT
FREQ	FREQUENCY
FS	FUSIBLE SWITCH; FLOW SWITCH
FSC	FOOD SERVICE EQUIPMENT CONTRACTOR
FT	FEET; FIRE TREATED; FOOT
FU	FUSE
FU SW	FUSED SWITCH
FURN	FURNISH; FURNACE; FURNITURE
FUT	FUTURE
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
G	
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GC	GENERAL CONTRACTOR
GEN	GENERAL; GENERATOR
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GFI	GROUND FAULT INTERRUPTER
GOVT	GOVERNMENT
GRN	GROUND
GYP	GYPSUM
H	
HDW	HARDWARE
HF	HIGH FREQUENCY
HID	HIGH INTENSITY DISCHARGE
HO	HOLD OPEN
HOA	HAND-OFF-AUTOMATIC
HORIZ	HORIZONTAL
HOSP	HOSPITAL
HP	HORSEPOWER; HEAT PUMP; HIGH PRESSURE
HPS	HIGH PRESSURE SODIUM
HT	HEIGHT
HV	HIGH VOLTAGE
HVAC	HEATING, VENTILATING AND AIR CONDITIONING
HZ	HERTZ; FREQUENCY IN CYCLES PER SECOND
I	
ID	INSIDE DIAMTER; INSIDE DIMENSION; IDENTIFICATION
ILLUM	ILLUMINATION
IMC	INTERMEDIATE METAL CONDUIT
INFO	INFORMATION
INSUL	INSULATION
INTERCOM	INTERCOMMUNICATION
INTL	INTERNATIONAL
IR	INFRARED; INSIDE RADIUS
IT	INFORMATION TECHNOLOGY
J	
JB	JUNCTION BOX
K	
KCMIL	THOUSAND CIRCULAR MILS
KHz	KILOHERTZ
KIT	KITCHEN
KO	KNOCKOUT
kV	KILOVOLT
kVA	KILOVOLT AMPERES
kVAh	KILOVOLT AMPERE PER HOUR
kVAR	KILOVAR; KILOVOLT AMPERE REACTIVE
kW	KILOWAT
kWh	KILOWATT HOURS
L	
L	LITER; ANGLE
LA	LIGHTNING ARRESTER
LAN	LOCAL AREA NETWORK
LED	LIGHT EMITTING DIODE
LF	LINEAR FEET (FOOT)
LIN	LINEAR
LM	LUMEN
LOC	LOCATION
LP	LIGHT POLE; LOW PRESSURE
LPW	LUMENS PER WATT
LT	LIGHT
LT SW	LIGHT SWITCH
LTD	LIMITED
LTG	LIGHTING
LV	LOW VOLTAGE
M	
M	METER
mA	MILLIAMPERE
MACH	MACHINE
MAG	MAGNET
MAINT	MAINTENANCE
MAN	MANUAL
MATL	MATERIAL
MAX	MAXIMIM
MC	MECHANICAL CONTRACTOR; METAL CLAD CABLE
MCA	MINIMUM CIRCUIT AMPS
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCM	THOUSAND CIRCULAR MILS
MDP	MAIN DISTRIBUTION PANEL
MDS	MAIN DISTRIBUTION SWITCHBOARD
ME	MECHANICAL ENGINEER
MECH	MECHANICAL
MED	MEDICAL; MEDIUM
MFD	MANUFACTURED
MFR	MANUFACTURER
MFR REC	MANUFACTURER'S RECOMMENDATION
MH	MANHOLE; METAL HALIDE
MHZ	MEGAHERTZ
MI	MINERAL INSULATED
MIC	MICROPHONE
MID	MIDDLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MLO	MAIN LUGS ONLY
MOA	MULTIOUTLET ASSEMBLY
MOCP	MAXIMUM OVERCURRENT PROTECTION
MOD	MODIFY; MODULE
MON	MONITOR
MOT	MOTOR
MOV	MOTOR OPERATED VALVE
MS	MOTOR STARTER
MTD	MOUNTED
MTG	MEETING; MOUNTING
MTL	METAL
MTS	MANUAL TRANSFER SWITCH
MULT	MULTIPLE
mV	MILLIVOLT
MVA	MEGAVOLT-AMPERE
MW	MEGAWATT; MICROWAVE
mW	MILLIWATT
MWH	MEGAWATT HOUR
N	
N	NORTH
NC	NORMALLY CLOSED
NE	NORMAL EMERGENCY
NEC	NATIONAL ELECTRICAL CODE
NEG	NEGATIVE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NEUT	NEUTRAL
NF	NON-FUSED
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NFS	NON-FUSED SWITCH
NIC	NOT IN CONTRACT
NM	NONMETALLIC
NMAG	NONMAGNETIC
NO	NORMALLY OPEN; NUMBER
NORM	NORMAL
NTS	NOT TO SCALE
O	
OA	OVERALL; OUTSIDE AIR
OC	ON CENTER
OCC	OCCUPANCY
OCPD	OVERCURRENT PROTECTION DEVICE
OD	OUTSIDE DIAMETER; OUTSIDE DIMENSION
OF/CI	OWNER FURNISHED / CONTRACTOR INSTALLED
OF/OI	OWNER FURNISHED / OWNER INSTALLED
OH	OVERHEAD
OL	OVERLOAD ELEMENT
OPP	OPPOSITE
OPT	OPTIONAL; OPTIMUM
OVC	OVERCURRENT
P	
P	POLE (S); PILOT
PA	POWER AMPLIFIER; PUBLIC ADDRESS
PART	PARTIAL
PB	PULL BOX; PANEL BOARD; PANIC BAR; PUSH-BUTTON
PC	PLUMBING CONTRACTOR; PIECE
PE	PHOTOELECTRIC, PNEUMATIC ELECTRIC
PEN	PENETRATE
PERF	PERFORATED
PERIM	PERIMETER
PERM	PERMANENT
PF	POWER FACTOR
PH	PHASE
PIV	POST INDICATOR VALVE
PL	PILOT LIGHT
PLBG	PLUMBING
PNL	PANEL
POS	POSITION; POSITIVE
PP	POWER POLE
PR	PAIR
PRELIM	PRELIMINARY
PREP	PREPARATION
PRESS SW	PRESSURE SWITCH
PREV	PREVIOUS
PRI	PRIMARY
PROJ	PROJECT
PS	PULL STATION
PT	POTENTIAL TRANSFORMER
PVC	POLYVINAL CHLORIDE (PLASTIC)
PWR	POWER
Q	
QA	QUALITY ASSURANCE
QC	QUALITY CONTROL
QTY	QUANTITY
QUAL	QUALITY
R	
R	RELAY; RADIUS
R/W	RIGHT OF WAY
RC	REMOTE CONTROL
RCP	REFLECTED CEILING PLAN
REC	RECESSED
RCPT	RECEPTACLE
REF	REFRIGERATOR; REFERENCE
REINF	REINFORCED
REPL	REPLACE
REQD	REQUIRED
REV	REVISION; REVOLUTIONS
RFI	REQUEST FOR INFORMATION
RFP	REQUEST FOR PROPOSAL
RH	RIGHT HAND
RHC	REHEAT COIL
ROW	RIGHT OF WAY
RS	RAPID START
RTG	RATING
RTU	ROOF TOP UNIT
S	
S/S	START / STOP
SAMP	SAMPLE
SCHED	SCHEDULE
SCHEM	SCHEMATIC
SD	SMOKE DETECTOR
SDMPR	SMOKE DAMPER
SEC	SECONDARY
SECT	SECTION
SEP	SEPARATE
SHT	SHEET
SIM	SIMILAR
SLV	SLEEVE
SMR	SURFACE MOUNTED RACEWAY
SNSR	SENSOR
SOLV	SOLENOID VALVE
SPDT	SINGLE POLE; DOUBLE THROW
SPEC	SPECIFICATION
SPKR	SPEAKER
SPLY	SUPPLY
SPST	SINGLE POLE; SINGLE THROW
SQ	SQUARE
SS	STAINLESS STEEL
ST	SINGLE THROW; STAIRS; STREET
ST PR	STATIC PRESSURE
STA	STATION
STD	STANDARD
STL	STEEL
STOR	STORAGE
STR	STARTER; STRAIGHT; STRIKE; STRINGERS
STRB	STROBE
STRB/HRN	STROBE / HORN
STRUCT	STRUCTURAL
SUB	SUBSTITUTE
SUP	SUPPLEMENTARY
SUPVR	SUPERVISOR
SURF	SURFACE
SUSP	SUSPEND
SW	SWITCH; SIDEWALK
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYM	SYMBOL
SYS	SYSTEM
T	
T&M	TIME AND MATERIAL
TECH	TECHNICAL
TEL	TELEPHONE
TEMP	TEMPORARY
TERM	TERMINAL
THRU	THROUGH
TL	TWIST LOCK
TOC	TOP OF CONCRETE; TOP OF CURB
TOL	TOLERANCE
TP	TWISTED PAIR; TELEPHONE POLE
TSP	TWISTED SHIELDED PAIR
TSTAT	THERMOSTAT
TV	TELEVISION
TVOUT	TELEVISION OUTLET
TYP	TYPICAL
U	
UG	UNDERGROUND
UH	UNIT HEATER
UNO	UNLESS NOTED OTHERWISE
UP	UTILITY POLE
UPS	UNINTERRUPTIBLE POWER SUPPLY
UL	UNDER WRITERS LABORATORIES
UTP	UNSHIELDED TWITED PAIR
UTIL	UTILITY
UV	UNIT VENTILATOR; ULTRAVIOLET
V	
V	VOLT
VA	VOLT AMPERE
VAM	VOLTAMMETER
VAR	VARIATION; VARIES; VOLT AMPERE REACTIVE
VD	VOLTAGE DROP; VOLUME DAMPER
VERT	VERTICAL
VF	VARIABLE FREQUENCY
VFD	VARIABLE FREQUENCY DRIVE
VID	VIDEO
VIF	VERIFY IN FIELD
VOLT	VOLTAGE
VR	VOLTAGE REGULATOR; VAPOR RETARDED
VRFY	VERIFY
VRLY	VOLTAGE RELAY
VS	VOLTMETER SWITCH; VENT STACK
W	
W	WIRE; WATT; WASTE; WEST; WIDE
W/	WITH
W/O	WITHOUT
WHM	WATTHOUR METER
WP	WEATHERPROOF; WATER PUMP; WATER HEATER
WR	WEATHER RESISTANT; WATER REPELLENT
WW	WIREWAY; WARM WHITE; WASTE WATER
X	
XFMR	TRANSFORMER
XP	EXPLOSION PROOF

ELECTRICAL LEGEND

	120V DUPLEX RECEPTACLE
GFCI	120V GFCI DUPLEX RECEPTACLE
WP	120V GFCI DUPLEX RECPTACLE, WEATHER PROOF
J	EQUIPMENT TERMINATION. VERIFY TERMINATION METHOD w/ MANUFACTURER

LIGHTING LEGEND

S	SINGLE POLE SWITCH
S3	THREE WAY SWITCH

COMMUNICATION LEGEND

TV	TELE/DATA LOCATION. PROVIDE SINGLE GANG BOX w/ 1" CONDUIT TO ABOVE ACCESSIBLE CEILING. (2xCAT6)

ELECTRICAL NOTES

1. WIRING IS SHOWN ON DRAWINGS ONLY FOR SPECIFIC ROUTES OR SPECIAL CONDITIONS. ALL WALL MOUNTED DEVICES ARE FINAL HEIGHT BY. ARCH.
2. WIRING AND CONDUIT OR MC CABLE SHALL BE REQUIRED FOR ALL OUTLETS AND DEVICES. FOLLOW INDICATED CIRCUITS NUMBERS AND PANEL DESIGNATION. OBTAIN PRIOR APPROVAL OF ENGINEER FOR DEVIATIONS.
3. ALTHOUGH ALL BRANCH CIRCUIT WIRING IS NOT SHOWN, IT IS THE INTENT OF THESE DOCUMENTS THAT A COMPLETE BRANCH CIRCUIT WIRING SYSTEM BE INSTALLED. ALL NEUTRALS SHALL BE FULL CAPACITY. THE USE OF SHARED OR COMMON NEUTRALS IS PROHIBITED ON ALL ELECTRIC WIRING.
4. PROVIDE CONTROL AND WIRE AS NECESSARY TO INSTALL ALL SYSTEMS DEVICES AND PANELS FOR COMPLETE SYSTEMS. FINAL CONNECTION TO PERMANENTLY MOUNTED EQUIPMENT IS PART OF THE ELECTRICAL SCOPE OF THIS PROJECT.
5. ALL INTERIOR WIRING SHALL BE THHN/THWN IN METAL CONDUIT OR MC CABLE. MAX OF 3'-0" OF FLEXIBLE CONDUIT MAY BE USED FOR FINAL EQUIPMENT TERMINATIONS.
6. EXTERIOR WIRING IS TO BE THHN/THWN IN CONDUIT. MAX. OF 3'-0" OF FLEXIBLE METALLIC SEATITLE CONDUIT MAY BE USED TO EXTERIOR EQUIPMENT.
7. GROUP AND TRAIN ALL TEL/DATA CABLE. SUPPORT FROM STRUCTURE.
8. VERIFY ALL FIELD CONDITIONS AND MEASUREMENTS PRIOR TO BIDDING. COORDINATE ALL WORK WITH OTHER TRADES. COORDINATE ALL CEILING MOUNTED DEVICES WITH ALL OTHER TRADES PRIOR TO INSTALLATION.
9. PERFORM ALL WORK IN ACCORDANCE WITH 2017 NEC.
10. COORDINATE FINAL FIXTURE LOCATIONS WITH OWNER AND GENERAL CONTRACTOR PRIOR TO INSTALLATION OF CEILING. FINAL COORDINATION OF SCOPE OF WORK, DIMENSIONS, FIXTURE PLACEMENT, ROUTINGS, ETC IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR AND ALL SUB-CONTRACTORS PRIOR TO BIDDING.

COMMUNICATION NOTES

1. TELE/DATA AND CATV CONDUIT IS SHOWN ON DRAWINGS ONLY FOR SPECIFIC ROUTES OR SPECIAL CONDITIONS. ALL WALL MOUNTED DEVICES ARE FINAL HEIGHT BY ARCHITECT.
2. CONDUIT AND PULL STRING WILL BE REQUIRED AT ALL TELE/DATA LOCATIONS ON THE DRAWINGS.
3. PROVIDE TELE/DATA AND CATV AS INDICATED. REVIEW DATA, SWITCH, RECEPTACLE, ETC LOCATIONS AND HEIGHTS w/ OWNER PRIOR TO INSTALLATION.
4. TELE/DATA AND CATV WIRING TO BE PERFORMED BY OWNER'S CONTRACTOR. CONTRACTOR IS TO PROVIDE RACEWAY AND PULL STRING AT EACH LOCATION INDICATED.
5. VERIFY ALL FIELD CONDITIONS AND MEASUREMENTS PRIOR TO BIDDING. COORDINATE ALL WORK w/ OTHER TRADES. COORDINATE ALL CEILING MOUNTED DEVICES w/ ALL OTHER TRADES PRIOR TO INSTALLATION.
6. PERFORM ALL WORK IN ACCORDANCE 2017 NEC.
7. COORDINATION OF FINAL FIXTURE LOCATION w/ OWNER AND GENERAL CONTRACTOR PRIOR TO INSTALLATION OF CEILING. FINAL COORDINATION OF SCOPE OF WORK, DIMENSIONS, FIXTURE PLACEMENT, ROUTINGS, ETC. IS THE RESPONSIBILITY OF THE GENERAL CONTRACTOR AND ALL SUB-CONTRACTORS PRIOR TO BIDDING.

MILLER ENGINEERING, INC.

WV OFFICE:
54 WEST RUN ROAD
MORGANTOWN, WV 26508
PH: (304) 291-2234

PA OFFICE:
429 LAUREL RUN ROAD
CARMICHAELS, PA 15320
PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

CONSTRUCTION DOCUMENTS

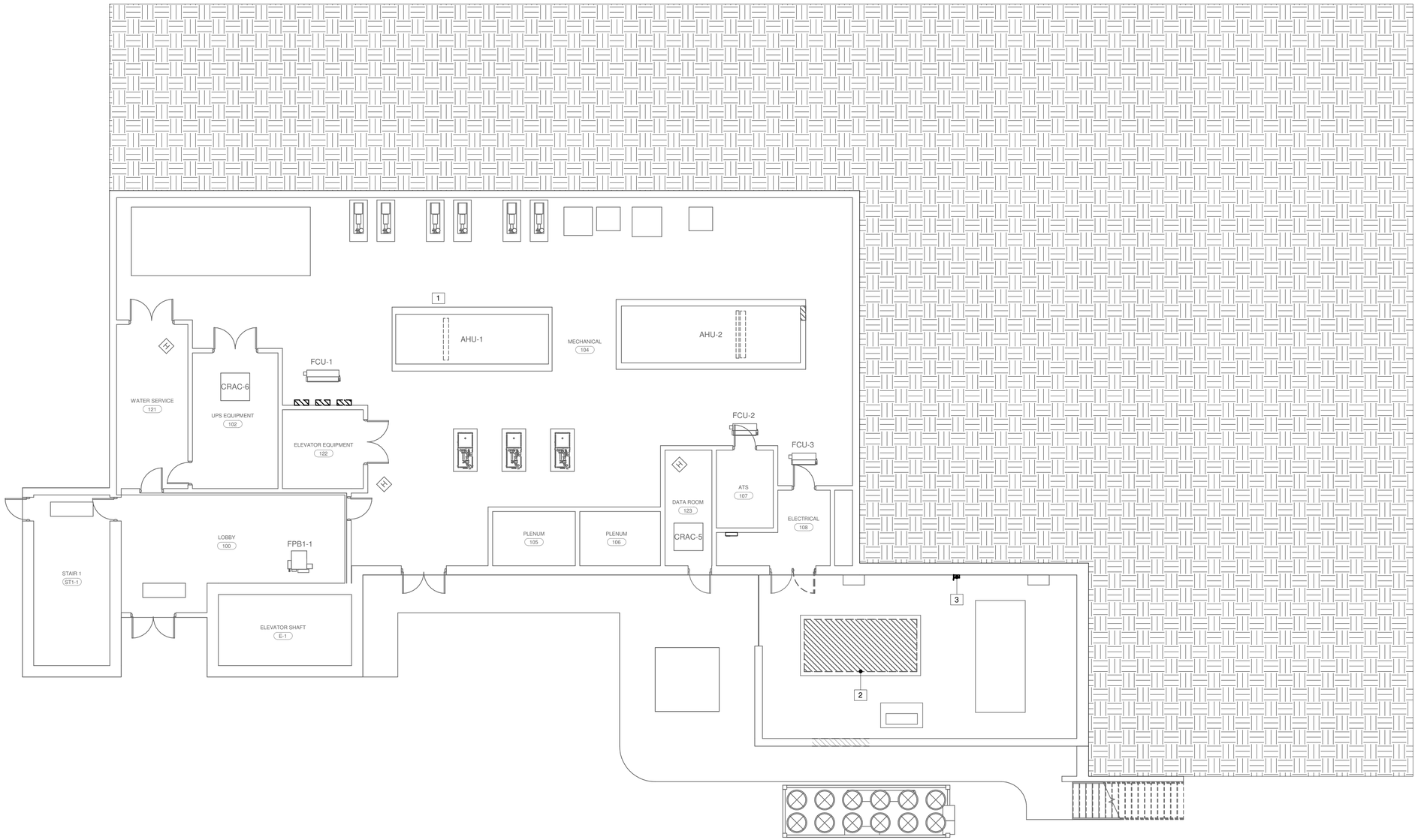
NO.	DESCRIPTION	DATE

PROJECT NUMBER:	21013
ORIGINAL PAGE SIZE:	22x34
DESIGNED BY:	BCM
DRAWN BY:	JMM, TWT
CHECKED BY:	BCM

SHEET NAME:

ELECTRICAL ABBREVIATIONS

E000



1 FIRST FLOOR ELECTRICAL DEMOLITION PLAN

1/8" = 1'-0"

SHEET NOTES

1. RELOCATE POWER AND WIRING CONDUITS BLOCKING ACCESS PANEL.
2. DEMO POWER TO CHILLER RECONNECTION AND RECONFIGURATION AS SHOWN ON E101.
3. DEMO EXISTING DISCONNECT SWITCH AND UNDERGROUND CONDUIT AND WIRING TO EXISTING CHILLER.

MILLER ENGINEERING, INC.

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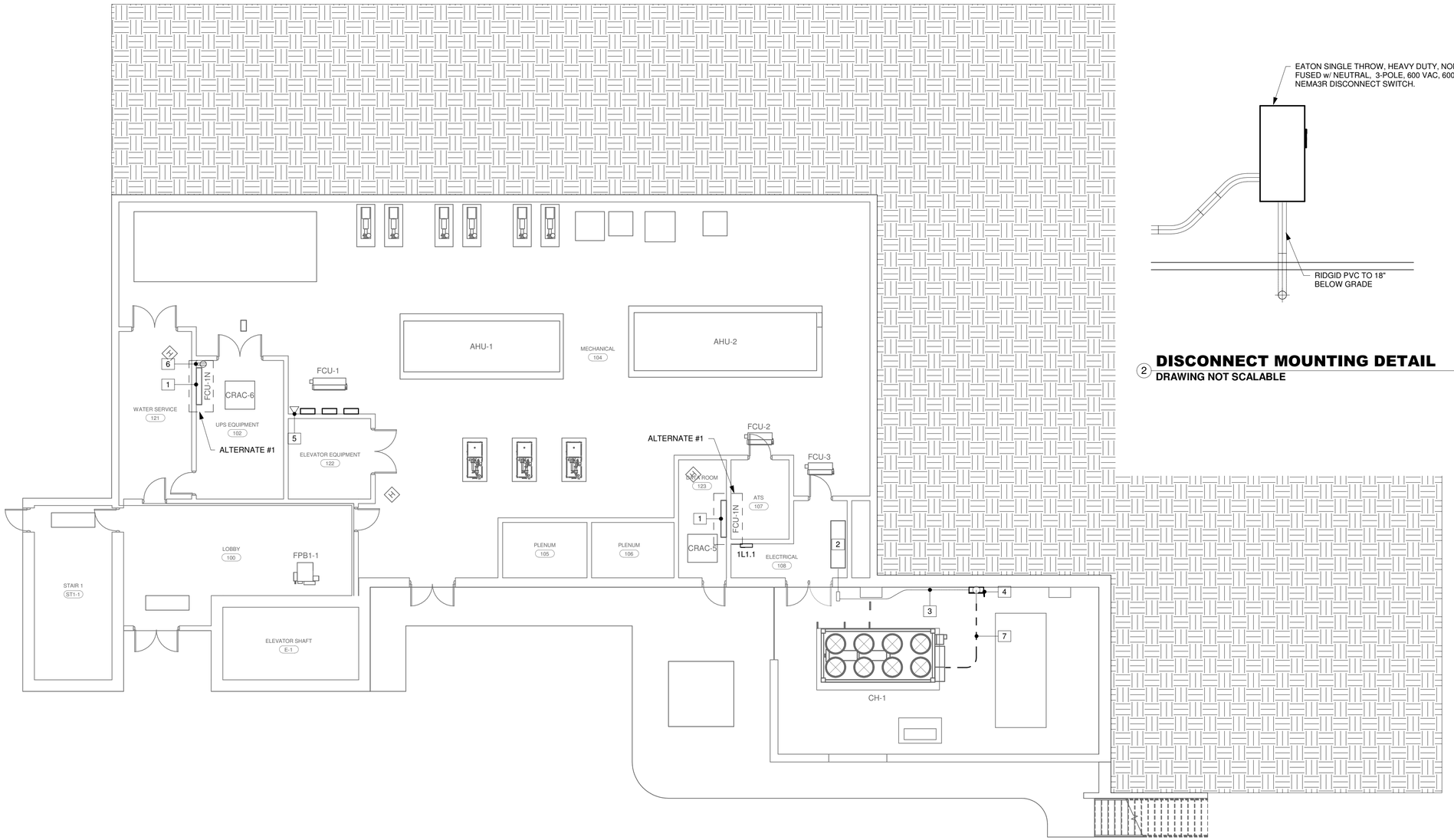
SHEET NAME:

ELECTRICAL DEMOLITION FIRST FLOOR PLAN

E001



1 FIRST FLOOR ELECTRICAL PLAN

1/8" = 1'-0"

2 DISCONNECT MOUNTING DETAIL

DRAWING NOT SCALABLE

SHEET NOTES

1. ALTERNATE #1: PROVIDE POWER TO FCU FROM PANEL 1L1.1. CONNECT TO EXISTING SPARE 20A BREAKER.
2. NEW SQUARE D I-LINE 600A BREAKER w/ 450A DIGITAL TRIP TO CHILLER FOR RECONNECTION.
3. 4" GRC CONDUIT w/ (3) 750 KCMIL L COPPER AND (1) 2/0 GRD. MOUNT ON WALL BELOW CHILLED WATER PIPING.
4. EATON SINGLE THROW, HEAVY DUTY, NON-FUSED w/ NEUTRAL, 3-POLE, 600 VAC, 600A, NEMA3R DISCONNECT SWITCH.
5. NEW DATA JACK. EXTEND DATA TO DATA ROOM 123 IN CONDUIT.
6. ALTERNATE #1: NEW RECEPTABLE FOR CONDENSATE PUMP. TIE POWER TO SAME AS FCU.
7. NEW 4" PVC CONDUIT FOR CHILLER. COORDINATE LOCATION w/ GC.

MILLER ENGINEERING, INC.

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CARMICHAELS, PA 15320
PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

CONSTRUCTION DOCUMENTS

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DRAWN BY:	JMM, TWT
CHECKED BY:	BCM

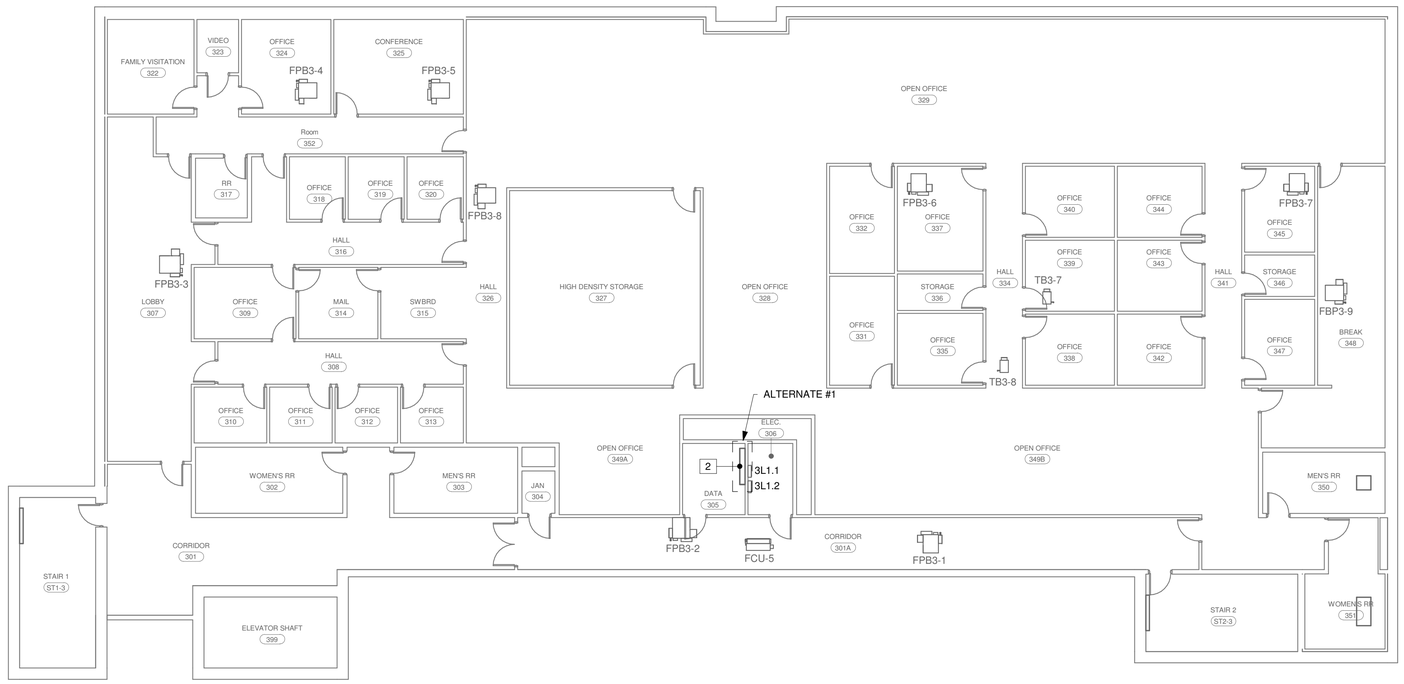
SHEET NAME:

ELECTRICAL FIRST FLOOR PLAN

E101

1 SECOND FLOOR ELECTRICAL PLAN

3/32" = 1'-0"



2 THIRD FLOOR ELECTRICAL PLAN

3/32" = 1'-0"

SHEET NOTES

1. ALTERNATE #1: PROVIDE POWER TO FCU FROM PANEL 2L1.1/2L1.2. CONNECT TO EXISTING SPARE 20A BREAKER.
2. ALTERNATE #1: PROVIDE POWER TO FCU FROM PANEL 3L1.1/3L1.2. CONNECT TO EXISTING SPARE 20A BREAKER.

MILLER ENGINEERING, INC.

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CARMICHAELS, PA 15320
PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

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DRAWN BY:	JMM, TWT
CHECKED BY:	BCM

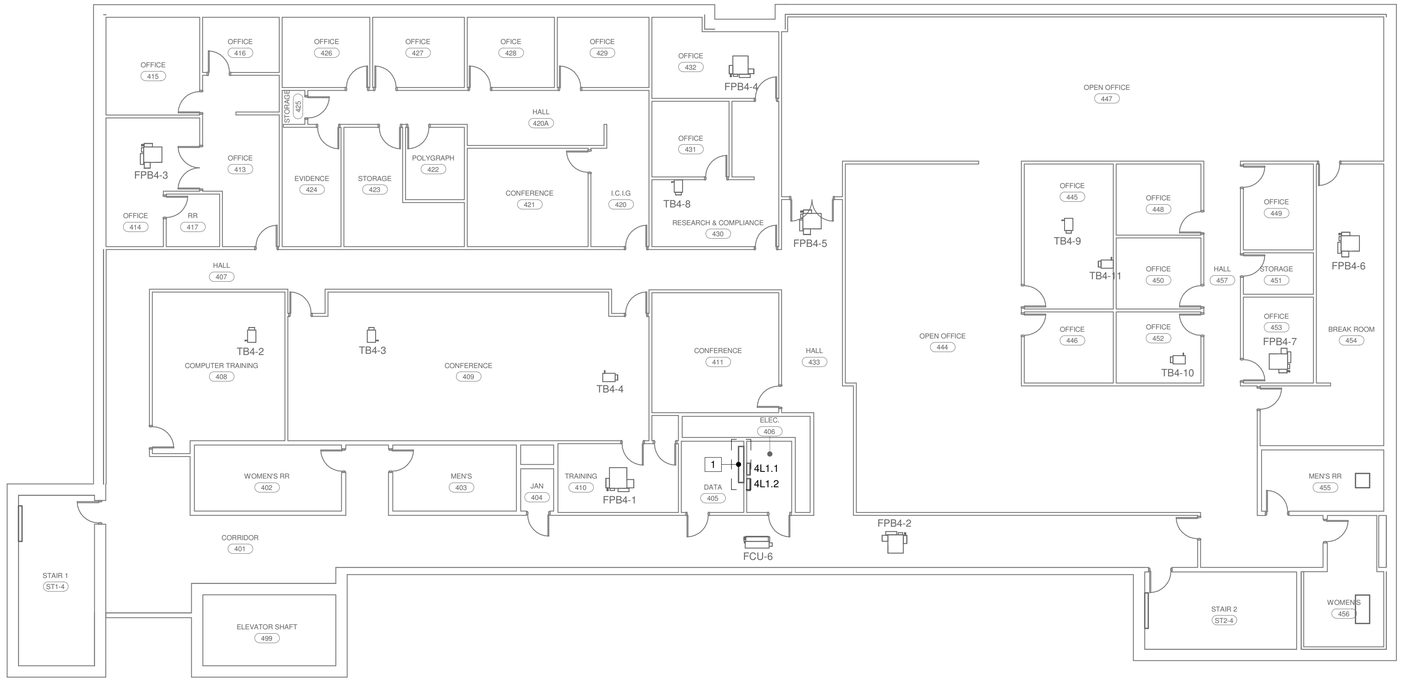
SHEET NAME:

ELECTRICAL SECOND AND THIRD FLOOR PLANS

E102

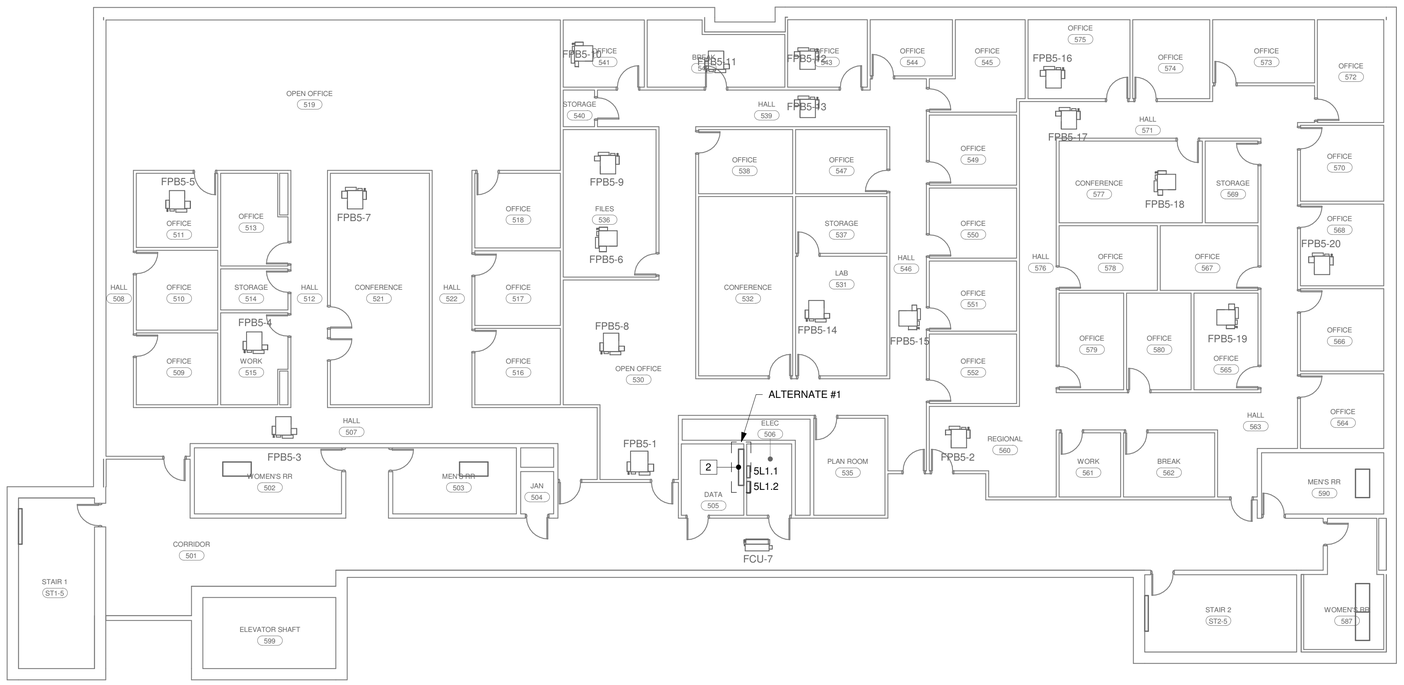
SHEET NOTES

1. ALTERNATE #1: POWER TO FCU FROM PANEL 4L1.1/4L1.2. CONNECT TO EXISTING SPARE 20A BREAKER.
2. ALTERNATE #1: PROVIDE POWER TO FCU FROM PANEL 5L1.1/5L1.2. CONNECT TO EXISTING SPARE 20A BREAKER.



1 FOURTH FLOOR ELECTRICAL PLAN

3/32" = 1'-0"



2 FIFTH FLOOR ELECTRICAL PLAN

3/32" = 1'-0"

MILLER ENGINEERING, INC.

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MORGANTOWN, WV 26508
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PA OFFICE:
429 LAUREL RUN ROAD
CARMICHAELS, PA 15320
PH: (724) 966-5655

CONSULTANT:

SEAL:

PROJECT NAME:

BUILDING 54 HVAC RENOVATIONS - REBID

PROJECT OWNER:

WEST VIRGINIA GENERAL SERVICES DIVISION

PROJECT STATUS:

CONSTRUCTION DOCUMENTS

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DESIGNED BY:	BCM
DRAWN BY:	JMM, TWT
CHECKED BY:	BCM

SHEET NAME:

ELECTRICAL FOURTH AND FIFTH FLOOR PLANS

E103

PROJECT MANUAL

FOR

BLDG 54 HVAC MODIFICATIONS - REBID

OWNER: WV GENERAL SERVICES

PREPARED BY:

MILLER ENGINEERING INC.,
(304) 291-2234
MEI PROJECT #: 21013

09/30/2022

SECTION 00 0110

TABLE OF CONTENTS

2.07 DIVISION 23 -- HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

A. 23 0001 - Basic Mechanical Materials and Methods
B. 23 0513 - Common Motor Requirements for HVAC Equipment
C. 23 0519 - Meters and Gauges for HVAC Piping
D. 23 0523 - General-Duty Valves for HVAC Piping
E. 23 0529 - Hangers and Supports for HVAC Piping and Equipment
F. 23 0553 - Identification for HVAC Piping and Equipment
G. 23 0593 - Testing, Adjusting, and Balancing for HVAC
H. 23 0713 - Duct Insulation
I. 23 0719 - HVAC Piping Insulation
J. 23 0913 - Instrumentation and Control Devices for HVAC
K. 23 0923 - Direct-Digital Control System for HVAC
L. 23 0993 - Sequence of Operations for HVAC Controls
M. 23 2113 - Hydronic Piping
N. 23 2114 - Hydronic Specialties
O. 23 6426 - Rotary-Screw Water Chillers
P. 23 8200 - Convection Heating and Cooling Units
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2.08 DIVISION 26 -- ELECTRICAL

A. 26 0001 - Basic Electrical Materials and Methods
B. 26 0505 - Selective Demolition for Electrical
C. 26 0519 - Low-Voltage Electrical Power Conductors and Cables
D. 26 0526 - Grounding and Bonding for Electrical Systems
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F. 26 0533.13 - Conduit for Electrical Systems
G. 26 0533.16 - Boxes for Electrical Systems
H. 26 0553 - Identification for Electrical Systems
I. 26 0583 - Wiring Connections
J. 26 2813 - Fuses
K. 26 2816.16 - Enclosed Switches

2.09 SUPPLEMENTAL INFORMATION

A. Original HVAC Sequence of Operation - 38 pgs
B. Building Automation System Original Submittal - 159 pgs
C. Building Automation System Original Drawings and Schedules - 30 pgs
D. Ice Storage System Original Submittal - 21 pgs

END OF SECTION

SECTION 00 0112

LIST OF BIDDING DOCUMENTS

CENTRALIZED REQUEST FOR QUOTATIONS INCLUDING THE FOLLOWING: (INCORPORATED BY REFERENCE ONLY)

1.01 INSTRUCTIONS TO VENDORS SUBMITTING BIDS

1.02 GENERAL TERMS AND CONDITIONS

1.03 ADDITIONAL TERMS AND CONDITIONS (CONSTRUCTION CONTRACTS ONLY)

1.04 CERTIFICATION AND SIGNATURE PAGE

1.05 ADDENDUM ACKNOWLEDGEMENT FORM

1.06 GENERAL CONSTRUCTIONS SPECIFICATIONS

1.07 PRICING PAGE

1.08 PURCHASING DIVISION CONSTRUCTION BID SUBMISSION REVIEW FORM

1.09 BID BOND INSTRUCTIONS AND SAMPLE BOND FORM

1.10 DISCLOSURE OF INTERESTED PARTIES TO CONTRACTS FORM

1.11 DRUG-FREE WORKPLACE CONFORMANCE AFFIDAVIT

END OF SECTION

SECTION 00 6000

PROJECT FORMS

THE AIA FORMS FOLLOWING THIS SECTION WILL BE UTILIZED IN THE EXECUTION OF THE PROJECT

END OF SECTION

AIA® Document G701™ – 2017

Change Order

PROJECT: *(Name and address)*
Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

CONTRACT INFORMATION:
Contract For: General Construction
Date:

CHANGE ORDER INFORMATION:
Change Order Number: 001
Date:

OWNER: *(Name and address)*
West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

ARCHITECT: *(Name and address)*
Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

CONTRACTOR: *(Name and address)*

THE CONTRACT IS CHANGED AS FOLLOWS:
(Insert a detailed description of the change and, if applicable, attach or reference specific exhibits. Also include agreed upon adjustments attributable to executed Construction Change Directives.)

The original Contract Sum was	$	0.00
The net change by previously authorized Change Orders	$	0.00
The Contract Sum prior to this Change Order was	$	0.00
The Contract Sum will be increased by this Change Order in the amount of	$	0.00
The new Contract Sum including this Change Order will be	$	0.00

The Contract Time will be increased by Zero (0) days.
The new date of Substantial Completion will be

NOTE: This Change Order does not include adjustments to the Contract Sum or Guaranteed Maximum Price, or the Contract Time, that have been authorized by Construction Change Directive until the cost and time have been agreed upon by both the Owner and Contractor, in which case a Change Order is executed to supersede the Construction Change Directive.

NOT VALID UNTIL SIGNED BY THE ARCHITECT, CONTRACTOR AND OWNER.

ARCHITECT	CONTRACTOR	OWNER
Miller Engineering, Inc.		West Virginia General Services Division
(Firm name)	*(Firm name)*	*(Firm name)*
SIGNATURE	SIGNATURE	SIGNATURE
Brian C. Miller, PE, President		Robert Kilpatrick
PRINTED NAME AND TITLE	PRINTED NAME AND TITLE	PRINTED NAME AND TITLE
DATE	DATE	DATE

AIA® Document G702® – 1992

Application and Certificate for Payment

TO OWNER: West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

PROJECT: Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

APPLICATION NO: 001
PERIOD TO:
CONTRACT FOR: General Construction
CONTRACT DATE:
PROJECT NOS: 21013 / / /

Distribution to:
OWNER: ☐
ARCHITECT: ☐
CONTRACTOR: ☐
FIELD: ☐
OTHER : ☐

FROM CONTRACTOR:

VIA ARCHITECT: Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

CONTRACTOR'S APPLICATION FOR PAYMENT

Application is made for payment, as shown below, in connection with the Contract.
AIA Document G703®, Continuation Sheet, is attached.

1. ORIGINAL CONTRACT SUM	$0.00
2. NET CHANGE BY CHANGE ORDERS	$0.00
3. CONTRACT SUM TO DATE (Line 1 ± 2)	$0.00
4. TOTAL COMPLETED & STORED TO DATE (Column G on G703)	$0.00
5. RETAINAGE:	
a. 0 % of Completed Work (Column D + E on G703)	$0.00
b. 0 % of Stored Material (Column F on G703)	$0.00
Total Retainage (Lines 5a + 5b or Total in Column I of G703)	$0.00
6. TOTAL EARNED LESS RETAINAGE (Line 4 Less Line 5 Total)	$0.00
7. LESS PREVIOUS CERTIFICATES FOR PAYMENT (Line 6 from prior Certificate)	$0.00
8. CURRENT PAYMENT DUE	$0.00
9. BALANCE TO FINISH, INCLUDING RETAINAGE (Line 3 less Line 6)	$0.00

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total changes approved in previous months by Owner	$0.00	$0.00
Total approved this Month	$0.00	$0.00
TOTALS	$0.00	$0.00
NET CHANGES by Change Order		$0.00

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner, and that current payment shown herein is now due.

CONTRACTOR:

By: _____ Date: _____

State of:

County of:

Subscribed and sworn to before me this day of

Notary Public:

My Commission expires:

ARCHITECT'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

AMOUNT CERTIFIED $0.00

(Attach explanation if amount certified differs from the amount applied. Initial all figures on this Application and on the Continuation Sheet that are changed to conform with the amount certified.)

ARCHITECT:

By: _____ Date: _____

This Certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the Contractor named herein. Issuance, payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

AIA Document G703® – 1992

Continuation Sheet

AIA Document G702®, Application and Certification for Payment, or G732™, Application and Certificate for Payment, Construction Manager as Adviser Edition, containing Contractor's signed certification is attached.
Use Column I on Contracts where variable retainage for line items may apply.

APPLICATION NO:	001
APPLICATION DATE:	
PERIOD TO:	
ARCHITECT'S PROJECT NO:	21013

A	B	C	D	E	F	G		H	I
			WORK COMPLETED						
ITEM NO.	DESCRIPTION OF WORK	SCHEDULED VALUE	FROM PREVIOUS APPLICATION (D + E)	THIS PERIOD	MATERIALS PRESENTLY STORED (NOT IN D OR E)	TOTAL COMPLETED AND STORED TO DATE (D + E + F)	% (G÷C)	BALANCE TO FINISH (C - G)	RETAINAGE (IF VARIABLE RATE)
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
		0.00	0.00	0.00	0.00	0.00	0.00%	0.00	0.00
	GRAND TOTAL	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**0.00%**	**$0.00**	**$0.00**

AIA® Document G704® – 2017

Certificate of Substantial Completion

PROJECT: *(name and address)* Building 54 HVAC Renovations 400 Adams Street, Fairmont, WV 26554	**CONTRACT INFORMATION:** Contract For: General Construction Date:	**CERTIFICATE INFORMATION:** Certificate Number: 001 Date:
OWNER: *(name and address)* West Virginia General Services Division 218 California Ave. Charleston, WV 25305	**ARCHITECT:** *(name and address)* Miller Engineering, Inc. 54 West Run Road Morgantown, WV 26508	**CONTRACTOR:** *(name and address)*

The Work identified below has been reviewed and found, to the Architect's best knowledge, information, and belief, to be substantially complete. Substantial Completion is the stage in the progress of the Work when the Work or designated portion is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use. The date of Substantial Completion of the Project or portion designated below is the date established by this Certificate.
(Identify the Work, or portion thereof, that is substantially complete.)

Miller Engineering, Inc.		Brian C. Miller, PE, President	
ARCHITECT *(Firm Name)*	**SIGNATURE**	**PRINTED NAME AND TITLE**	**DATE OF SUBSTANTIAL COMPLETION**

WARRANTIES
The date of Substantial Completion of the Project or portion designated above is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below:
(Identify warranties that do not commence on the date of Substantial Completion, if any, and indicate their date of commencement.)

WORK TO BE COMPLETED OR CORRECTED
A list of items to be completed or corrected is attached hereto, or transmitted as agreed upon by the parties, and identified as follows:
(Identify the list of Work to be completed or corrected.)

The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. Unless otherwise agreed to in writing, the date of commencement of warranties for items on the attached list will be the date of issuance of the final Certificate of Payment or the date of final payment, whichever occurs first. The Contractor will complete or correct the Work on the list of items attached hereto within ( ) days from the above date of Substantial Completion.

Cost estimate of Work to be completed or corrected: $

The responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work, insurance, and other items identified below shall be as follows:
(Note: Owner's and Contractor's legal and insurance counsel should review insurance requirements and coverage.)

The Owner and Contractor hereby accept the responsibilities assigned to them in this Certificate of Substantial Completion:

CONTRACTOR *(Firm Name)*	**SIGNATURE**	**PRINTED NAME AND TITLE**	**DATE**
West Virginia General Services Division		Robert Kilpatrick	
OWNER *(Firm Name)*	**SIGNATURE**	**PRINTED NAME AND TITLE**	**DATE**

AIA® Document G706™ – 1994

Contractor's Affidavit of Payment of Debts and Claims

PROJECT: *(Name and address)* Building 54 HVAC Renovations 400 Adams Street, Fairmont, WV 26554	**ARCHITECT'S PROJECT NUMBER:** 21013 **CONTRACT FOR:** General Construction	OWNER: ☐ ARCHITECT: ☐ CONTRACTOR: ☐ SURETY: ☐ OTHER: ☐
TO OWNER: *(Name and address)* West Virginia General Services Division 218 California Ave. Charleston, WV 25305	**CONTRACT DATED:**	

STATE OF:
COUNTY OF:

The undersigned hereby certifies that, except as listed below, payment has been made in full and all obligations have otherwise been satisfied for all materials and equipment furnished, for all work, labor, and services performed, and for all known indebtedness and claims against the Contractor for damages arising in any manner in connection with the performance of the Contract referenced above for which the Owner or Owner's property might in any way be held responsible or encumbered.

EXCEPTIONS:

SUPPORTING DOCUMENTS ATTACHED HERETO:

1. Consent of Surety to Final Payment. Whenever Surety is involved, Consent of Surety is required. AIA Document G707, Consent of Surety, may be used for this purpose

Indicate Attachment ☐ Yes ☒ No

The following supporting documents should be attached hereto if required by the Owner:

1. Contractor's Release or Waiver of Liens, conditional upon receipt of final payment.

2. Separate Releases or Waivers of Liens from Subcontractors and material and equipment suppliers, to the extent required by the Owner, accompanied by a list thereof.

3. Contractor's Affidavit of Release of Liens (AIA Document G706A).

CONTRACTOR: *(Name and address)*

BY: _____
(Signature of authorized representative)

_____
(Printed name and title)

Subscribed and sworn to before me on this date:

Notary Public:
My Commission Expires:

AIA® Document G706A™ – 1994

Contractor's Affidavit of Release of Liens

PROJECT: *(Name and address)*
Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554
TO OWNER: *(Name and address)*
West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

ARCHITECT'S PROJECT NUMBER:
21013
CONTRACT FOR: General Construction
CONTRACT DATED:

OWNER: ☐
ARCHITECT: ☐
CONTRACTOR: ☐
SURETY: ☐
OTHER: ☐

STATE OF:
COUNTY OF:

The undersigned hereby certifies that to the best of the undersigned's knowledge, information and belief, except as listed below, the Releases or Waivers of Lien attached hereto include the Contractor, all Subcontractors, all suppliers of materials and equipment, and all performers of Work, labor or services who have or may have liens or encumbrances or the right to assert liens or encumbrances against any property of the Owner arising in any manner out of the performance of the Contract referenced above.

EXCEPTIONS:

SUPPORTING DOCUMENTS ATTACHED HERETO:

1. Contractor's Release or Waiver of Liens, conditional upon receipt of final payment.
2. Separate Releases or Waivers of Liens from Subcontractors and material and equipment suppliers, to the extent required by the Owner, accompanied by a list thereof.

CONTRACTOR: *(Name and address)*

BY: _____
(Signature of authorized representative)

_____
(Printed name and title)

Subscribed and sworn to before me on this date:

Notary Public:
My Commission Expires:

AIA® Document G707™ – 1994

Consent Of Surety to Final Payment

PROJECT: *(Name and address)* Building 54 HVAC Renovations 400 Adams Street, Fairmont, WV 26554	**ARCHITECT'S PROJECT NUMBER:** 21013 **CONTRACT FOR:** General Construction	OWNER: ☐ ARCHITECT: ☐ CONTRACTOR: ☐ SURETY: ☐ OTHER: ☐
TO OWNER: *(Name and address)* West Virginia General Services Division 218 California Ave. Charleston, WV 25305	**CONTRACT DATED:**	

In accordance with the provisions of the Contract between the Owner and the Contractor as indicated above, the
(*Insert name and address of Surety*)

, SURETY,

on bond of
(Insert name and address of Contractor)

, CONTRACTOR,

hereby approves of the final payment to the Contractor, and agrees that final payment to the Contractor shall not relieve the Surety of any of its obligations to
(Insert name and address of Owner)

West Virginia General Services Division
112 California Ave.
5th Floor
Charleston, WV 25305

, OWNER,

as set forth in said Surety's bond.

IN WITNESS WHEREOF, the Surety has hereunto set its hand on this date:
(Insert in writing the month followed by the numeric date and year.)

_____
(Surety)

_____
(Signature of authorized representative)

Attest:
(Seal):

_____
(Printed name and title)

AIA® Document G710™ – 2017

Architect's Supplemental Instructions

PROJECT: *(name and address)*
Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

CONTRACT INFORMATION:
Contract For: General Construction
Date:

ASI INFORMATION:
ASI Number: 001
Date:

OWNER: *(name and address)*
West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

ARCHITECT: *(name and address)*
Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

CONTRACTOR: *(name and address)*

The Contractor shall carry out the Work in accordance with the following supplemental instructions without change in Contract Sum or Contract Time. Proceeding with the Work in accordance with these instructions indicates your acknowledgment that there will be no change in the Contract Sum or Contract Time.
(Insert a detailed description of the Architect's supplemental instructions and, if applicable, attach or reference specific exhibits.)

ISSUED BY THE ARCHITECT:

Miller Engineering, Inc.
ARCHITECT *(Firm name)*

SIGNATURE

Brian C. Miller, PE, President
PRINTED NAME AND TITLE

DATE

AIA® Document G714™ – 2017

Construction Change Directive

PROJECT: *(name and address)*
Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

CONTRACT INFORMATION:
Contract For: General Construction
Date:

CCD INFORMATION:
Directive Number: 001
Date:

OWNER: *(name and address)*
West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

ARCHITECT: *(name and address)*
Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

CONTRACTOR: *(name and address)*

The Contractor is hereby directed to make the following change(s) in this Contract:
(Insert a detailed description of the change and, if applicable, attach or reference specific exhibits.)

PROPOSED ADJUSTMENTS

1. The proposed basis of adjustment to the Contract Sum or Guaranteed Maximum Price is:

- ☒ Lump Sum decrease of $0.00
- ☐ Unit Price of $ per
- ☐ Cost, as defined below, plus the following fee:
  (Insert a definition of, or method for determining, cost)
- ☐ As follows:

2. The Contract Time is proposed to remain unchanged. The proposed adjustment, if any, is (0 days).

NOTE: The Owner, Architect and Contractor should execute a Change Order to supersede this Construction Change Directive to the extent they agree upon adjustments to the Contract Sum, Contract Time, or Guaranteed Maximum price for the change(s) described herein.

When signed by the Owner and Architect and received by the Contractor, this document becomes effective IMMEDIATELY as a Construction Change Directive (CCD), and the Contractor shall proceed with the change(s) described above.

Contractor signature indicates agreement with the proposed adjustments in Contract Sum and Contract Time set forth in this CCD.

Miller Engineering, Inc.	West Virginia General Services Division	
ARCHITECT *(Firm name)*	**OWNER** *(Firm name)*	**CONTRACTOR** *(Firm name)*
SIGNATURE	**SIGNATURE**	**SIGNATURE**
Brian C. Miller, PE, President	Robert Kilpatrick	
PRINTED NAME AND TITLE	**PRINTED NAME AND TITLE**	**PRINTED NAME AND TITLE**
DATE	**DATE**	**DATE**

AIA® Document G716™ – 2004

Request for Information ("RFI")

TO:
Brian C. Miller, PE
Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

FROM:

PROJECT:
Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

ISSUE DATE:

RFI No. 001

REQUESTED REPLY DATE:

PROJECT NUMBERS: 21013 /

COPIES TO:

RFI DESCRIPTION: *(Fully describe the question or type of information requested.)*

REFERENCES/ATTACHMENTS: *(List specific documents researched when seeking the information requested.)*
SPECIFICATIONS: **DRAWINGS:** **OTHER:**

SENDER'S RECOMMENDATION: *(If RFI concerns a site or construction condition, the sender may provide a recommended solution, including cost and/or schedule considerations.)*

RECEIVER'S REPLY: *(Provide answer to RFI, including cost and/or schedule considerations.)*

BY	DATE	COPIES TO

Note: This reply is not an authorization to proceed with work involving additional cost, time or both. If any reply requires a change to the Contract Documents, a Change Order, Construction Change Directive or a Minor Change in the work must be executed in accordance with the Contract Documents.

SECTION 00 7200

AIA GENERAL CONDITIONS (AIA A201-2017)

1.01 THE GENERAL CONDITIONS APPLICABLE TO THIS CONTRACT ARE AIA A201-2017

1.02 A BLANK COPY OF THE GENERAL CONDITIONS APPLICABLE TO THIS CONTRACT IS ATTACHED FOLLOWING THIS PAGE.

1.03 RELATED REQUIREMENTS

A. SECTION 00 7300 - SUPPLEMENTARY CONDITIONS TO AIA A201-2017: REFER TO DOCUMENT 00 7300 FOR AMENDMENTS TO THESE GENERAL CONDITIONS.

END OF SECTION

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

Building 54 HVAC Renovations
400 Adams Street, Fairmont, WV 26554

THE OWNER:
(Name, legal status and address)

West Virginia General Services Division
218 California Ave.
Charleston, WV 25305

THE ARCHITECT:
(Name, legal status and address)

Miller Engineering, Inc.
54 West Run Road
Morgantown, WV 26508

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

TABLE OF ARTICLES

Init.
/

15 CLAIMS AND DISPUTES

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(Topics and numbers in bold are Section headings.)

ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent

consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and 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 the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. The parties will use AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements,

assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- **.1** allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- **.2** Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- **.3** whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the

Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work
The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights
The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification
§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' 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, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not 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 that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 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 3.18.1 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.

ARTICLE 4 ARCHITECT
§ 4.1 General
§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract
§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the

Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations

and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor,

prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

.1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and

.2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work,

promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

.1 The change in the Work;
.2 The amount of the adjustment, if any, in the Contract Sum; and
.3 The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

.1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
.2 Unit prices stated in the Contract Documents or subsequently agreed upon;
.3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
.4 As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

.1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;
.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
.4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
.5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will

affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and binding dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and

unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- **.1** defective Work not remedied;
- **.2** third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- **.3** failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- **.4** reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- **.5** damage to the Owner or a Separate Contractor;
- **.6** reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
- **.7** repeated failure to carry out the Work in accordance with the Contract Documents.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

.1 liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;

.2 failure of the Work to comply with the requirements of the Contract Documents;

.3 terms of special warranties required by the Contract Documents; or

.4 audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

.1 employees on the Work and other persons who may be affected thereby;

.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and

.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, 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), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.2.2 Failure to Purchase Required Property Insurance. If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.

§ 11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance. Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to

the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located, excluding that jurisdiction's choice of law rules. If the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

.1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;

.2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped;

.3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or

.4 The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

.1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;

.2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;

.3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or

.4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

.1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 Accept assignment of subcontracts pursuant to Section 5.4; and

.3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance,

the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

.1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or

.2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in the notice;

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. 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 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and binding dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the

Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

§ 15.3.3 Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for binding dispute resolution. If such a demand is made and the party receiving the demand fails to file for binding dispute resolution within 60 days after receipt thereof, then both parties waive their rights to binding dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

§ 15.4 Arbitration

§ 15.4.1 If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. The Arbitration shall be conducted in the place where the Project is located, unless another location is mutually agreed upon. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement, shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

§ 15.4.4 Consolidation or Joinder

§ 15.4.4.1 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ 15.4.4.2 Subject to the rules of the American Arbitration Association or other applicable arbitration rules, either party may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as those of the Owner and Contractor under this Agreement.

SECTION 00 7300

SUPPLEMENTARY CONDITIONS TO AIA A201-2017

PART 1 GENERAL

1.01 SUMMARY

A. The State of West Virginia Supplementary Conditions to AIA 201-2017 General Conditions of the Contract for Construction amend and supplement the General Conditions defined in Document 00 7200 - AIA General Conditions (A201-2017) & Contract Forms and other provisions of the Contract Documents as indicated below.

B. The terms used in these Supplementary Conditions that are defined in the General Conditions have the meanings assigned to them in the General Conditions.

C. A blank copy of the applicable Supplementary Conditions is attached following this page.

D. Successful Vendor will be required to sign these Supplementary Conditions with the Owner, prior to Contract award.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

State of West Virginia

Supplementary Conditions to AIA Document A201-2017
General Conditions of the Contract for Construction

The following Supplementary Conditions modify the General Conditions of the Contract for Construction, AIA Document A201, 2017 Edition. Where a portion of the General Conditions is modified or deleted by these Supplementary Conditions, the unaltered portions of the General Conditions shall remain in effect.

Order of Precedence: The documents contained in the contract to which this document has been attached shall be interpreted in the following order of precedence:

First Priority – Documents developed by the State or agency and utilized to provide public notice of the solicitation, along with other general terms and conditions shall be first in priority.

Second Priority – This document "Supplementary Conditions to the AIA Document A201-2017 General Conditions of the Contract for Construction" shall be second in priority.

Third Priority – all other AIA documents including, but not limited to, the AIA Document A201-2017 General Conditions of the Contract for Construction and the A101-2017 Standard Form of Agreement Between Owner and Contractor (when utilized) shall be third or lower in priority.

ARTICLE 1
GENERAL PROVISIONS

Add the following Section to Article 1:

§1.05 PARTY RELATIONS

§1.05 The Owner and their consultants, the Architect and their Consultants, and the Contractor and their Subcontractors agree to proceed with the Work on the basis of mutual trust, good faith and fair dealing.

§1.1 BASIC DEFINITIONS

§1.1.1 THE CONTRACT DOCUMENTS

§1.1.1 Delete the last sentence of this Section and substitute the following:

The Contract Documents also include the Bidding Documents (Advertisement or Invitation to Bid, Request for Quotations/Bids, Instructions to Bidders, Form of Proposal, Bid Bond and Sample Forms), Performance Bond, Payment Bond, Maintenance Bond (if applicable), Certificates of Insurance, Special Provisions For Disadvantaged and Women Business Enterprise Utilization (if bound herein).

§1.1.2 THE CONTRACT

§1.1.2 Make the following changes to Section 1.1.2:

In the last sentence, insert "and the Contractor" after "The Architect" and delete "the Architect's" and insert "their respective".

§1.2 Correlation and intent of Contract Documents

§1.2.1.1 In the second sentence, remove "any law" and insert "West Virginia law or any applicable federal law". In the last sentence, remove "by law" and insert "West Virginia law or any applicable federal law".

§1.7 Digital Data Use and Transmission

§1.7 Delete the last sentence of this section in its entirety.

§1.8 Building Information Models Use and Reliance

§ 1.8 Remove this section in its entirety and replace it with the following:

"Any use of, or reliance on, all or a portion of a building information model must be approved in advance by Owner and will only be permitted if the Parties have agreed upon and executed written documents to memorialize protocols governing the use of, and reliance on, the information contained in the model."

ARTICLE 2
OWNER

§2.1 GENERAL

§ 2.1.1 Add the following after the last sentence:

Notwithstanding the foregoing, the parties understand that since Owner is a government entity, change orders will often require approval by entities in addition to owner. When owner is a state agency, those entities may include, but are not limited to, the West Virginia Attorney General's Office and the West Virginia Purchasing Division. Additionally, approval may be required by agencies providing project funding, including but not limited to, West Virginia School Building Authority and agencies of the United States federal government.

§2.1.2 Delete Section 2.1.2 in its entirety.

§2.1 Add the following Section to 2.1:

§2.1.3 The Owner and the agency funding the project reserve the right to maintain a full time or part time project representative (sometimes referred to as the "Clerk of the Works") at the project site who shall keep the Owner informed of the progress and quality of the Work and responsibilities. The Contractor shall cooperate and assist the Clerk of the Works in the performance of his/her duties. The Clerk of the Works will not interfere with or be responsible for the Contractor's supervision and direction of the Work, and the Contractor's means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work. The Clerk of the Works may facilitate communications between the Owner, Architect, and Contractor but has no authority to make decisions for the Owner, approve modifications to the Contract Documents, the Contract Time, or Contract Sum. Additionally, Contractor is not permitted to rely on or consider decisions made by the Clerk of the Works on behalf of Owner

§2.2 Evidence of the Owner's Financial Arrangements: Delete § 2.2 and all of its subsections in its entirety.

§2.3 Information and Services Required of Owner

§2.3.2 Make the following changes to Section 2.3.2:

In first sentence, delete the period and add ", when required pursuant to West Virginia Code §30-12-1 et seq." Add the following sentence at the end of Section 2.3.2: "If the Owner does not retain an architect lawfully licensed to practice architecture or an entity lawfully practicing architecture in the jurisdiction where the Project is located, the Owner will appoint an individual to assume the role and obligations of the Architect pursuant to this Agreement."

§2.3.3 Delete this section in its entirety.

§2.3.4 Delete the last sentence of Section 2.3.4 and substitute the following:

The Contractor shall confirm the locations of each utility. If the Owner has provided geotechnical and other tests to determine subsurface conditions, the Owner will provide such documents to the Contractor; the Contractor acknowledges that it will make no claims for any subsurface or any other conditions revealed by these tests.

ARTICLE 3
CONTRACTOR

§3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

§3.2.2 Add the following sentence to the end of Section 3.2.2:

Claims by Contractor resulting from its failure to familiarize itself with the site shall be deemed waived. Additionally, by submitting a bid or otherwise entering into this contract, Contractor acknowledges that it has reviewed and understands the contract documents and the work required by those documents. Any claims arising from Contractor's failure to review and understand the contract documents shall be deemed waived.

§3.2.3 Delete Section 3.2.3 in its entirety and substitute the following:

§3.2.3 The Contractor acknowledges its continuing duty to review and evaluate the Construction Documents during performance of its services and shall immediately notify the Owner and the Architect about any problems, conflicts, defects, deficiencies, inconsistencies or omissions it discovers in or between the Construction Documents; and variances it discovers between the Construction Documents and applicable laws, statutes, building codes, rules and regulations.

§ 3.2.4 Add the following clauses to Section 3.2.4:

§3.2.4.1 If the Contractor performs any Work which it knows or should have known involves a recognized problem, conflict, defect, deficiency, inconsistency or omission in the Construction Documents; or a variance between the Construction Documents and requirements of applicable laws, statutes, building codes, rules and regulations, without notifying the Owner and the Architect prior to receiving written authorization from the Architect to proceed, the Contractor shall be responsible for the consequences of such performance.

§3.2.4.2 Before ordering any materials or doing any Work, the Contractor and Subcontractors shall verify all measurements at the site and shall be responsible for the correctness of same. Discrepancies shall be reported in writing to the Architect prior to proceeding with the Work. No extra charge or compensation will be

entertained due to differences between actual measurements and dimensions indicated on the drawings, if such differences do not result in a change in the scope of Work or if the Architect failed to receive written notice before the Work was performed.

§3.4 LABOR AND MATERIALS

§3.4.1 Vendor must review and comply with the following statutory requirements affecting public construction projects, as well as any other applicable laws that are not referenced herein:

- W. Va. Code § 5-19-1 et seq., relating to domestic steel preference.
- W. Va. Code § 5A-3-56 relating to domestic steel preference, provided that the Owner is a state agency subject to Chapter 5A, Article 3 of the W. Va. Code.
- W. Va. Code § §21-1C-1 *et seq.*, relating to local hiring preference
- W. Va. Code §21-1D-1 *et seq.*, relating to drug free workplace requirements.

§3.4 Add the following Sections to 3.4:

§3.4.4 Where materials and equipment are to be provided by the Owner under the Contract Documents, the Contractor shall notify the Owner in writing as to when materials and equipment are required on the project site in sufficient time to avoid delay in the Work.

§3.4.5 The Contractor shall employ labor on the Project or in connection with the Work, capable of working harmoniously with all trade crafts and any other individuals associated with the Project. The Contractor shall also use its best efforts and implement policies and practices to minimize the likelihood of any strike, work stoppage or other labor disturbance. Except as specifically provided in this Agreement, Contractor shall not be entitled to any adjustment in the Contract sum or Contract time and shall be liable to the Owner for all damages suffered by the Owner occurring as a result of work stoppages, slowdowns, disputes, or strikes by the work force of or provided by Contractor or its Subcontractors.

§3.5 WARRANTY

§3.5 Add the following sentence at the end of Section 3.5:

The Contractor agrees to assign to the Owner at time of Final Completion of the Work, any and all manufacturer's warranties relating to materials and labor used in the Work and further agrees to perform the Work in such a manner so as to preserve any and all such warranties.

§3.8 ALLOWANCES

§3.8.3 Make the following change to Section 3.8.3:

§3.8.3 Delete "with reasonable promptness" and insert "in sufficient time to avoid delay in the Work."

Add the following Section to 3.8:

§3.8.4 The Contractor shall promptly submit to the Owner an itemized account of any expenditure by the Contractor of the Contract allowance in sufficient detail to allow the Owner to properly account for such expenditure.

§3.9 SUPERINTENDENT/PROJECT MANAGER

§3.9.1 Add the following sentence to the end of Section 3.9.1:

The Contractor may also employ a competent project manager.

§3.9.2 Make the following changes to Section 3.9.2:

In the first sentence, add "and project manager, if applicable" after "superintendent." In the second sentence, add "or project manager, if applicable," after "superintendent."

§3.9.3 Make the following changes to Section 3.9.3:

In the first sentence, add "or project manager, if applicable," after "superintendent." In the second sentence, add "or project manager, if applicable," after "superintendent."

§3.9 Add the following Section to 3.9:

§3.9.4 The Owner shall have the right, at any time, to direct a change in the Contractor's representatives if their performance is deemed unsatisfactory.

§3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

§3.10.1 Make the following changes to Section 3.10.1:

In the first sentence, delete the word "promptly" and substitute "by the earliest reasonable date".

Add the following sentence to the end of Section 3.10.1: "The Contractor shall submit an updated construction schedule with each payment application, unless waived by the Owner."

Add the following Sections to 3.10:

§3.10.4 At any time after the first thirty (30) days of the Contract Time, if it is found that the project is two (2) weeks or more behind schedule, beyond approved time extensions, or if at any time during

the last thirty (30) days of the scheduled Contract Time the Contractor is one (1) week or more behind schedule, the Contractor shall immediately submit a plan to the Owner describing how the Work will be placed back on schedule within the remaining Contract Time.

§3.10.5 If the Owner and the Architect determine that the performance of the Work during any stage of the construction schedule last approved by the Owner has not progressed or reached the level of completion required by the Contract Documents, the Owner will have the right to order the Contractor to take corrective measures (hereinafter referred to collectively as Extraordinary Measures) necessary to expedite the progress of the Work, including, without limitation: (1) working additional shifts or overtime; (2) supplying additional manpower, equipment and facilities; and (3) other similar measures. Such Extraordinary Measures shall continue until the progress of the Work complies with the last approved construction schedule. The Owner's right to require Extraordinary Measures is solely for the purpose of ensuring the Contractor's compliance with the construction schedule after allowing for approved extensions of Contract Time as provided elsewhere in this Agreement. The Contractor is not entitled to an adjustment in the Contract Sum in connection with any Extraordinary Measures required by the Owner. The Owner may exercise its rights under this Section as frequently as the Owner deems necessary to ensure that the Contractor's performance of the Work will comply with the construction schedule.

§3.11 DOCUMENTS AND SAMPLES AT THE SITE

§3.11 Insert the following sentence at the end of Section 3.11:

The Contractor's compliance with this Section 3.11 shall be a condition precedent to any obligation of the Owner to make Final Payment pursuant to this Agreement.

§3.15 CLEANING UP

§3.15.2 Delete Section 3.15.2 in its entirety and substitute the following:

§3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and may withhold such reasonable costs as necessary for the fulfillment of the Contractor's obligation under this Section 3.15. If the reasonable costs of such cleaning exceed the Contract Sum then due the Contractor, the Contractor shall reimburse the Owner the difference within thirty (30) consecutive calendar days of the Owner's written request.

Any materials, tools, supplies, or other personal property left by the Contractor shall be deemed abandoned property and the Owner shall have no obligation to hold or store the property on behalf of Contractor and may dispose of the abandoned property as if it were property of the State of West Virginia. Provided however, that prior to treating property as abandoned and disposing of it, Owner must first provide Contractor with 10 days notice of its intent to do so. If any materials, tools, supplies or other personal property belong to a subcontractor, then Contractor is obligated to communicate this notice to its subcontractor immediately.

§3.15 Add the following Section to 3.15:

§3.15.3 In order to achieve Substantial Completion, as defined by Section 9.8, for any portion of the Work, the Contractor must have the area where the Work is located fully cleaned and all materials and/or debris removed from site. The Certificate of Substantial Completion will not be issued until the Contractor has met this obligation.

ARTICLE 4
ARCHITECT

§4.1 GENERAL

§4.2 ADMINISTRATION OF THE CONTRACT

§4.2 Make the following changes to Section 4.2:

§4.2.1 In the first sentence of Section 4.2.1 after the word Architect add ", unless otherwise indicated by the Owner,".

§4.2.2 In the first sentence of Section 4.2.2 strike the word "generally."

§4.2.3 In the first sentence of Section 4.2.3 strike the word "reasonably."

§4.2.5 Add the following sentence at the end of Section 4.2.5:

The Architect upon receipt of an Application for Payment from the Contractor shall either review and certify such amounts due for payment or return such Application for Payment to the Contractor for correction(s) within five (5) consecutive business days of receipt.

§4.2.7 Delete the first sentence of Section 4.2.7 and substitute the following:

The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples for the purpose of checking for conformance with the Contract Documents.

Modify the second to last sentence by removing it in its entirety and replacing it with the following: The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures, unless the Architect has established the required construction means, methods, techniques, sequences, or procedures, or the Contract Documents require such approval.

§4.2.8 Make the following change to Section 4.2.8:

In the first sentence, after the word Architect add ", in consultation with the Owner,".

ARTICLE 5
SUBCONTRACTORS

§5.2 Award of Subcontracts and Other Contracts for Portions of Work

§5.2.1 Add the following sentence to Section 5.2.1.

This provision in no way limits the Contractor's legal obligations to report subcontractors and labor/material suppliers under W. Va. Code § 5-22-1(f) and obtain approval under W. Va. Code § 5-22-1(g) prior to any subcontractor substitution.

§5.4 Contingent Assignment of Subcontracts: This section is removed in its entirety and replaced with the following:

§5.4 Emergency Contracts with Subcontractors:

In the event that the general contractor fails to fulfill its contractual obligations and the performance bond has failed to provide an adequate remedy, Owner has the right to execute emergency contracts with subcontractors to ensure continuation of the work, provided that doing so is in compliance with the laws, rules, and procedures governing emergency contracting authority for Owner, and the emergency contract terms comply with all other applicable laws, rules, and procedures.

ARTICLE 7
CHANGES IN THE WORK

§7.1 General

§7.1.2. In Section 7.1.2. remove the word "alone" and insert "with approval by the Owner."

§7.2 CHANGE ORDERS

§7.2 Add the following Section to 7.2:

§7.2.2 A written Change Order as defined under 7.2.1 above constitutes a final settlement of all matters relating to the change in the Work which is the subject of the Change Order, including, but not limited to general conditions, all direct or indirect costs associated with such change and any and all adjustment to the Contract Sum and Contract Time. The parties also understand and agree that if Owner is a state agency, change orders may require approval by entities in addition to Owner. Those entities may include, but are not limited to, the West Virginia Purchasing Division, and the West Virginia Attorney General's Office. Owner and Contractor must discuss the change order approval requirements prior to executing this agreement.

Add the following section to § 7.2

§7.2.3. Allowance for Overhead and Profit: Contractor's overhead and profit for a change order issued under this Article included in the total cost to the Owner shall not exceed based on the following schedule:

.1 For the Contractor, for any Work performed by the Contractor's own forces, fifteen percent (15%) of the cost.

.2 For the Contractor, for Work performed by the Contractor's Subcontractor, ten percent (10%) of the amount due the Subcontractor.

.3 For each Subcontractor or Sub-Subcontractor involved, for any Work performed by that Subcontractor's own forces, fifteen percent (15%) of the cost.

.4. For each Subcontractor, for Work performed by the Subcontractor's Sub-subcontractors, ten percent (10%) of the amount due the Sub-subcontractor.

.5 Cost to which overhead and profit is to be applied shall be determined in accordance with Section 7.3.7. Estimated labor hours shall include hours only for those workmen and working foremen directly involved in performing the Change Order work. Supervision above the level of working foremen (such as general foremen, superintendent, project manager, etc.) is considered to be included in the allowance for Overhead and Profit. Hand tools are defined as equipment with a value of $1,000 or less. For Contractor owned equipment, the "bare" equipment rental rates allowed to be used for pricing Change Order proposals shall be not more than the monthly rate listed in the most current publication of The AED Green Book divided by 176 to arrive at a maximum hourly rate to be applied to the hours the equipment is used performing the Change Order work.

.6 In order to facilitate checking of quotations for extras or credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, material, equipment and Subcontractors. Details to be submitted will include detailed line item estimates showing detailed materials quantity take-offs, material prices by item and related labor hour pricing information and extensions (by line item or by drawing as applicable.) Where major cost items are Subcontracts, they shall also be itemized as prescribed above. In no case will a change involving over $10,000 be approved without such an itemization.

.7 Local Business and Occupation Taxes, if applicable, shall be calculated on the cost of the Work, overhead and profit.

.8 Overhead and profit shall not be calculated on changes in the Work involving unit prices. Unit prices are to have overhead and profit included in the price quoted.

.9 Under no circumstances is Contractor permitted to charge for the passage of time (often referred to as general conditions or winter conditions) without an identified, itemized, and concretely provable cost borne by Contractor. Contractor has a duty to mitigate costs during a delay period to the fullest extent possible and Contractor will not be paid for costs that could have been mitigated. Calculating a daily delay rate without properly identifying, itemizing, and proving actual, unmitigateable costs, is prohibited. Contractor understands and accepts that it has the responsibility to prove that costs could not be mitigated prior to submitting a request for payment.

§7.3 CONSTRUCTION CHANGE DIRECTIVES

§7.3.4 Make the following change in Section 7.3.4:

In the fourth line of the first sentence, delete the words "an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount" and substitute "an allowance for overhead and profit in accordance with clauses 7.3.11.1 through 7.3.11.9 below."

§7.3.7 Delete the word "recorded" and replace it with "processed".

§7.3.9 Delete Section 7.3.9 in its entirety and substitute the following:

§7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, amounts not in dispute for such changes in the Work shall be included in Applications for Payment provided these amounts have been added to the Contract by Change Order and a purchase order has been issued for the Change Order.

§7.3.10 Add the following sentence to the end of Section 7.3.10:

The Parties will utilize their best efforts to issue a change order within 60 days of agreement being reached, but failure to do so will not give rise to grounds for contract cancellation, penalties, or any other cause of action.

Add the following Section to 7.3:

§7.3.11 In Section 7.3.7, the allowance for overhead and profit for a change directive issued under this Article included in the total cost to the Owner shall not exceed the following schedule:

.1 For the Contractor, for any Work performed by the Contractor's own forces, fifteen percent (15%) of the cost.

.2 For the Contractor, for Work performed by the Contractor's Subcontractor, ten percent (10%) of the amount due the Subcontractor.

.3 For each Subcontractor or Sub-Subcontractor involved, for any Work performed by that Subcontractor's own forces, fifteen percent (15%) of the cost.

.4. For each Subcontractor, for Work performed by the Subcontractor's Sub-subcontractors, ten percent (10%) of the amount due the Sub-subcontractor.

.5 Cost to which overhead and profit is to be applied shall be determined in accordance with Section 7.3.7. Estimated labor hours shall include hours only for those workmen and working foremen directly involved in performing the Change Order work. Supervision above the level of working foremen (such as general foremen, superintendent, project manager, etc.) is considered to be included in the allowance for Overhead and Profit. Hand tools are defined as equipment with a value of $1,000 or less. For Contractor owned equipment, the "bare" equipment rental rates allowed to be used for pricing Change Order proposals shall be not more than the monthly rate listed in the most current publication of The AED Green Book divided by 176 to arrive at a maximum hourly rate to be applied to the hours the equipment is used performing the Change Order work.

.6 In order to facilitate checking of quotations for extras or credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, material, equipment and Subcontractors. Details to be submitted will include detailed line item estimates showing detailed materials quantity take-offs, material prices by item and related labor hour pricing information and extensions (by line item or by drawing as applicable.) Where major cost items are Subcontracts, they shall also be itemized as prescribed above. In no case will a change involving over $10,000 be approved without such an itemization.

.7 Local Business and Occupation Taxes, if applicable, shall be calculated on the cost of the Work, overhead and profit.

.8 Overhead and profit shall not be calculated on changes in the Work involving unit prices. Unit prices are to have overhead and profit included in the price quoted.

.9 Under no circumstances is Contractor permitted to charge for the passage of time (often referred to as general conditions or winter conditions) without an identified, itemized, and concretely provable cost borne by Contractor. Contractor has a duty to mitigate costs during a delay period to the fullest extent possible and Contractor will not be paid for costs that could have been mitigated. Calculating a daily delay rate

without properly identifying, itemizing, and proving actual, unmitigateable costs, is prohibited. Contractor understands and accepts that it has the responsibility to prove that costs could not be mitigated prior to submitting a request for payment.

§7.4 Minor Changes in Work. Insert the following sentence at the end of section 7.4:

"Contractor may request that Architect provide written confirmation that Owner has agreed to the minor change, and if requested, Architect will provide it."

ARTICLE 8
TIME

§8.3 DELAYS AND EXTENSIONS OF TIME

§8.3.1 In the first sentence, delete "unusual delay in deliveries," and add "unmitigatable costs attributable to" before the words "adverse weather conditions."

ARTICLE 9
PAYMENTS AND COMPLETION

§9.1 Contract Sum

§9.1.2 Add the following sentence to the end of section 9.1.2:

"Any equitable adjustment of unit prices must be processed as a change order to the contract"

§9.2 SCHEDULE OF VALUES

§9.2 Make the following changes to Section 9.2:

In the first sentence add "and the Owner" after the first reference to the Architect. In the second sentence add "or the Owner" after Architect. Remove the last sentence in its entirety and replace it with the following:

"Any changes to the schedule of values shall be submitted to the Architect and the Owner and supported by such data to substantiate its accuracy as the Architect or owner may require. This schedule, unless objected to by the Architect or the Owner, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment."

§9.3 APPLICATIONS FOR PAYMENT

§9.3 Make the following changes to Section 9.3:

§9.3.1 In the first sentence add "and the Owner" after the first reference to the Architect and add "and other required documents" after the words "schedule of values."

§9.3.1.1 Delete clause 9.3.1.1 in its entirety and substitute the following:

§9.3.1.1 Such applications may include requests for payment on account of changes in the Work authorized by Construction Change Directives and Change Orders only after a purchase order has been issued for the Work affected.

§9.3.1 Add the following clauses to Section 9.3.1:

§9.3.1.3 Until the Work is fifty percent (50%) complete, the Owner will withhold as retainage 10% of the amount due the Contractor on account of progress payments. At the time the Work is fifty percent (50%) complete and thereafter, if the manner of completion of the Work and its progress are and remain satisfactory to the Owner and Architect, and in the absence of other good and sufficient reasons, the Architect will, on presentation by the Contractor of Consent of Surety, authorize any remaining partial payments to be paid in full.

§9.3.1.4 The full Contract retainage may be reinstated if the manner of completion of the Work and its progress do not remain satisfactory to the Owner and Architect, if the Surety withholds its consent, or for other good and sufficient reasons.

§9.4 CERTIFICATES FOR PAYMENT

§9.4.1 After the phrase "in the full amount of the Application for Payment," insert the phrase "less any retainage withheld pursuant to section 9.3.1.3,".

§9.6 PROGRESS PAYMENTS

§9.6.7 Delete Section 9.6.7 in its entirety.

§9.6.8 Delete Section 9.6.8 in its entirety.

§9.7 FAILURE OF PAYMENT

§9.7 Make the following changes in Section 9.7:

In line two, change "seven days" to "sixty days." In line four, delete "binding dispute resolution" and substitute "the West Virginia Claims Commission"

§9.8 SUBSTANTIAL COMPLETION

§9.8.3 Add the following clause to Section 9.8.3:

If Architect is required to perform more than one inspection under this subsection, Contractor shall be responsible for paying the Owner for the cost of the additional inspection, which will be paid by Owner to Architect, at the hourly rate established in the contract between Owner and Architect.

§9.8.5 Add the following clause to Section 9.8.5:

§9.8.5.1 The payment of retainage shall be sufficient to increase the total payments to ninety-five percent (95%) for the Work or designated portion thereof being accepted as Substantially Complete, less any amounts as the Architect shall determine for any Work that is not complete, not in accordance with the Contract Documents, or for unsettled claims.

§9.10 FINAL COMPLETION AND FINAL PAYMENT

§9.10.1 Add the following to the end of Section 9.10.1:

If Architect is required to perform more than one inspection under this subsection, Contractor shall be responsible for paying the Owner for the cost of the additional inspection, which will be paid by Owner to Architect, at the hourly rate established in the contract between Owner and Architect.

§9.10.2 Make the following changes in Section 9.10.2:

In the first sentence, delete "for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner)."

Add the following clause to Section 9.10.2:

§9.10.2.1 Before final payment is due the Contractor, all applicable State and local taxes must be paid. If requested by the Owner, the Contractor shall present evidence that payment or satisfaction of all such tax obligations has been made.

§9.10.3 Add the following clause to Section 9.10.3:

9.10.3.1 Unless and to the extent final completion is delayed through no fault of the Contractor as provided in Section 9.10.3, the Owner shall be under no obligation to increase payments above ninety-five percent (95%) until final completion of the Work is Certified by the Architect.

§9.10.4 Make the following changes in Section 9.10.4:

In the first sentence, delete the word "the" and replace it with "Unless and until the Contractor makes a subsequent Claim against the Owner, the".

Add the following as the last sentence. "Neither the Owner's offer of a final payment nor its acceptance by the Contractor shall legally prevent or limit the Owner's right to assert any and all counterclaims in litigation filed by the Contractor as allowed in section 15.1.8."

Add the following Sections to Article 9:

§9.11 LIQUIDATED DAMAGES

§9.11.1 The Owner will suffer financial loss if the Work is not Substantially Complete within the Contract Time as defined in Article 8, and if final completion is not achieved within the specified time frame following Substantial Completion. As liquidated damages, and not as a penalty, the Contractor and the Contractor's surety shall be liable for and shall pay the Owner the sum(s) stated in this Agreement and/or purchase order.

§9.11.2 Allowances may be made for delays due to shortages of materials and/or energy resources, subject to proof by documentation, and also for delays due to strikes or other delays beyond the control of the Contractor. All delays and any claim for extension of Contract Time must be properly documented in accordance with Section 15.1.5 by the Contractor and must be made within the time limits stated in Section 15.1.2.

ARTICLE 10
PROTECTION OF PERSONS AND PROPERTY

§10.2.8 INJURY OR DAMAGE TO PERSON OR PROPERTY

§10.2.8 Make the following changes to Section 10.2.8:

In the first sentence, delete "within a reasonable time not exceeding 21 days" and substitute "immediately".

§10.3 HAZARDOUS MATERIALS

§10.3.3 Delete Section 10.3.3 in its entirety.

ARTICLE 11
INSURANCE AND BONDS

§11.1 CONTRACTOR'S LIABILITY INSURANCE

§11.1.2 Add the following to the end of §11.1.2.

At a minimum the Contract shall provide, at the Contractor's Expense:

§11.1.2.1. a Performance Bond and a Labor and Material Payment Bond for 100% of the Contract Sum and, if applicable, a two-year roofing Maintenance Bond for the full value of the roofing system.

§11.1.2.2 An attorney-in-fact who executes the bonds on behalf of the surety shall affix thereto a certified and current copy of power of attorney.

§11.1.2.3 The bonds shall be issued on State of West Virginia forms. The Contractor shall deliver the required bonds and all other contract documents to the Owner not later than 15 days following receipt of the Owner's notice of intent to award a Contract.

§11.2 Owner's Insurance Delete section 11.2 in its entirety.

§11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

§11.4 Section 11.4 is deleted in its entirety.

§11.5.1 Make the following changes in Section 11.5.1:

In the first sentence, substitute "Contractor" for "Owner" each time the latter word appears.

§11.5.2 Delete Section 11.5.2 in its entirety and substitute the following:

§11.5.2 Prior to settlement of insured loss, the Contractor shall notify the parties of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The parties shall have 14 days from the receipt of notice to object. If no objection is made, the Contractor shall proceed as proposed and allocate the settlement accordingly. If such objection is made, the dispute shall be resolved as provided in Section 15.4. The Contractor, in that case, shall make settlement with insurers in accordance with directions of the Court. If distribution of the insurance proceeds as directed by the Court is required, the Court will direct such distribution. Any work to repair the damage will be incorporated into the contract as a change order.

ARTICLE 13
MISCELLANEOUS PROVISIONS

§13.4 TESTS AND INSPECTIONS

§13.4.1 Remove the phrase "so require" and insert in its place "prohibit delegation of the test to Contractor"

§13.6 INTEREST

§13.6 Delete Section 13.5 in its entirety and substitute the following:

Notwithstanding any other provision in the Contract Documents, West Virginia Code does not authorize the payment of interest on late payments. Accordingly, interest charges for late payment are prohibited.

Add the following Sections to Article 13:

§13.6 WORKERS COMPENSATION

The Contractor shall provide proof of compliance with West Virginia Worker's Compensation laws and regulations.

§13.7 CONTRACTOR'S LICENSE

§13.7.1 West Virginia Code §21-11-2 requires that all persons desiring to perform contractual work in West Virginia shall be duly licensed. The West Virginia Contractor's Licensing Board is empowered to issue a contractor's license.

§13.7.2 West Virginia Code §21-11-11 requires any prospective Bidder to include the Bidder's contractor's license number on its Bid. The successful Bidder will be required to furnish a copy of its contractor's license in a classification appropriate to the Work prior to issuance of a purchase order/contract.

ARTICLE 14
TERMINATION OR SUSPENSION OF THE CONTRACT

§14.1 TERMINATION BY THE CONTRACTOR

§14.1.1 Make the following changes in Section 14.1.1:

At the end of clause 14.1.1.3 delete "; or" and insert a period.

Delete clause 14.1.1.4 in its entirety.

§14.1.3 Delete Section 14.1.3 in its entirety and substitute the following:

§14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exist, the Contractor may, upon seven days written notice to the Owner and Architect, terminate the Contract. In such event, the Contractor shall be paid for all Work performed in accordance with the Contract Documents, for reasonable and proven termination expenses and a reasonable allowance for overhead and profit. However, such payment, exclusive of termination expenses, shall not exceed the Contract Sum as reduced by other payments made to the Contractor and further reduced by the value of Work as yet not completed. The Contractor shall be entitled to reasonable overhead, but not profit, on Work not performed.

§14.2 TERMINATION BY THE OWNER FOR CAUSE

§14.2.4 Delete Section 14.2.4 in its entirety and substitute the following:

§14.2.4 If the unpaid balance of the Contract Sum exceeds the cost of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other

damages incurred by the Owner and not expressly waived, such excess shall not be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Owner shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

§14.4.1 Delete Section 14.4.1 in its entirety and substitute the following:

§14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause upon thirty days written notice.

§14.4.3 Delete Section 14.4.3 in its entirety and substitute the following:

§14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment from the Owner on the same basis provided in Section 14.1.3 above.

Add the following Section to Article 14:

§14.5 FISCAL YEAR FUNDING

§14.5 Work performed under this Contract is to continue in the succeeding fiscal year contingent upon funds being appropriated by the Legislature for this Work. In the event funds are not appropriated for this Work, this Contract becomes of no effect and is null and void after June 30.

ARTICLE 15
CLAIMS AND DISPUTES

§15.1 Claims

§15.1.2 TIME LIMITS ON CLAIMS

§15.1.2 Delete Section 15.1.2 in its entirety and substitute the following:

Any applicable statute of limitations shall be in accordance with West Virginia Code.

§15.1.3 **NOTICE OF CLAIMS** Add the following to § 15.1.3:

§15.1.3.3 All claims, and notice of claims that require an increase in contract time, contract scope, or contract sum must be made in writing.

§ 15.1.8 is added to the Contract as follows:

§ 15.1.8 Counterclaims – In the event that Contractor makes a claim, Owner reserves the right to make a counterclaim and will not be barred from doing so even if final payment has been made.

§15.2 INITIAL DECISION

§15.2.1 In the third sentence of Section 15.2.1 , insert "or litigation" following the word "mediation" and remove the phrase "binding dispute resolution" and replace it with "or litigation".

§15.2.5 Delete the last sentence in Section 15.2.5 and substitute the following:

Approval or rejection of a claim by the Initial Decision Maker shall be final and binding on the parties unless it is pursued further by either party in accordance with Section 15.2.6.

§15.2.6 Make the following change to clause 15.2.6.1:

In the last sentence, delete "or pursue binding dispute resolution proceedings."

§15.2.8 Delete Section 15.2.8 in its entirety.

§15.3 MEDIATION

§15.3.1 Delete "binding dispute resolution" and substitute "litigation in a court of competent jurisdiction."

§15.3.2 Delete Section 15.3.2 in its entirety and substitute the following:

§15.3.2 The parties shall endeavor to resolve their Claims by non-binding mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement.

§ 15.3.3 Remove section 15.3.3 in its entirety

§15.4 ARBITRATION

§15.4 Delete Section 15.4 in its entirety and substitute the following:

§15.4 SETTLEMENT OF CLAIMS

§15.4.1 The Constitution of West Virginia grants the State sovereign immunity from any and all Claims against the public treasury. This immunity applies and is extended to all agencies of the State, including the Owner. It shall be in full force and effect as it relates to this Contract. The West Virginia Legislature, recognizing that certain Claims against the State may constitute a moral obligation of the State and should be heard, has established the West Virginia Claims Commission for this purpose. The Parties understand that this sovereign immunity and the Constitution of the

State of West Virginia prohibit the State and Owner, from entering into binding arbitration. Notwithstanding any provision to the contrary in the Contract Documents, all references to arbitration, regardless of whether they are included in the AIA Document A201-2017 or another related document are hereby deleted and all Claims of the Contractor for monetary relief, and only of the Contractor, arising out of or related to this Contract shall be decided by the West Virginia Claims Commission. The following Sections have been rewritten to bring them into conformance with the foregoing.

§15.4.2 Claims by the Owner may be brought against the Contractor in the Circuit Court of Kanawha County, West Virginia, or in any other court that has jurisdiction, as the Owner may elect.

§15.4.3 Any Claim arising out of or related to the Contract, except Claims relating to aesthetic effect and except those waived as provided for in Sections 15.1.6, 9.10.4 and 9.10.5, shall, within 30 days after submission of the decision by the Initial Decision Maker, be settled for the Contractor by the West Virginia Claims Commission or, for the Owner, by the Circuit Court of Kanawha County or any other court of jurisdiction as the Owner may elect.

§15.4.4 Notice of such action shall be filed in writing with the other party to the Contract, and a copy of such notice shall be filed with the Initial Decision Maker and the Architect, if applicable.

§15.4.5 During court proceedings, the Owner and the Contractor shall comply with Section 15.1.3.

§15.4.6 Claims shall be made within the time limits specified in Section 15.2.6.1.

§15.4.7 The party filing a Claim must assert in the demand all Claims then known to that party on which action is permitted.

Add the following Article:

ARTICLE 16
EQUAL OPPORTUNITY

§16.1 COMPLIANCE WITH REGULATIONS UNDER TITLE VI OF THE FEDERAL CIVIL RIGHTS ACT OF 1964 AND EXECUTIVE ORDER 65-2 BY THE GOVERNOR OF WEST VIRGINIA DATED DECEMBER 15, 1965

§16.1.1 The Contractor agrees that it will comply with Title VI of the Federal Civil Rights Act of 1964 (P.L. 88352) and the regulations of the State of West Virginia, to the end that no person in the State, or in the United States, shall on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or otherwise subjected to discrimination under any program or activity for which the Contractor receives any recompense or other consideration of value, either directly or indirectly from the State; and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this Agreement.

§16.1.2 If any real property or structure thereon is provided or improved, this assurance shall obligate the Contractor, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which any State payment is extended or for another purpose involving the provision of similar services or benefits. If any other goods or services are so provided, this assurance shall obligate the Contractor for the period during which it supplies such goods or services.

§16.1.3 The Contractor recognizes and agrees that such right to provide property, goods or services to the State will be extended in reliance on the representations and agreements made in assurance, and that the State shall have the right to seek judicial enforcement of this assurance. This is binding on the Contractor, its successors, transferee, and assignee, or any authorized person on behalf of the Contractor.

END OF SUPPLEMENTARY CONDITIONS TO AIA DOCUMENT A201-2017

Any provisions of the Contract Documents that conflict with these Supplementary Conditions shall be null and void unless they have been approved in writing by the applicable State purchasing officer and the Attorney General, and are clearly identified as such in the bid documents.

The Owner and Contractor hereby agree to the full performance of the covenants contained herein.

IN WITNESS WHEREOF, the Owner and Contractor have entered into this Agreement as of the effective date as stated in the A101-2017 (when utilized) or other Contract Documents.

Owner:		Contractor:	
By:	_____	By:	_____
Title:	_____	Title:	_____
Date:	_____	Date:	_____

This Supplementary Conditions to AIA Document A201-2017, General Conditions of the Contract for Construction, has been approved as to form on this 20th day of February, 2019, by the West Virginia Attorney General's office as indicated in the signature line below. Any modification of this document is void unless expressly approved in writing by the West Virginia Attorney General's Office.

PATRICK MORRISEY, ATTORNEY GENERAL

BY: _____

DEPUTY ATTORNEY GENERAL

SECTION 01 1000

SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: Bldg 54 HVAC Modifications - Rebid

B. Owner's Name: WV General Services .

C. Engineer's Name: Miller Engineering Inc.,

D. The Project consists of the modification of HVAC systems in the building including items such as replacement of an air cooled chiller, replacement of heating and cooling coils in AHUs and RTUs, replacement of the building automation system (BAS) in its entirety, and other supporting trades work. All to be performed by the successful bidder (Vendor).

1.02 DESCRIPTION OF ALTERATIONS WORK

A. Scope of demolition and removal work is set forth in the project documents.

B. Scope of alterations work is indicated on drawings.

C. A technical scope of work immediately follows this section.

D. Plumbing: Alter existing system and add new construction, keeping existing in operation.

E. HVAC: Alter existing system and add new construction, keeping existing in operation.

F. Building Automation Systems: Replace existing system with new construction, keeping existing in operation until ready for changeover. Changeover may be phased as approved by Architect/ Engineer.

G. Electrical Power and Lighting: Replace existing system with new construction, keeping existing in operation until ready for changeover.

H. Fire Alarm: Alter existing system and add new construction, keeping existing in operation.

1.03 OWNER OCCUPANCY

A. Owner intends to continue to occupy portions of the existing buildings during the entire construction period.

B. Owner intends to occupy the Project upon Substantial Completion.

C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

D. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES

A. Construction Operations: Limited to areas of work and spaces designated by the Owner..
   1. Locate and conduct construction activities in ways that will limit disturbance to site.

B. Arrange use of site and premises to allow:
   1. Owner occupancy.
   2. Work by Others.
   3. Use of site and premises by the public.

C. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.

D. Time Restrictions:
   1. Limit conduct of especially noisy exterior work to the hours of 7:00 pm to 7:00 am.

E. Utility Outages and Shutdown:
   1. Limit disruption of utility services to hours the building is unoccupied.

2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 14 days notice to Owner and authorities having jurisdiction.
3. Prevent accidental disruption of utility services to other facilities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

SEE NARRATIVE SCOPE OF WORK IMMEDIATELY FOLLOWING THIS PAGE

END OF SECTION

WV GSD – Building 54 HVAC Modifications
Summary/ Narrative Scope of Work
30Sep22

NOTICE:

ALL Bidders and subcontractors are encouraged to review this document prior to bidding. It does not stand alone from, but is part of, the project documents. This scope is a road map to the project work to increase the understanding of the project for bidding purposes. It is not a substitution for thorough review of all the project documents, which is required of all potential bidders prior to bidding. This written scope is part of the bidding/contract documents and contract requirements, and should be distributed to all subcontractors prior to bidding. All contractors, subcontractors, and their personnel are required to be fully and appropriately licensed for all work they perform on the project, as required by the WV State Code. Vendor is to coordinate the work of all subcontractors on this project prior to the submission of a bid.

GENERAL SUMMARY:

HVAC Modifications:
Generally, this project is to make improvements to the building related to addressing control and equipment concerns. The renovations will be performed while the building remains occupied. The existing system utilizes 3 air handling systems with chilled water and hot water (35% propylene glycol) configured with both fan powered and non-fan powered VAV with reheat. Heat source is gas fired condensing HW boilers. The cooling source is an air cooled chiller with an ice storage system. The ice storage system will be removed in its entirety by the project. Some support areas are served by fan coil units and CRAC (Computer Room Air Conditioner) units, various other HVAC components and systems serve the building.

Pre-bid/ Site Review:
A mandatory pre-bid meeting will be conducted on the day indicated in the Request for Quotations (RFQ). The pre-bid meeting will be conducted at the building and will be followed by a walk-through of the building systems, including the opportunity to look above ceilings. Bidders are encouraged to bring subs to the pre-bid.

Do not park in assigned parking for the pre-bid. Park only in public access or metered areas. No parking permits will be issued for those attending the pre-bid or walk-through.

ORDER OF WORK:

In order to expedite the acquisition of the equipment, which requires what is assumed to be a long lead-time for major components, Vendor will provide all necessary major component submittals, for review, within thirty (30) days after award of the Contract.

RELATED ITEMS:

Project Documents Note:
Where the words “all”, “typ all”, “typ” or “typical all” are used, the note shall apply to all occurrences on the project, unless otherwise specifically noted, regardless of the indications on the project drawings. Any statement which specifically points out or includes work does not exclude related work found elsewhere in the documents or requirements, it is intended to help point out items of consideration in bidding and anticipate bidder questions.

Coordination of Trades:
The responsibility for all construction coordination lies ultimately with the Vendor/ prime contractor, but also with each trade involved, as part of the bidding process. All trades involved within the project must understand their role within the project in terms of scope of work, the timing of such work, and the overall project schedule set forth in the project documents.

Submittals:
It is the project’s intention that the submittals for the replacement coils, chiller, and controls be expedited upon notification of award. The project intent is for the coils and controls work to occur during the lead time for the chiller, such that the chiller installation will be the last major milestone for the project. The project expectation is that both the coil replacement and the BAS, in anticipation of the chiller delivery, will be completed in 6 months.

Owner Occupancy:
The Owner will continue to occupy the facilities during construction; though specific areas of work related to individual components will be temporary vacated to accommodate modifications. Work will be coordinated to accommodate Owner occupancy and continued operations involving staff and visitors. Work hours and outage requirements for the project will be coordinated at the kick off meeting.

Selective Demolition:
THIS PROJECT REQUIRES BOTH SCOPE AND TIMING SELECTIVE DEMOLITION. Demolition of all existing systems, equipment, and components shall be coordinated with all the other trades involved with the project.

The responsibility for all demolition coordination, scope, and timing lies ultimately with the prime contractor, but also lies with each trade involved. All systems,

components, and equipment indicated by shaded areas on the project drawings will be demolished unless they are to be re-used. The timing of demolition of any systems or equipment much be in such a manner that permits continued building operations during construction. Any system or equipment demolished in a manner that disallows for continued operations during construction will be re-installed (or an Engineer-accepted temporary solution will be installed) by the vendor at no additional cost to the Owner. No system shall be taken out of service without the approval of the Owner.

Anything in any trade which is not re-used in the project must be totally removed from the facility as part of demolition, nothing will be abandoned in place unless specifically noted on the project drawings on a case by case basis. The Owner reserves the right of first refusal of removed materials and components, but otherwise all will be disposed of in accordance with best industry practices, and local, state, and federal laws.

Warranty:
The installed project shall have a one year parts and labor warranty, except the chiller will have a 2 year parts and labor warranty. The chiller compressors will have a 5 year parts and labor warranty.

Best Industry Practices:
All work will be performed in accordance with plans and specifications and in accordance with best industry practices. The Engineer will be the sole authority in regards to this or any project requirement and the decisions of the Engineer and Owner are final.

Location:
The general project location is WV GSD Building 54 in Fairmont, WV.

Safety:
All work will be performed in accordance with all local, state, and federal safety regulations and with the Owner’s Jobsite Safety Handbook" requirements. See Owner's Additional Requirements, Section 01 1001 of the project manual; including safety protocols such as hot work permits, etc., at all times. No fire alarm system work will be executed without prior written authorization, on a daily basis, from the Owner’s Building Supervisor. The authorization must include a detailed description of the work to be performed, the potential impact on the building occupants, emergency on site call numbers for the day, and a sign off confirmation of the system’s return to normal. A project fire alarm log will be kept throughout the project.

Outages:
Outages will be coordinated and scheduled with the Owner. A scheduled outage is tentative until it is confirmed in writing by the Owner and the Engineer.

Supplemental Information:
Information on the existing system with the building, including submittals, control drawings, and sequences of operation have been provided for reference and are attached to the project manual. It has been provided to document the existing conditions of the project which must be taken into account in the preparation of a bid. Vendor is highly encouraged to review this information and distribute it to subcontractors to ensure coordination during bidding. The supplemental information is part of the project documents. The requirements found therein apply to the project, for example; the fire alarm interface and the requirement for the BAS to receive and act on smoke detection on each floor must be included and functional at the end of the project. The control drawings are for information on the existing systems and do not limit the requirements for this project.

TRADES INFORMATION:

Mechanical:
The project will replace the chiller with a new dual circuit screw compressor machine, and the existing ice storage system will be demoed and removed. Piping changes will be required related to the chiller and ice storage. Additionally, the two air handling units (designated AHU1, AHU2, and RTU1 – generically referred to as “AHU’s”) will have their respective cooling coils removed and replaced with new coils to increase performance. AHU stainless steel drain pans are integral to the units and will remain with the new coils setting in the existing pan on stainless steel coil rails. In AHU 1 and RTU 1, the heating and cooling coils are mounted back to back. Due care must be taken not to damage the heating coil during the replacement of the cooling coil. AHU 2 will have the heating coil replaced to align with the replacement cooling coil face area, which will be increased. The rooftop mounted unit was designated “RTU1” on the original project drawings, and for the sake of clarity, it will remain so designated for this project. It is not a packaged rooftop unit in the conventional sense, and is a semi-custom outdoor air handling unit mounted on the roof. Piping changes to the AHUs will be made to accommodate the higher coil flows. 7. When the ice storage system is removed, the piping will be removed back to the tees and 3 way valve, where they will be capped. The 3 way valve will be permanently fixed to flow water through the remaining loop.

VAV boxes, both fan powered and non-fan powered with integral controller/operator(s), will have their existing controllers and damper operators replaced with new controller/operator(s). In all cases, VAV controllers will be replaced. Each box will be cleaned and the flow measuring station will be cleaned and calibrated as part of the controller replacement. Damaged VAV box insulation will be repaired.

The Owner currently has a rental chiller with pump serving the building, this will remain on-line until the chiller can be replaced. The original building chiller is located in a masonry surround and remains in place. It is connected to the

building in parallel with the rental chiller and the existing piping, both permanent and temporary, and incorporates isolation valves to allow the rental to operate while the original is removed. Remove the existing chiller and install a new chiller in its location. The selected chiller must fit within the footprint of the existing chiller without extension to the chiller pad or surround, and is a project requirement as described elsewhere. The new chiller will require the addition of a ventilation intake louver in the masonry surround. Replacing the chiller will be a project priority and chiller submittals will be expedited at the time of project award.

Under Alternate #1 six new fan coil units will be installed complete with new BAS, CW, HW, and condensate piping.

The existing BAS system will be replaced with a new BAS system. Fully review the HVAC sequence of operation and the original construction sequence of operation prior to bidding. Information on the existing BAS has been provided in the supplemental information attached to the project manual. The systems referenced therein, not including the ice storage system which will be removed, are for reference to indicate all systems and interfaces which must be included for proper operation. The information is to help the Vendor gain a better understanding of the operation of the original system sequence and the performance requirements of the project for BAS. ALL unit controllers and building control panels will be replaced, along with all network and control wiring. The “muscle” of the BAS, valve and damper operators (excluding VAV damper controllers with integral operators) will remain if they are functional and readily compatible with the new BAS. If this requirement presents a concern for any reason, a clarifying bid question is required, otherwise the operators will remain. The BAS will incorporate native BACNET control of the building systems as indicated in the sequence of operation. If any existing unitary equipment is Modbus or Lon, it will still be incorporated into the new BAS. In addition to the heating equipment referenced herein, building systems such as exhaust, stairwell pressurization fans and dampers will be controlled by the BAS. All existing equipment controlled or monitored by the existing BAS will be controlled and monitored by the new BAS. All controls will be in accordance with the intent of the sequences of operation; including graphics. Where the original building sequence of operation and the specified sequence conflict, the Engineer will provide guidance to resolve the conflict during submittals and construction. Final tweaks and adjustments to the BAS by the Engineer, through closeout, are a project requirement. The BAS subcontractor may remove and install ceiling tiles in the performance of the controls replacement but will be responsible for track or significant tile damage.

The following requirements must be met by the new BAS

- New controls will be tied into owners existing Trane Ensemble System for a seamless user interface. Hotlinks/targets to other applications and/or

separate web pages will be NOT accepted as a “seamless” interface to the Ensemble System.

- Provide long term data logging and archiving of data for a minimum of 3 years.
- All data, alarms, and graphics shall be available for user interface from both local workstation(s) as well as mobile devices through either a mobile browser and/or mobile app.
- BAS contractor shall provide any necessary controls hardware and/or software upgrades to the existing Ensemble System to meet the requirements of the successful integration and operation of the project.
- The Fire Alarm Control Panel for HVAC systems located in the building lobby, serving stairwell pressurization, etc., will be re-used but must be fully interfaced to the new Building Automation System.
- Each BAS panel will have a dedicated UPS capable of running the panel for at least three hours. Any buss nodes or wireless repeaters must also be covered by a UPS.
- Note that anything currently controlled by the existing BAS will be controlled by the new BAS to the requirements of the old unless specifically exempted in the new specifications. For example, the building has hot water radiant panels and cabinet unit heaters which are and will be controlled by the BAS.
- The submitted sequence of operation must be written by the controls vendor in their unique wording and may not copy or “parrot” the sequences found in the project manual.
- This is a full out replacement of the building BAS where only “muscle” devices may remain if compatible, however, the building must remain operational.
- The BAS will incorporate an outside air chiller setpoint reset as part of the sequence. The details and tweaks of the setpoint will be determined in consultation with the Engineer during startup/warranty.
- The existing control wiring may not be re-used, and any required will be replaced with new however control conduits may be. All wiring must be
- All control cabinets will be replaced as the systems must operate side by side during a progressive changeover from old to new. Old cabinets will be removed and may not be used as junction boxes.

The Vendor is responsible for drain down of the HVAC system CW and HW piping as necessary to accomplish the work, regardless of the number of times it may have to be drained. The project is responsible for storing the system(s) propylene glycol during drain down(s) and refilling and venting the air from the system(s) to return to normal operation. The Vendor is also responsible for filling the system and removing any remaining glycol in excess of 50 gallons after the glycol feeders are full. The design basis chiller has a published volume of approximately 30 gallons.

Testing, Adjusting, and Balancing:
The AHUs and the RTU will be fully profiled for air and water, the VAV boxes will be fully profiled and calibrated for air. All air and water flow monitoring stations will be field verified/calibrated during TAB. All pumps will be profiled. The fancoil units under Alternate #1 will be profiled for water.

Electrical:
Electrical wiring, conduits, devices, etc. will be provided as necessary to meet all electrical service requirements of the replacement project. Power to demolished equipment and any electric not reused will be demolished to source, except where noted to remain on the project drawings. Temporary demo will be made safe and maintained in a safe condition until the time of reconnection. All remaining and new equipment will be powered. Verify all power requirements prior to bidding. Equipment will be reconnected to existing power in many locations, though some require wiring and breaker changes. All wiring during construction will be “made safe” using best industry practices.

For all data locations required by the project, the RJ 45 Cat 6a jack end will be punched down in the machine rooms. The IDF end will be left with a 20 foot whip at the location in the data rooms designated by the Owner; for punch down by the Owner’s personnel.

Plumbing:
Plumbing work includes installation and reconnection of condensate drain systems for HVAC equipment as indicated in the project drawings and to serve all condensate producing equipment. Verify with HVAC prior to bidding.

Fire Alarm:
FA modifications required in the project will be limited to ensuring the new Building Automation System (BAS) interfaces to the existing fire alarm in the same manner as the existing BAS for function. The Vendor will provide the necessary materials and expertise to effect the interface and maintain the FA system and devices as fully operational during the performance of the work, including ceiling work. Fire alarm work will follow the Owner’s procedures for notification prior to performing work on the existing fire alarm systems. Building 54 is served by an Edwards EST3 system. Coordinate scope and depth of work with BAS prior to bidding. The Fire Alarm Control Panel (FCP) for HVAC systems located in the building lobby, serving stairwell pressurization, etc., will be re-used but must be fully interfaced to the new Building Automation System to implement all functions currently controlled by the FCP. The Project will interface and integrate the new BAS to the existing FCS to ensure the existing functions of the FCS, as previously accepted by the WVSFM, are maintained. The WVSFM will review and test the systems according to the original requirements prior to final acceptance.

Fire Protection:
FP work is unanticipated to accomplish the project.

Architectural/ General Trades:
The work consists of some new construction and minor demolition of existing and modifications to support the HVAC work, predominantly demolition of equipment pads and alteration of the masonry chiller surround for installation of a new louver to increase the air available for chiller ventilation. The work on the surround will include angle steel “picture frames” on both the brick veneer and the CMU wall. The scope includes limited removal and re-installation of ceiling areas required to perform the HVAC work and will be coordinated with the mechanical vendor prior to bidding. Any trade may remove and install ceiling tiles in the performance of the controls replacement but will be responsible for track or significant tile damage.

Structural Modifications:
No building structural modifications are foreseen in this project.

OTHER REQUIREMENTS:

Owner Project Coordination:
The work in Building 54 will be performed while the Owner retains occupancy of the building. The work must be planned and performed in coordination with the Owner such that the disruption to the operation of the building is limited. As an example, the coil replacements for the AHUs will be performed over a weekend or a state holiday, and the work must be planned to ensure that building is returned to normal for the next state business day. This may require different AHUs to have their coils replaced on different weekends.

Roofing Integrity and Warranty (Roofing Damage):
The roofing material is TPO (thermoplastic polyolefin) membrane by Versico and carries a warranty through 3Nov2034. The roof will be protected from damage during the performance of the Work. No roofing work is included in the project but work will be performed to roof mounted equipment. In the event of roof damage during the performance of the work and attributable to the Vendor, the repair work will be performed in accordance with the manufacturer’s warranty requirements, by factory trained personnel, and repairs to the TPO roof will be made so as not to void the roof warranty. After repairs, updated warranty documentation, including inspection and acceptance by the manufacturer’s factory representative, will be provided as part of closeout documents.

Asbestos Containing Material (ACM):
The building is approximately 7 years old. There are no known ACM materials in the building and no known ACM materials were used in its construction.

Construction Implementation:
The vendor will submit a detailed project schedule prior to the start of work, for review and approval. The vendor will follow the approved project schedule and will only modify it on the written approval of the Owner and Engineer. Vendor will submit an up-to-date progress schedule, indicating progress relative to the approved schedule, every two weeks, with each pay application, or at the Owner's request. In the event the vendor falls behind schedule, as indicated in the project conditions, plans for returning to the schedule will be submitted, for approval, to the Engineer.

It is generally envisioned that that the AHU coil work and the BAS work will occur prior to the delivery of the new chiller. Work on the project must begin in a reasonable time after notice to proceed, regardless of the chiller delivery status. A schedule where all work waits on the chiller delivery is unacceptable and will not be entertained.

There is laydown space available in the boiler room, particularly once the ice storage system is demoed. Proper access and life safety egress must be maintained in areas where material is stored. Up to 4 parking spaces may be available for parking, otherwise arrangements must be made for parking off site.

BAS/ Project Phasing:
The existing BAS must remain operational while the new system is installed. New devices and control panels must be in place and operation before the existing panels may be removed. The new BAS system installation must be planned such that the new controls may be brought online in an orderly planned manner but must not result in significant negative impact on the building occupants. The sequence of the work will be submitted in a written plan and coordinated with the Owner and Engineer, who will review and ultimately accept the plan for execution.

Project Record Drawings:
Project record drawings ("red-lines") will be maintained, on-site, by all trades at all times. The drawings will be kept in a neat and organized manner, ready for review on request, and will clearly indicate field adjustments or deviations in red. Piping and conduit changes will include the pipe sizes and designations, where equipment is moved, it will be dimensioned to the nearest fixed walls. Failure to meet the on-site requirement will result in reduction of the requested payment for the period in question until such a time as the requirement is met. The Engineer will determine the value to be held and is the sole authority in this regard. At substantial completion, the red-lines will be submitted to for review and acceptance.

Site Security:
Vendor will maintain the site in a secure manner and follow the Owner's requirements for access and security for all personnel. Background checks for all personnel on site are required, and each must pass to be permitted on site.

Codes Applicable To the Project:
Work performed on the project is to be performed under best industry practices and the following codes:

ANSI/ICC A117.1 – Accessibility Standards – Current WV Adoption
NFPA 101 - Life Safety Code - 2018
NFPA 70 - National Electric Code - 2020
NFPA 72 - Nation Fire Alarm Code - 2019
IBC - International Building Code - 2018
IMC - International Mechanical Code - 2018
IPC - International Plumbing Code - 2018
IECC – International Energy Conservation Code - 2015
IFGC - International Fuel Gas Code – 2018

Alternate #1:
Under Alternate #1, Vendor will install 6 fan coil units (FCUs) in the locations shown on the project drawings. The installation will include all necessary labor and materials for a complete installation and will generally include the units, piping, electrical, and controls for each unit. The project drawings indicate which units are under Alternate #1.

End of Summary/ Narrative Scope of Work

SECTION 01 1001

OWNER'S ADDITIONAL REQUIREMENTS

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

A. Additional Project Requirements:
   1. The material attached to this section are applicable to the project in their entirety.

PART 2 PRODUCTS

PART 3 EXECUTION

3.01 OWNER REQUIREMENTS

A. Execute the project in compliance with the additonal requirements following this section.

B. Prior to beginning any work covered by the Contract, vendor shall have read, reviewed, and acknowledged in writing the attached Jobsite Safety Handbook.

END OF SECTION

Jobsite Safety Handbook

For Contractors

Department of Administration (DOA)

General Services Division (GSD)

218 California Avenue
Charleston, WV

THIS HANDBOOK IS TO BE POSTED IN A VISIBLE AREA AT ALL CONSTRUCTION PROJECTS AND/OR CONTRACTOR WORKSITES

Contractor Contact: _____ Phone #: _____

EMERGENCY CONTACTS:

Project Manager:

Name: _____ Phone #: _____

Emergency Services #: _____

GSD Safety Section:

1900 Kanawha Boulevard East, Bldg 1 Room MB12 Charleston, WV 25305

Jonathan Trout: Work# 304 352-5522 Cell# 304-205-2721

Marsha Bowling Work# 304-352-5523 Cell# 304-951-1410

Revision 4/18/22

TABLE OF CONTENTS

Jobsite Safety Handbook

JOBSITE SAFETY HANDBOOK

The following is a summary of applicable jobsite safety requirements. This handbook is intended to be used as a guide and in no way reflects all applicable safety requirements. All employees are responsible for ensuring a safe working environment. All hazards must be addressed regardless if they have been addressed in this handbook. All contractors working on GSD projects are required to follow OSHA regulations.

GSD safety and health procedures are available for review 24/7 in the Main Capitol Building basement, MB-12.

1. BUILDING ALARMS

In the event of a fire, sound the alarm and/or notify other building occupants immediately. Contractor personnel shall respond appropriately to all alarms by exiting the building immediately and remaining at least 50 feet from the building to allow for emergency response access.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Workers must use personal protective equipment, such as:

- Hard hats when overhead, falling or flying hazards exist;
- Safety glasses or face shields for welding, cutting, nailing (including pneumatic), or when working with concrete and/or harmful chemicals;
- Proper shoes or boots to lessen slipping hazards and prevent toe crushing and nail punctures;
- Safety belts and/or harness systems for fall protection.

3. HOUSEKEEPING AND ACCESS AROUND SITE

- Keep all walkways and stairways clear of trash/debris and other materials such as tools and supplies to prevent tripping.
- Keep boxes, scrap lumber and other materials picked up and put in a dumpster or trash/debris area to prevent fire and tripping hazards.
- Provide enough light to allow workers to see and to prevent accidents.

4. STAIRS AND LADDERS

- All stairs are to be equipped with standard handrails.
- Keep ladders in good condition and free of defects – Do not use job made ladders.
- Inspect ladders before use for broken rungs or other defects so falls don't happen. Discard defective ladders.
- Secure ladders at the top and brace or tie off at the bottom to prevent them from slipping and causing falls.

5. SCAFFOLDS AND OTHER WORK PLATFORMS

Scaffolding is to be assembled and used according to OSHA regulations.

General scaffolding guidance:

- Provide ladders or stairs to access scaffold and work platforms safely.
- Keep scaffolds and work platforms free of debris. Keep tools and materials as neat as possible on scaffolds and platforms. This will help prevent materials from falling and workers from tripping.
- Erect scaffolds on firm and level foundations.
- Scaffold legs must be placed on firm footing and secured from movement or tipping, especially on dirt or similar surfaces (a good foundation is a must).
- Erecting and dismantling scaffolds must be under the supervision of a Competent Person.
- The competent person must inspect scaffolds before each use.
- Don't use blocks, bricks, or pieces of lumber to level or stabilize the footings. Manufactured base plates or "mud sills" made of hardwood or equivalent can be used.

Planking:

- Fully plank or use manufactured decking to provide a full work platform on scaffolds. The platform decking and/or scaffold planks must be scaffold grade and not have any visible defects.
- Extend planks or decking material at least 6' over the edge or cleat them to prevent movement. The work platform or planks must not extend more than 12" beyond the end supports to prevent tipping when stepping or working.
- Be sure that manufactured scaffolds are the proper size and that the end hooks are attached to the scaffold frame.

Guardrails:

- Guard scaffold platforms that are more than 10 feet above the ground or floor surface must have a standard guardrail. If guardrails are not practical, use other fall protection devices such as safety belts/harnesses and lanyards.
- Place the top rail approximately 42" above the work platform or planking, with a mid-rail about half that high at 21".
- Install toe boards when other workers are below the scaffold.

6. FALL PROTECTION

OSHA has specific and detailed requirements for fall protection – refer to 29 CFR 1926 Subpart M, 29 CFR 1910, 29 CFR Subpart I. A few of those requirements are listed below:

Guarding:

- Install guardrails around open floors and walls when the fall distance is 4’ or more. The top rail must withstand a 200 lb load.
- Construct guardrails with a top rail approximately 42” high with a midrail about half that high at 21”.
- Install toe boards when other workers are below the work area.
- Cover floor openings larger than 2x2 (inches) with material to safely support the working load.
- Use other fall protection systems like personal fall arrest systems (harness & lanyard), slide guards, roof anchors or alternative safe work practices when a guardrail system cannot be used. Only wear proper shoes or footwear to lessen slipping hazards.
- Train workers on safe work practices before performing work on foundation walls, roofs, trusses, or where performing exterior wall erections and floor installations.
- Flagging systems can be used, where appropriate. Flagging systems must comply with OSHA guidance.

7. EXCAVATION AND TRENCHING

Refer to OSHA regulations for excavation and trenching requirements, along with regulations for walking and working surfaces: 29 CFR 1926 Subpart P, 29 CFR 1910 Subpart D

Some of the Excavation and Trenching requirements are listed below:

- Find the location of all underground utilities by contacting West Virginia 811 before digging. Dial 811 or 800-245-4848.
- Keep workers away from digging equipment and never allow workers in an excavation when equipment is in use.
- Keep workers from getting between equipment in use and other obstacles and machinery that can cause crushing hazards.
- Keep equipment and the excavated dirt back 2 feet from the edge of the excavation.
- Have a competent person conduct daily inspections and correct any hazards before workers enter a trench or excavation.
- Provide workers a way to get into and out of a trench or excavation. Ladders and ramps can be used and must be within 25’ of the worker.
- For excavations and utility trenches over 5 feet deep, use shoring (trench boxes), benching, or slope back the sides. Unless soil analysis has been completed, the earth’s slope must be at least 1-1/2 horizontal to 1 vertical
- Keep water out of trenches with a pump or drainage system, and inspect the area for soil movement and potential cave-ins.
- Open ditches more than 24 hours or overnight must have fence protection.
- Keep drivers in the cab and workers away when dirt and other debris are being loaded into dump trucks. Workers must never be allowed under any load and must stay clear of the back of vehicles.

8. TOOLS AND EQUIPMENT

- Maintain all hand tools and equipment in safe condition and check regularly for defects. Broken or damaged tools and equipment must be removed from the jobsite.
- Use double insulated tools, or ensure the tools are grounded (check for ground plug).
- Equip all power saws (circular, skill, table, etc) with blade guards. Saws must be turned off when unattended. Unplug all power tools when not in use.
- Make sure cords are not damaged. The outer insulation must not be cut or damaged.
- Pneumatic and powder-actuated tools must only be used by trained and experienced personnel. Require proper eye protection for workers.
- Never leave cartridges for pneumatic or powder-actuated tools unattended. Keep equipment in a safe place, according to manufacturer's instructions.

9. VEHICLES AND MOBILE EQUIPMENT

- Inform workers verbally and provide training to stay clear of backing and turning vehicles and equipment with rotating cabs.
- Maintain back-up alarms for equipment with limited rear view or use someone to help guide them back.
- Verify experience or provide training to crane and heavy equipment operators.
- Maintain at least 10 foot clearance from overhead power lines when operating equipment.
- Block up the raised bed when inspecting or repairing dump trucks.
- Use a tag line to control materials moved by a crane.

10. ELECTRICAL

- Prohibit work on new and existing energized (hot) electrical circuits until all power is shut off and a positive "Lockout/Tagout System" is in place.
- Maintain all electrical tools and equipment in safe condition and check regularly for defects.
- Broken or damaged tools and equipment must be removed from the jobsite.
- Protect all temporary power (including extension cords) with Ground Fault Circuit Interrupters (GFCI's). Plug into a GFCI protected temporary power pole, a GFCI protected generator, or use a GFCI extension cord to protect against shocks.
- Locate and identify overhead electrical power lines. Make sure that ladders, scaffolds, equipment or materials never come within 10 feet of electrical power lines.
- Exterior electrical must be approved (UL, NEMA, etc) for exterior use (no internal junction boxes).

11. FIRE PREVENTION

- Provide fire extinguishers near all welding, soldering or other ignition sources.
- Avoid spraying of paint, solvents or other types of flammable materials in rooms with poor ventilation. Build up of fumes and vapors can cause explosions or fires.
- Store gasoline and other flammable materials in a safety can outdoors or in an approved storage facility. (Metal cans with self-sealing lids).

12. CHEMICAL HAZARDS

All hazardous chemicals present in the workplace must have an up-to-date Material Safety Data Sheet (MSDS). All contractors shall maintain MSDS for chemicals used or stored at GSD facilities. All warnings and directions for use must be followed.

13. CONFINED SPACES

By definition, a **confined space**:

- Is large enough for an employee to enter fully and perform assigned work;
- Is not designed for continuous occupancy by the employee; and
- Has a limited or restricted means of entry or exit.

These spaces may include underground vaults, tanks, storage bins, pits and diked areas, vessels, silos and other similar areas.

By definition, a **permit-required confined space** has one or more of these characteristics:

- Contains or has the potential to contain a hazardous atmosphere;
- Contains a material with the potential to engulf someone who enters the space;
- Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and/or
- Contains any other recognized serious safety or health hazards.

Entry into confined spaces without an evaluation is forbidden. Entry into permit-required confined spaces requires compliance with all OSHA requirements. Entry into non-permit spaces will require an evaluation by GSD Safety to confirm that conditions remain non-permit required.

Contractors that perform confined space entry activities are required to comply with OSHA regulations. GSD will not provide confined space rescue equipment.

14. LOCK-OUT/TAG-OUT

Before working on, repairing, adjusting or replacing equipment and machinery, all appropriate safety procedures, including lockout/tagout, must be utilized to place the machinery or equipment in a neutral or zero mechanical state.

Outside contractors are expected to have knowledge of lock-out/tag-out requirements.

Contractor Acknowledgement:

I, the undersigned, have read, reviewed and acknowledge my understanding of the General Services Division safety requirements, as set forth in this handbook. I am also aware that all applicable rules and regulations are to be followed, regardless of whether they are specifically mentioned in this handbook.

Contractor Representative (Print Name): _____

Contractor Representative Signature: _____ Date: _____

This signed acknowledgement must be signed and returned to the GSD Safety Section prior to start of project work.

SECTION 01 2000

PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Documentation of changes in Contract Sum and Contract Time.

C. Change procedures.

D. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

A. Section 00 7200 - AIA General Conditions (AIA A201-2017) & Contract Forms: Additional requirements for progress payments, final payment, changes in the Work.

B. Section 00 7300 - Supplementary Conditions: Percentage allowances for Contractor's overhead and profit for Change Orders.

1.03 SCHEDULE OF VALUES

A. Use Schedule of Values Form: AIA G703, edition stipulated in the Agreement (Contract).

B. Forms filled out by hand will not be accepted.

C. Submit Schedule of Values in duplicate within 15 days after Notice to Proceed.

D. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.

E. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement (Contract).

B. Use Form AIA G702 and Form AIA G703, edition stipulated in the Agreement (Contract).

C. Forms filled out by hand will not be accepted.

D. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   3. Scheduled Values.
   4. Previous Applications.
   5. Work in Place and Stored Materials under this Application.
   6. Authorized Change Orders.
   7. Total Completed and Stored to Date of Application.
   8. Percentage of Completion.
   9. Balance to Finish.
   10. Retainage.

E. Execute certification by signature of authorized officer.

F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.
   1. Only products stored on the job site can be billed against on the application for payment.

G. Submit one electronic and three hard-copies of each Application for Payment.

1.05 MODIFICATION PROCEDURES

A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Engineer will issue instructions directly to Contractor.

B. For other required changes, Engineer will issue a document requesting a change order price with appropriate backup. Answers to requests for information (RFI) do not necessarily constitute a change order request.

C. Computation of Change in Contract Amount: As specified in the Agreement (Contract) and Conditions of the Contract.

D. Substantiation of Costs: Provide full information required for evaluation, per the Contract.
   1. Provide following data:
      a. Quantities of products, labor, and equipment.
      b. Overhead and profit.
      c. Justification for any change in Contract Time.
      d. Credit for deletions from Contract, similarly documented.
   2. Support each request for additional costs with additional information, as required by the Contract, and:
      a. Provide the following data:
         1) Origin and date of claim.
         2) Dates and times work was performed, and by whom.
         3) Time records and wage rates paid.
         4) Invoices and receipts for products, equipment, and subcontracts, similarly documented.

E. Execution of Change Orders: Architect/ Engineer will issue Change Orders (AIA G701) for signatures of parties as provided in the Conditions of the Contract. Agency will submit Change Order requests to the State Purchasing Division for final approval.

F. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

G. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

H. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 01 7000.

END OF SECTION

SECTION 01 2300
ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description of Alternates.
   1. Alternate #1: Provide all labor and materials to install fancoil units in date rooms as indicated in the project documents.

1.02 ACCEPTANCE OF ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the awarded Purchase Order.

B. Alternates will be accepted in order as required by Owner's policies and regulations.

C. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 2500

SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions after award of the Contract.

1.02 RELATED REQUIREMENTS

A. Centralized Request For Quotation requirements for substitution requests as indicated in the General Construction specifications Item 13.

B. Section 01 3000 - Administrative Requirements: Submittal procedures, coordination.

1.03 DEFINITIONS

A. Centralized Request For Quotation requirements for substitution requests as indicated in the General Construction specifications Item 13.

B. Substitutions for Cause: Proposed requests which are for a reason demonstrated to be beyond the control of the Contractor.

C. Substitutions for Convenience of the Contractor: Proposed requests offering advantages solely to the Contractor with no significant demonstration of benefit to the Owner.

D. Substitutions for Convenience of the Owner: Proposed requests for substitution which the Contractor demonstrate that such a substitution benefits the Owner in regards to either schedule, cost, or improved function.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
   4. Agrees to coordinate installation and make changes to any other work or trade that may be required for the work to be complete, with no additional cost to Owner.
   5. Waives claims for additional costs or time extension that may subsequently become apparent.
   6. Agrees to reimburse Owner and Architect/ Engineer for review or redesign services associated with re-approval by authorities.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
   1. Note explicitly any non-compliant characteristics.

C. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
   1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   2. Substitution request is fully documented and properly submitted.
   3. Requested substitution will not adversely affect Contractor's construction schedule.
   4. Requested substitution has received necessary approvals of authorities having jurisdiction.
   5. Requested substitution is compatible with other portions of the Work.
   6. Requested substitution has been coordinated with other portions of the Work.
   7. Requested substitution provides specified warranty.

8. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

E. Limit each request to a single proposed substitution item. Each request to be submitted with an associated bid question for tracking purposes.
   1. Submit an electronic document, combining a contractors request form with supporting data into a single document. Confirm receipt of document with Architect/ Engineer. Architect/ Engineer may request paper submittals to complete review.
   2. Deliver physical samples, to agreed upon location, where required for material and finish review.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

A. Centralized Request For Quotations specifies time restrictions for submitting requests for substitutions during the bidding period, and the documents required.

B. Submittal Form (before award of contract): Contractor's form as acceptable to Architect/ Engineer

C. Submit request substitution request with sufficient backup information detail to fully demonstrate compliance with all of the project requirements. Failure to submit sufficient information is sufficient reason for the request to be rejected.

D. Design Basis: Where design basis equipment is specified, any other equipment submitted is considered a substitution. The substitution request must document and demonstrate full compliance will all the requirements of the project documents and exceed the design basis equipment in the sole opinion of the Architect/ Engineer, whose decision is final.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

A. Substitutions for Cause: Will be considered but such consideration is no guarantee of acceptance.

B. Design Basis: Where design basis equipment is specified, any other equipment submitted is considered a substitution. The substitution request must document and demonstrate full compliance will all the requirements of the project documents and exceed the design basis equipment in the sole opinion of the Architect/ Engineer, whose decision is final.

C. Substitutions for Contractor Convenience: Substitutions solely for the Convenience of the Contractor will not be accepted.

D. Substitutions for Owner Convenience: Contractor must demonstrate, and Owner must concur, that subsitution benefits the Owner in regards to either schedule, cost, and/or improved function.

E. Submittal Form (after award of contract):
   1. Utilize form indicated by Engineer.

F. Architect/ Engineer will consider requests for substitutions only within 15 days after date of the Notice to Proceed.

G. All substitutions during Construction shall be submitted by a Prime/ General Contractor.

H. Substitution requests for an item are limited to 2 submissions per manufacturer.

3.04 RESOLUTION (POST AWARD)

A. Architect/ Engineer may request additional information and documentation prior to rendering a decision. Contractor (Vendor) is to provide this data in an expeditious manner.

B. Architect/ Engineer will notify Contractor (Vendor) in writing of decision to accept or reject request. Judgement of the Engineer shall be final. The review of a request does not imply acceptance. A rejected submittal due to lack of information or noncompliance with contract

requirements may be resubmitted, with revisions, one time. Any resubmissions after one attempt at revision will only be made with the consent of the Owner.

3.05 ACCEPTANCE

A. Substitutions submitted by Technical Question during bidding will be accepted or rejected by the answer to the Technical Question.

B. After bidding, only by written authorization by the Architect/ Engineer.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. Include completed Substitution Request Forms as part of the Project record.

C. Substitutions accepted post-award are a contractual change to the Project. They will be documented and incorporated into the Work of the Project. Accepted substitutions which would result in a change to Contract Sum or Contract Time must be approved by Change Order.

END OF SECTION

SECTION 01 3000

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction meeting.

B. Site mobilization meeting.

C. Progress meetings.

D. Construction progress schedule.

E. Submittals for review, information, and project closeout.

F. Number of copies of submittals.

G. Requests for Interpretation (RFI) procedures.

H. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 00 7200 - AIA General Conditions (AIA A201-2017) & Contract Forms: Dates for applications for payment

B. Section 01 6000 - Product Requirements: General product requirements.

1.03 PROJECT COORDINATOR

A. Project Coordinator: General Services Division's Owner's Representivie.

B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for contractor access, traffic, and parking facilities.

C. During construction, coordinate use of site and facilities through the Project Coordinator.

D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.

E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities. Responsibility for providing temporary utilities and construction facilities is identified in Section 01 1000 - Summary.

F. Coordinate field engineering and layout work under instructions of the Project Coordinator.

G. Make the following types of submittals to Engineer through the Project Coordinator:
   1. Requests for Interpretation.
   2. Shop drawings, product data, and samples.
   3. Test and inspection reports.
   4. Design data.
   5. Manufacturer's instructions and field reports.
   6. Applications for payment and change order requests.
   7. Progress schedules.
   8. Coordination drawings.
   9. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Project Coordinator will coordinate and schedule a meeting after Contract Award.

B. Attendance Required:
   1. Owner.
   2. Architect/ Engineer.
   3. Contractor (Vendor).

C. Agenda:
   1. Submission of full list of subcontractors, list of products, schedule of values, and progress schedule.
   2. Designation of personnel representing the parties to Contract, Owner, and Architect/ Engineer.
   3. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
   4. Scheduling.

D. Record minutes and distribute copies within two days after meeting to Engineer for review and approval. Once approved send to participants, with two copies to Architect/ Engineer, Owner, participants, and those affected by decisions made.

3.02 SITE MOBILIZATION MEETING

A. Project Coordinator will schedule meeting at the Project site prior to Contractor (Vendor) occupancy.

B. Attendance Required:
   1. Contractor (Vendor).
   2. Owner.
   3. Contractor (Vendor)'s superintendent.
   4. Major subcontractors.

C. Agenda:
   1. Use of premises by Owner and Contractor (Vendor).
   2. Owner's requirements.
   3. Construction facilities and controls provided by Owner.
   4. Temporary utilities provided by Owner.
   5. Survey and building layout.
   6. Security and housekeeping procedures.
   7. Schedules.
   8. Application for payment procedures.
   9. Procedures for testing.
   10. Procedures for maintaining record documents.
   11. Requirements for start-up of equipment.
   12. Inspection and acceptance of equipment put into service during construction period.

D. Record minutes and submit within two days to Architect/ Engineer for review and approval . Once approved, by Architect/ Engineer, send copies to Architect/ Engineer, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

A. Contractor to make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

B. Attendance Required:
   1. Contractor (Vendor).
   2. Owner.
   3. Architect/ Engineer.
   4. Contractor (Vendor)'s superintendent.
   5. Major subcontractors.

C. Agenda:
   1. Review minutes of previous meetings.
   2. Review of work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems that impede, or will impede, planned progress.
   5. Review of submittals schedule and status of submittals.
   6. Review of off-site fabrication and delivery schedules.

7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. RFIs
14. New items
15. Other business relating to work.

D. Record minutes and submit within two days to Architect/ Engineer for review and approval . Once approved, by Architect/ Engineer, send copies to Architect/ Engineer, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

A. Within 10 days of date of Notice to Proceed, submit preliminary schedule.

B. If preliminary schedule requires revision after review, submit revised schedule within 5 days.

C. Within 10 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   1. Include written certification that major contractors have reviewed and accepted proposed schedule.

D. Within 5 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

F. Owner reserves the right to require the contractor to reimburse Owner for additional charges from the Architect/Engineer for Additional Services to review the submittal more than two (2) times. Unless the proceeding results from approved change orders causing revisions to previously approved submittals.

3.05 REQUESTS FOR INTERPRETATION (RFI)

A. Definition: A request seeking one of the following:
   1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
   2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Prior Notification: Prio to preparing an RFI, notify Engineer by phone to discuss concern.

C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.
   2. Prepare in a format and with content acceptable to Owner.

D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor (Vendor)'s signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Unacceptable Uses for RFIs: Do not use RFIs to request the following::
      a. Approval of submittals (use procedures specified elsewhere in this section).
      b. Approval of substitutions (see Section - 01 6000 - Product Requirements)

c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).

3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response.
   a. The Owner will make the determination of such frivolous RFIs and reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect (Engineer), and any of its consultants, due to processing of such RFIs, without appeal.

E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
2. Discrete and consecutive RFI number, and descriptive subject/title.
3. Reference to particular Contract Document(s), sheet number, spec page, ect. requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
4. Annotations: Field dimensions and/or description of conditions which have engendered the request.
5. Contractor (Vendor)'s suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

G. Review Time: Architect/ Engineer will respond and return RFIs to Contractor (Vendor) within fourteen calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

H. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor (Vendor)'s belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect/ Engineer within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.06 SUBMITTAL SCHEDULE

A. Submit to Architect/ Engineer for review a schedule for submittals in tabular format.

1. Submit at the same time as the preliminary schedule specified in Section - 01 3216 - Construction Progress Schedule.
2. Coordinate with Contractor (Vendor)'s construction schedule and schedule of values.
3. Format schedule to allow tracking of status of submittals throughout duration of construction.
4. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, role and name of subcontractor, and unique sequential submittal number..
5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
    a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.07 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
    1. Product data.
    2. Shop drawings.
    3. Samples for selection.
    4. Samples for verification.

B. Submit to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

E. Submittals for review may be delayed by complexity of submittal.

3.08 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
    1. Design data.
    2. Certificates.
    3. Test reports.
    4. Inspection reports.
    5. Manufacturer's instructions.
    6. Manufacturer's field reports.
    7. Other types indicated.

3.09 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 7800 - Closeout Submittals:
    1. Project record documents.
    2. Operation and maintenance data.
    3. Warranties.
    4. Bonds.
    5. Other types as indicated.

D. Submit for Owner's benefit during and after project completion.

3.10 NUMBER OF COPIES OF SUBMITTALS

A. Documents for Review:
    1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies that Contractor (Vendor) requires, plus two copies that will be retained by Architect/

Engineer/Engineer. No drawing originally in 11 x 17 will be submitted in a size smaller than 11 x 17.

2. Larger Sheets, Not Larger Than 36 x 48 inches: Submit the number of opaque reproductions that Contractor (Vendor) requires, plus two copies that will be retained by Architect/ Engineer/Engineer.
3. Documents may be scanned and returned by the Architect (Engineer) on contractors request but the originals on file are the reference materials for the project.

B. Documents for Information: Submit two copies.

C. Samples: Submit the number specified in individual specification sections; one of which will be retained by Engineer
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor (Vendor) unless specifically so stated.

3.11 SUBMITTAL PROCEDURES

A. General Requirements:
   1. A List of Submittals for the project will be submitted within 10 days after Notice to Proceed.
   2. Use a single transmittal for related items.
   3. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   4. Transmit using approved form.
      a. Use Contractor (Vendor)'s form, subject to prior approval by Architect/ Engineer.
   5. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   6. Identify: Project; Contractor (Vendor); subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   7. Apply Contractor (Vendor)'s stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
      a. Submittals from sources other than the Contractor (Vendor), or without Contractor (Vendor)'s stamp will not be acknowledged, reviewed, or returned.
   8. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
      a. Deliver submittals to Architect/ Engineer at business address.
         1) Provide 1 copy for Engineer's record plus number of copies required by the Contractor for return.
            (a) The elevator submittal requires 2 paper copies to the Engineer and 2 paper copies to the Elevator Consultant in addition to the Contractor return copies.
         2) Submit an electronic copy concurrent with delivery of paper copies.
   9. Schedule submittals to expedite the Project, and coordinate submission of related items.
      a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor (Vendor).
      b. For sequential reviews involving Architect/ Engineer's consultants, Owner, or another affected party, allow an additional 7 days.
      c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect/ Engineer's approval, allow an additional 30 days.
      d. Some submittals may take longer to review due to their complexity, items beyond the control of the design team, or missing information/ disorganization.
   10. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
   11. Provide space for Contractor (Vendor) and Architect/ Engineer review stamps.
   12. When revised for resubmission, identify all changes made since previous submission.
   13. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.

14. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.

B. Product Data Procedures:
   1. Submit only information required by individual specification sections.
   2. Collect required information into a single submittal.
   3. Submit concurrently with related shop drawing submittal.
   4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:
   1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
   2. Do not reproduce Contract Documents to create shop drawings.
   3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
   1. Transmit related items together as single package.
   2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.12 SUBMITTAL REVIEW

A. Submittals for Review: Architect/ Engineer will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect/ Engineer will acknowledge receipt and review. See below for actions to be taken.

C. Architect/ Engineer's actions will be reflected by marking each returned submittal using actual stamp on hard copies of submittals. Electronic scan will be returned upon completion of review and Contractor's required return copies will be mailed or hand-delivered at the next progress meeting.

D. Architect/ Engineer's and consultants' actions on items submitted for review:
   1. Authorizing purchasing, fabrication, delivery, and installation:
      a. "No Exceptions Taken".
      b. "See Exceptions Noted".
         1) Exceptions may call for re-submission of a part of the original submittal, or for additional information, prior to release, to allow some part of the submittal to proceed to purchasing or fabricatiom, to benefit the project schedule.
   2. Not Authorizing fabrication, delivery, and installation:
      a. "Revise and Resubmit".
         1) Resubmit revised item, with review notations acknowledged and incorporated.
         2) Non-responsive resubmittals may be rejected.
         3) Resubmisstions are limited to oone attempt to re-submit. the Owner may asses additional Architectural or Enginering fees on and time and materials basis, for successive submittals, without appeal.
      b. "Not Approved".
         1) Submit item complying with requirements of Contract Documents.

E. Architect/ Engineer's and consultants' actions on items submitted for information:
   1. Items for which no action was taken:
      a. "Received" - to notify the Contractor (Vendor) that the submittal has been received for record only.
   2. Items for which action was taken:
      a. "Reviewed" - no further action is required from Contractor (Vendor).

F. Owner reserves the right to require the contractor to reimburse owner for additional charges from the architect/engineer for additional services to review the submittal more than two (2) times. Unless the proceeding results from approved change orders causing revisions to previously approved submittals.

END OF SECTION

SECTION 01 3216

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary schedule.

1.02 RELATED SECTIONS

A. Section 01 1000 - Summary: Work sequence.

1.03 REFERENCE STANDARDS

A. AGC (CPSM) - Construction Planning and Scheduling Manual; 2004.

B. M-H (CPM) - CPM in Construction Management - Project Management with CPM; 2015.

1.04 SUBMITTALS

A. Within 10 days after date established in Notice to Proceed, submit preliminary schedule.

B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.

1. Include written certification that major Subcontractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

F. Submit in PDF format.

G. Submit under transmittal letter form specified in Section 01 3000 - Administrative Requirements.

1.05 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

B. Diagram Sheet Size: Maximum 11 x 17 inches.

C. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

B. Identify each item by specification section number.

C. Identify work of separate stages and other logically grouped activities.

D. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

E. Coordinate content with schedule of values specified in Section 01 2000 - Price and Payment Procedures.

F. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

A. Identify the first work day of each week.

3.04 REVIEW AND EVALUATION OF SCHEDULE

A. Participate in joint review and evaluation of schedule with Architect/ Engineer at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.05 UPDATING SCHEDULE

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity.

C. Annotate diagrams to graphically depict current status of Work.

D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit reports required to support recommended changes.

G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect.

3.06 DISTRIBUTION OF SCHEDULE

A. Distribute copies of updated schedules to Contractor (Vendor)'s project site file, to subcontractors, suppliers, Architect/ Engineer, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION

SECTION 01 4000

QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.

B. Quality assurance.

C. References and standards.

D. Testing and inspection agencies and services.

E. Control of installation.

F. Mock-ups.

G. Manufacturers' field services.

H. Defect Assessment.

1.02 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittal procedures.

B. Section 01 6000 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing; 2014a.

B. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2010.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor (Vendor) or installation/application subcontractor to Architect/ Engineer, in quantities specified for Product Data.

1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect/ Engineer.

C. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Prior to start of work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.

1.06 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Architect/ Engineer before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect/ Engineer shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.07 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Contractor (Vendor) shall employ and pay for services of an independent testing agency to perform specified testing.

B. Employment of agency in no way relieves Contractor (Vendor) of obligation to perform Work in accordance with requirements of Contract Documents.

PART 3 EXECUTION

2.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect/ Engineer before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

2.02 MOCK-UPS

A. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be a comparison standard for the remaining Work.

D. Where mock-up has been accepted by Architect/ Engineer and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect/ Engineer.

2.03 TESTING AND INSPECTION

A. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect/ Engineer and Contractor (Vendor) in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect/ Engineer and Contractor (Vendor) of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Architect/ Engineer.
   6. Submit reports of all tests/inspections specified.

B. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.

3. Agency may not assume any duties of Contractor (Vendor).
4. Agency has no authority to stop the Work.

C. Contractor (Vendor) Responsibilities:
1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
3. Provide incidental labor and facilities:
a. To provide access to Work to be tested/inspected.
b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
c. To facilitate tests/inspections.
d. To provide storage and curing of test samples.
4. Notify Architect/ Engineer and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor (Vendor) beyond specified requirements.
6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor (Vendor) beyond specified requirements.

D. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect/ Engineer.

E. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor (Vendor).

2.04 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

2.05 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

B. If, in the opinion of Engineer, it is not practical to remove and replace the work, Engineer will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 5000

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary sanitary facilities.

B. Temporary Controls: Barriers and enclosures.

C. Security requirements.

D. Vehicular access and parking.

E. Waste removal facilities and services.

1.02 TEMPORARY UTILITIES

A. Owner will provide the following:
   1. Electrical power and metering, consisting of connection to existing facilities.
   2. Water supply, consisting of connection to existing facilities.

B. Existing facilities may be used.

C. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.03 TEMPORARY SANITARY FACILITIES

A. Use of existing facilities is permitted.

B. Maintain daily in clean and sanitary condition. Failure to do so may result in requirement for job site portable toilets.

C. At end of construction, return facilities to same or better condition as originally found.

1.04 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.

C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.05 INTERIOR ENCLOSURES

A. Provide temporary partitions to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.

B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:
   1. No attachments to existing surfaces will be allowed.

1.06 SECURITY

A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

B. Coordinate with Owner's security program.

1.07 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Provide and maintain access to fire hydrants, free of obstructions.

C. Provide off-site parking for employees.

1. Parking may be available at on site but may be limited. If not available, make other provisions for parking.

D. Do not allow vehicle parking on existing pavement.

E. Coordinate delivery of materials with the Owner for access to loading docks.

1.08 WASTE REMOVAL

A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

B. Provide containers with lids. Remove trash from site periodically.

C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.09 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
1. Provide seeding as necessary.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 6000

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Re-use of existing products.

C. Transportation, handling, storage and protection.

D. Product option requirements.

E. Substitution limitations.

F. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators; 2014.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

1. Any submittals that list multiple products without properly identifying the part number, model, etc. used for this specific project will be rejected.

B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.

B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.

C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor (Vendor); remove from site.

D. Specific Products to be Reused: The reuse of certain materials and equipment already existing on the project site is required.

1. See Section 01 1000 and construction documents for list of items required to be salvaged for reuse and relocation.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. Use of products having any of the following characteristics is not permitted:

1. Made using or containing CFC's or HCFC's.
2. Containing lead, cadmium, or asbestos.

C. Where other criteria are met, Contractor (Vendor) shall give preference to products that:

1. If used on interior, have lower emissions

2. If wet-applied, have lower VOC content
    a. Have longer documented life span under normal use.

D. Motors: Refer to Section 23 0513 - Common Motor Requirements for HVAC Equipment, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.04 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 01 2500 - Substitution Procedures.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

3.02 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.03 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

G. Comply with manufacturer's warranty conditions, if any.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01 7000

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.

C. Pre-installation meetings.

D. Cutting and patching.

E. Cleaning and protection.

F. Starting of systems and equipment.

G. Demonstration and instruction of Owner personnel.

H. Closeout procedures, including Contractor (Vendor)'s Correction Punch List, except payment procedures.

I. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

A. Section 01 1000 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.

B. Section 01 4000 - Quality Requirements: Testing and inspection procedures.

C. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.
   2. Integrity of weather exposed or moisture resistant element.
   3. Efficiency, maintenance, or safety of any operational element.
   4. Visual qualities of sight exposed elements.
   5. Work of Owner or separate Contractor.
   6. Include in request:
      a. Identification of Project.
      b. Location and description of affected work.
      c. Necessity for cutting or alteration.
      d. Description of proposed work and products to be used.
      e. Effect on work of Owner or separate Contractor.
      f. Written permission of affected separate Contractor.
      g. Date and time work will be executed.

C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 PROJECT CONDITIONS

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
   1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.

2. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.

C. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
   1. At All Times: Excessively noisy tools and operations will not be tolerated inside the building at any time of day; excessively noisy includes jackhammers.
   2. Outdoors: Limit conduct of especially noisy exterior work to the hours of 6 pm to 7 am.
   3. Indoors: Limit conduct of especially noisy interior work to the hours of 6 pm to 7 am.

1.06 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached. Attachment to existing substrates is only allowed to facilitate elevator equipment. No attachments to architectural features arre allowed.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work,

assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Engineer 14 days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of examination, preparation and installation procedures.
   2. Review coordination with related work.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.

B. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.05 ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as indicated.
   2. Report discrepancies to Engineer before disturbing existing installation.
   3. Beginning of alterations work constitutes acceptance of existing conditions.

B. Remove existing work as indicated and as required to accomplish new work.
   1. Remove items indicated on drawings.
   2. Relocate items indicated on drawings.
   3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
   4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.

C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
   2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.

3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
    a. Notify owner one week prior to all disruptions.
    b. Disable existing systems only to make switchovers and connections; minimize duration of outages.
    c. All disruptions must be approved by owner.
    d. Provide temporary connections as required to maintain existing systems in service.
4. Verify that abandoned services serve only abandoned facilities.
5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

D. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.

E. Adapt existing work to fit new work: Make as neat and smooth transition as possible.

F. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

G. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

H. Clean existing systems and equipment.

I. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

J. Do not begin new construction in alterations areas before demolition is complete.

K. Comply with all other applicable requirements of this section.

3.06 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

C. Perform whatever cutting and patching is necessary to:
1. Complete the work.
2. Fit products together to integrate with other work.
3. Provide openings for penetration of mechanical, electrical, and other services.
4. Match work that has been cut to adjacent work.
5. Repair areas adjacent to cuts to required condition.
6. Repair new work damaged by subsequent work.
7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-complying work.

D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.

J. Patching:
   1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   2. Match color, texture, and appearance.
   3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Engineer and Owner 14 days prior to start-up of major systems and equipment.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable Contractor (Vendor) personnel and manufacturer's representative in accordance with manufacturers' instructions.

G. Where required in specific Sections, Engineer will witness start-up of designated systems and equipment.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.

B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

H. Demonstration and instruction will be witnessed by the Engineer. Notify Engineer and Owner 14 days prior.

3.11 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.12 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to Engineer.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor (Vendor)'s Correction Punch List for Contractor (Vendor)'s Notice of Substantial Completion.

C. Notify Engineer when work is considered ready for Substantial Completion.

D. Submit written certification containing Contractor (Vendor)'s Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect/ Engineer's Substantial Completion inspection.

E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect/ Engineer's and Contractor (Vendor)'s comprehensive list of items identified to be completed or corrected and submit to Architect/ Engineer.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

G. Notify Engineer when work is considered finally complete.

H. Complete items of work determined by Architect/ Engineer listed in executed Certificate of Substantial Completion.

I. Complete items of work determined by Engineer's final inspection.

3.14 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION

SECTION 01 7419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Contractor (Vendor) shall submit periodic Waste Disposal Reports; all landfill disposal, incineration, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

E. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.

F. Regulatory Requirements: Contractor (Vendor) is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
   1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
   2. Submit Report on a form acceptable to Owner.
   3. Landfill Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
      c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   4. Incinerator Disposal: Include the following information:
      a. Identification of material.
      b. Amount, in tons or cubic yards, of trash/waste material from the project delivered to incinerators.
      c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
   5. Recycled and Salvaged Materials: Include the following information for each:
      a. Identification of material, including those retrieved by installer for use on other projects.
      b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
      c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
      d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
      e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
   6. Material Reused on Project: Include the following information for each:
      a. Identification of material and how it was used in the project.
      b. Amount, in tons or cubic yards.
      c. Include weight tickets as evidence of quantity.
   7. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

A. See Section 01 3000 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 01 5000 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 01 6000 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 01 7000 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect/ Engineer.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 7800

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project Record Documents.

B. Operation and Maintenance Data.

C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 01 7000 - Execution and Closeout Requirements: Contract closeout procedures.

C. Individual Product Sections: Specific requirements for operation and maintenance data.

D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect/ Engineer with claim for final Application for Payment.

B. Operation and Maintenance Data:
   1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/ Engineer will review draft and return one copy with comments.
   2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit two copy(ies) of completed documents 15 days prior to final inspection. These copies will be reviewed and returned with comments, if necessary. Revise as required and redistribute to all parties.
   4. Submit two sets of revised final documents in final form within 10 days after final inspection.

C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 3 EXECUTION

2.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   2. Field changes of dimension and detail.
   3. Details not on original Contract drawings.

2.02 OPERATION AND MAINTENANCE DATA

A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

2.03 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. For Each Item of Equipment and Each System:
   1. Description of unit or system, and component parts.
   2. Identify function, normal operating characteristics, and limiting conditions.
   3. Include performance curves, with engineering data and tests.
   4. Complete nomenclature and model number of replaceable parts.

B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

F. Provide servicing and lubrication schedule, and list of lubricants required.

G. Include manufacturer's printed operation and maintenance instructions.

H. Include sequence of operation by controls manufacturer.

I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

J. Additional Requirements: As specified in individual product specification sections.

2.04 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect/ Engineer, Consultants, Contractor (Vendor) and subcontractors, with names of responsible parties.

F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

H. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

J. Arrangement of Contents: Organize each volume in parts as follows:
   1. Project Directory.
   2. Table of Contents, of all volumes, and of this volume.
   3. Operation and Maintenance Data: Arranged by system, then by product category.
      a. Source data.
      b. Operation and maintenance data.
      c. Field quality control data.
      d. Original warranties and bonds.

K. Provide (1) electronic copy of close-out documentation.

2.05 WARRANTIES

A. Obtain warranties, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties until time specified for submittal.

END OF SECTION

SECTION 01 7900

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.
   3. Electrical systems and equipment.
   4. Fire Alarm Systems.
   5. Items specified in individual product Sections.

C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
   1. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

A. Section 01 7800 - Closeout Submittals: Operation and maintenance manuals.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
   1. Submit one copy to the Engineer, not to be returned.

B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees. Provide a detailed syllabus for each traing session for Review by the Engineer.
   1. Submit to Architect/ Engineer for transmittal to Owner.
   2. Submit not less than four weeks prior to start of training.
   3. Revise and resubmit until acceptable.
   4. Provide an overall schedule showing all training sessions.
   5. Include at least the following for each training session:
      a. Identification, date, time, and duration.
      b. Description of products and/or systems to be covered.
      c. Name of firm and person conducting training; include qualifications.
      d. Intended audience, such as job description.
      e. Objectives of training and suggested methods of ensuring adequate training.
      f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
      g. Media to be used, such a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor (Vendor).

C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
   1. Include applicable portion of O&M manuals.
   2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
   3. Provide one extra copy of each training manual to be included with operation and maintenance data.

D. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
   1. Format: DVD Disc.
   2. Label each disc and container with session identification and date.

1.04 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.

1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

A. All demonstration must be completed, to the satisfaction of the Engineer, prior to the scheduling of training.

B. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

C. Demonstration may be combined with Owner personnel training if applicable.

D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.
   2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
   1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

A. Training will not be conducted until the O&M manuals have been reviewed and approved. the O&M manuals will be an integral part of the training. provide a set of O&M, above the required number of closeout sets, for each two persons attending training.

B. Contractor will prepare the Training Plan based on draft plans submitted.

C. Conduct training on-site unless otherwise indicated.

D. Owner will provide classroom and seating at no cost to Contractor (Vendor).

E. Provide training in minimum two hour segments.

F. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to deduct Owner travel and payroll expenses from final pay application. Contractor (Vendor) for personnel "show-up" time.

G. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to deduct Owner travel and payroll expenses for personnel "show-up" time, from final pay application.

H. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
   1. The location of the O&M manuals and procedures for use and preservation; backup copies.
   2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
   3. Typical uses of the O&M manuals.

I. Product- and System-Specific Training:
   1. Review the applicable O&M manuals.
   2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.

3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
4. Provide hands-on training on all operational modes possible and preventive maintenance.
5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
6. Discuss common troubleshooting problems and solutions.
7. Discuss any peculiarities of equipment installation or operation.
8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
9. Review recommended tools and spare parts inventory suggestions of manufacturers.
10. Review spare parts and tools required to be furnished by Contractor (Vendor).
11. Review spare parts suppliers and sources and procurement procedures.

J. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION

SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete reinforcement.

B. Concrete curing.

1.02 REFERENCE STANDARDS

A. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).

C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; 1998 (Reapproved 2004).

D. ACI 301 - Specifications for Structural Concrete; 2016.

E. ACI 302.1R - Guide to Concrete Floor and Slab Construction; 2015.

F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

G. ACI 305R - Guide to Hot Weather Concreting; 2010.

H. ACI 306R - Guide to Cold Weather Concreting; 2016.

I. ACI 308R - Guide to External Curing of Concrete; 2016.

J. ACI 318 - Building Code Requirements for Structural Concrete; 2019, with Errata (2021).

K. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2020.

L. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2018a.

M. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.

N. ASTM C150/C150M - Standard Specification for Portland Cement; 2021.

O. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2017a.

P. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2019.

Q. ASTM C845/C845M - Standard Specification for Expansive Hydraulic Cement; 2018.

R. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.

S. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2012.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

C. Mix Design: Submit proposed concrete mix design.
   1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
   2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.

1.04 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301 and ACI 318.

B. Follow recommendations of ACI 305R when concreting during hot weather.

C. Follow recommendations of ACI 306R when concreting during cold weather.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
   1. Type: Deformed billet-steel bars.
   2. Finish: Unfinished, unless otherwise indicated.

B. Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, ASTM A1064/A1064M.
   1. Form: Flat Sheets.
   2. WWR Style: 4 x 8-W6 x W10.

2.02 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Type I - Normal Portland type.

B. Blended, Expansive Hydraulic Cement: ASTM C845/C845M, Type K.

C. Fine and Coarse Aggregates: ASTM C33/C33M.

D. Lightweight Aggregate: ASTM C330/C330M.

E. Fly Ash: ASTM C618, Class C or F.

F. Calcined Pozzolan: ASTM C618, Class N.

G. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.

H. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.03 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

PART 3 EXECUTION

3.01 EXAMINATION

3.02 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

3.03 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

3.04 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
   1. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.05 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Surfaces Not in Contact with Forms:
   1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
   2. Final Curing: Begin after initial curing but before surface is dry.

3.06 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Architect/ Engineer. The cost of additional testing shall be borne by Contractor (Vendor) when defective concrete is identified.

3.07 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

SECTION 07 8400
FIRESTOPPING

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01 7000 - Execution and Closeout Requirements: Cutting and patching.

1.02 REFERENCE STANDARDS

A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.

B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2013a.

C. ASTM E1966 - Standard Test Method for Fire Resistive Joint Systems; 2007 (Reapproved 2011).

D. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2015a.

E. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2013.

F. ITS (DIR) - Directory of Listed Products; current edition.

G. FM 4991 - Approval Standard for Firestop Contractors; 2013.

H. FM (AG) - FM Approval Guide; current edition.

I. FA (AG) - FM Approval Guide; Factory Mutual Research Corporation; current edition.

J. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

K. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

L. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

M. UL (FRD) - Fire Resistance Directory; current edition.

1.03 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
   2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.04 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:
   1. 3M Fire Protection Products; _____: www.3m.com/firestop.
   2. Hilti, Inc: www.us.hilti.com/#sle.

B. Firestopping Materials: Any materials meeting requirements.

C. Materials: Use any material meeting requirements.

D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

E. Fire Ratings: Refer to drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.

B. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
   1. Movement: Provide systems that have been tested to show movement capability as indicated.
   2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
   3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
   4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

C. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
   1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
   2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
   3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
   4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.03 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.
   1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by authorities having jurisdiction.

C. Engineer reserves the right to inspect all firestopping.

D. Install labeling required by code.

E. Maintain log of all fire stopping material used and locations. Submit log at close-out.

3.04 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 9200
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping: Firestopping sealants.

1.03 REFERENCE STANDARDS

A. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants; 2015.

B. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2000 (Reapproved 2011).

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.

D. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
   1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
   2. List of backing materials approved for use with the specific product.
   3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
   4. Substrates the product should not be used on.
   5. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
   6. Certification by manufacturer indicating that product complies with specification requirements.

C. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
   1. Adhesion Testing: In accordance with ASTM C794.
   2. Compatibility Testing: In accordance with ASTM C1087.
   3. Allow sufficient time for testing to avoid delaying the work.
   4. Deliver to manufacturer sufficient samples for testing.
   5. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
   6. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.

1.06 WARRANTY

A. Correct defective work within a five year period after Date of Substantial Completion.

B. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Install bond breaker backing tape where backer rod cannot be used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION

SECTION 08 3100

ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall-mounted access units.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

A. Wall-Mounted Units:
   1. Location: at mechanical, electrical, and plumbing devices located within walls that require access.
   2. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.

2.02 WALL-MOUNTED UNITS

A. Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
   1. Material: Steel.
   2. Door Style: Single thickness with rolled or turned in edges.
   3. Frames: 16 gauge, 0.0598 inch, minimum thickness.
   4. Factory Finish: Polyester powder coat; color as selected by Architect from manufacturer's standard colors.
   5. Hardware:
      a. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
      b. Latch/Lock: Screw driver slot for quarter turn cam latch.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings, and secure units rigidly in place.

C. Position units to provide convenient access to concealed equipment when necessary.

3.03 SCHEDULE

A. Provide access hatches where required for mechanical, electrical, and plumbing device access as follows:
   1. One-handed Operation: 10”x10”
   2. Two-handed Operation: 18”x18”
   3. Head plus hands Operation: 24”x24”
   4. Body Access, inluding one location at each bathroom chase space: 36”x36”

END OF SECTION

SECTION 08 9100
LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers, frames, and accessories.

1.02 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2014 (2015 Errata).

B. AAMA 612 - Voluntary Specification, Performance Requirements, and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum; 2017a.

C. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2017a.

D. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2017a.

E. AMCA 511 - Certified Ratings Program for Air Control Devices; 2010.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.

D. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.

E. Test Reports: Independent agency reports showing compliance with specified performance criteria.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum ten years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least ten years of documented experience.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.
   1. Finish: Include twenty year coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Louvers:
   1. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.

1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
2. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
3. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

2.03 FINISHES

A. Class II Natural Anodized Finish: AAMA 611 AA-M12C22A31 Clear anodic coating not less than 0.4 mils thick.

B. Primer: Zinc chromate, alkyd type.

C. Color: to match existing.

2.04 ACCESSORIES

A. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.

B. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.

B. Install louvers level and plumb.

C. Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

D. Secure louver frames in openings with concealed fasteners.

3.03 CLEANING

A. Strip protective finish coverings.

B. Clean surfaces and components.

END OF SECTION

SECTION 09 2116

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal stud wall framing.

B. Metal channel ceiling framing.

C. Acoustic insulation.

D. Gypsum wallboard.

E. Joint treatment and accessories.

1.02 REFERENCE STANDARDS

A. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2014.

B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.

C. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2015.

D. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2013.

E. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2015.

F. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2014.

G. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum Veneer Base; 2014a.

H. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2014.

I. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2012.

J. GA-216 - Application and Finishing of Gypsum Board; 2013.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

PART 2 PRODUCTS

2.01 METAL FRAMING MATERIALS

A. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
   1. Studs: C-shaped with knurled or embossed faces.
   2. Runners: U shaped, sized to match studs.

B. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.

2.02 BOARD MATERIALS

A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.

2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
    a. Mold resistant board is required at all locations.
3. Thickness:
    a. Vertical Surfaces: 5/8 inch.
    b. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

B. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.

2.03 GYPSUM WALLBOARD ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 3 inch.

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
1. Types: As detailed or required for finished appearance.

D. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.

E. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

F. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.

B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.

3.03 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Studs: Space studs at 16 inches on center.
1. Extend partition framing to structure where indicated and to ceiling in other locations.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

D. Blocking: Install wood blocking for support of:
1. Framed openings.
2. Toilet accessories.
3. Wall-mounted door hardware.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.07 JOINT TREATMENT

A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   2. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.

3.08 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 5100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

B. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2017.

C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2013.

D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2020.

E. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2019.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on suspension system components and acoustical units.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Acoustical Panels: Gypsum, with the following characteristics:
   1. Classification: ASTM E1264 Type XX.
   2. Size: 24 by 24 inches.
   3. Thickness: 3/4 inch.
   4. Panel Edge: Square.
   5. Color: White.
   6. Suspension System: Exposed grid.

2.02 SUSPENSION SYSTEM(S)

A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
   1. Materials:
      a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.

B. Exposed Suspension System: Hot-dipped galvanized steel grid with aluminum cap.
   1. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
   2. Profile: Tee; 15/16 inch face width.
   3. Finish: Baked enamel.
   4. Color: White.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.

B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.

C. Hold-Down Clips: Manufacturer's standard clips to suit application.

D. Perimeter Moldings: Same metal and finish as grid.

PART 3 EXECUTION

3.01 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.

D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.

E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners.

3.02 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

E. Cutting Acoustical Units:
   1. Make field cut edges of same profile as factory edges.

F. Install hold-down clips on vertical panels.

END OF SECTION

SECTION 09 9123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints.

C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
   5. Floors, unless specifically indicated.
   6. Glass.
   7. Concealed pipes, ducts, and conduits.

1.02 DEFINITIONS

A. Comply with ASTM D16 for interpretation of terms used in this section.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.

C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.

D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.

E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

F. SSPC-SP 1 - Solvent Cleaning; 2015.

G. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
   2. MPI product number (e.g., MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.

C. Electrostatically Applied Coating: Submit manufacturer's literature including descriptive data and recommendations for mixing, application, and curing.

D. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.

1.05 QUALITY ASSURANCE

A. Electrostatically Applied Coating: Provide written certification attesting that applicators have been factory trained, and that application equipment used complies with manufacturer's requirements.

1.06 MOCK-UP

A. See Section 01 4000 - Quality Requirements, for general requirements for mock-up.

B. Provide door and frame assembly illustrating paint color, texture, and finish.

C. Locate where directed by Architect.

D. Mock-up may remain as part of the work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.

D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
   1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
   2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
   4. Supply each paint material in quantity required to complete entire project's work from a single production run.
   5. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:
   1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
      a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
      b. Architectural coatings VOC limits of the State in which the Project is located.

c. Meeting EPA airPLUS requirements for Low-Emissions Materials.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Flammability: Comply with applicable code for surface burning characteristics.

D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect/ Engineer from the manufacturer's full line.

E. Colors: To be selected from manufacturer's full range of available colors.

1. Selection to be made by Architect/ Engineer after award of contract.

2.02 PAINT SYSTEMS - INTERIOR

A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, wood, and shop primed steel.

1. Two top coats and one coat primer.
2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.
3. Top Coat Sheen:
   a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
   b. Eggshell: MPI gloss level 3; use this sheen at all locations.
4. Primer: As recommended by top coat manufacturer for specific substrate.

B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:

1. Medium duty applications include doors, door frames, and railings.
2. Two top coats and one coat primer.
3. Top Coat(s): High Performance Architectural Interior Latex; MPI #138, 139, 140, or 141.
4. Top Coat Sheen:
   a. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.
5. Primer: As recommended by top coat manufacturer for specific substrate.

2.03 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.04 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been adequately prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. If substrate preparation is the responsibility of another installer, notify Architect/ Engineer of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:

1. Gypsum Wallboard: 12 percent.
2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.

F. Ferrous Metal:
   1. Solvent clean according to SSPC-SP 1.
   2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
   3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.

G. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

H. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with tinted primer.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".

B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

D. Apply each coat to uniform appearance in thicknesses specified by manufacturer.

E. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

F. Sand wood and metal surfaces lightly between coats to achieve required finish.

G. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

I. Electrostatically Applied Coating: Apply prime and finish materials in accordance with manufacturer's directions. Apply each material at not less that the manufacturer's recommended spreading rate. Use special equipment, applicators, and techniques recommended by manufacturer's as best suited for the particular applications.

J. Electrostatically Applied Coating: Apply additional coats beyond scheduled requirements when undercoating, stains or other conditions show through final paint coat until the special coating is of uniform finish, color and appearance.

3.04 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

A. Protect finishes until completion of project.

B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

SECTION 22 0001

BASIC PLUMBING MATERIALS AND METHODS

GENERAL REQUIREMENTS

1.01 CONFORM TO THE CURRENT REQUIRMENTS OF THE IMC AND IPC - 2015

1.02 PERFORM ALL WORK UNDER THIS SECTION IN ACCORDANCE WITH APPLICABLE CODES & STANDARDS AND BEST INDUSTRY AND TRADE PRACTICES.

1.03 COORDINATE ALL WITH WITH OTHER TRADES PRIOR TO BIDDING. THIS IS A RENOVATION PROJECT.

1.04 SUSPECT MATERIAL: SHOULD THE CONTRACTOR ENCOUNTER SUSPECTED ACM MATERIAL, THEY ARE TO STOP WORK IN THE AFFECTED AREA AND NOTIFY THE OWNER AND ENGINEER. THE OWNER WILL ARRANGE FOR TESTING IF THE EXISTING ACM DOCUMENTATION IS UNCLEAR. REMEDIATION OF ACM IS NOT INCLUDED IN THIS PROJECT SCOPE BY THE CONTRACTOR.

MATERIALS & METHODS

2.01 BEST INDUSTRY PRACTICES

A. Contractor will employ best industry practices and utilize the materials and methods found within the project drawings and specifications.

2.02 PIPING SPECIALTIES

A. Unions: Screwed type for pipes 2-1/2 inches (63 mm) and smaller; flanged type for pipes 3 inches (75 mm) and larger.

B. Traps: Self-scouring with no internal divisions; liquid seal of at least 2 inches (50 mm) but less than 4 inches (100 mm); brass or bronze with chrome-plating where exposed to view.

END OF SECTION

SECTION 22 1005

PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary waste piping, above grade.

B. Storm drainage piping, buried within 5 feet of building.
   1. Storm drainage piping, above grade.
   2. Pipe flanges, unions, and couplings.
   3. Pipe hangers and supports.
   4. Ball valves.

1.02 REFERENCE STANDARDS

A. ASME B31.9 - Building Services Piping; 2014.

B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

D. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2015.

E. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2015.

F. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2013.

G. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2012.

H. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

J. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; 2009.

K. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2011.

L. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.

M. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2013.

N. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

P. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015).

Q. NSF 372 - Drinking Water System Components - Lead Content; 2011.

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

D. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.06 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 with not less than 150 psi pressure rating.
   1. Fittings: ASTM D2466, PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.
   5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

6. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
    a. Bases: High-density polypropylene.
    b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
    c. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
    d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
    e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

B. Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Screw Type Anchors: Comply with ICC-ES AC193.
2. Masonry Screw Type Anchors: Comply with ICC-ES AC106.
3. Other Types: As required.

2.05 BALL VALVES

A. Manufacturers:
1. Conbraco Industries, Inc: www.apollovalves.com.
2. Nibco, Inc: www.nibco.com.
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

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

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

H. Provide access where valves and fittings are not exposed.

I. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Install bell and spigot pipe with bell end upstream.

L. Install valves with stems upright or horizontal, not inverted.

M. Install water piping to ASME B31.9.

N. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

O. Sleeve pipes passing through partitions, walls, and floors.

P. Inserts:
   1. Provide inserts for placement in concrete formwork.

Q. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Provide hangers adjacent to motor-driven equipment with vibration isolation.

3.04 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

D. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

3.05 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

3.06 SCHEDULES

A. Pipe Hanger Spacing:
   1. Plastic Piping:
      a. All Sizes:
         1) Maximum Hanger Spacing: 6 ft.

END OF SECTION

SECTION 23 0001

BASIC MECHANICAL MATERIALS & METHODS

GENERAL REQUIREMENTS

1.01 CONFORM TO THE CURRENT REQUIRMENTS OF THE IMC AND IPC - 2018

1.02 PERFORM ALL WORK UNDER THIS SECTION IN ACCORDANCE WITH APPLICABLE CODES & STANDARDS AND BEST INDUSTRY AND TRADE PRACTICES.

1.03 COORDINATE ALL WITH WITH OTHER TRADES PRIOR TO BIDDING. THIS IS A RENOVATION PROJECT.

1.04 ROOF PENETRATIONS: ALL ROOF PENETRATIONS WILL BE BY FACTORY APPROVED METHOD, ROUND PENETRATIONS WILL USE FACTORY ROOF BOOTS, BY SAME NAUFACTURER AS ORIGINAL ROOF. ALL PENETRATIONS MUST MEET WARRANTY REQUIREMENTS REGARDLESS OF ROOF AGE. ROOF PENETRATIONS ON ROOFS WITH AN ACTIVE WARRANTY MUST BE REVIEWED, APPROVED, AND ADDED TO THE WARRANTY WITH FULL DOCUMENTATION.

1.05 SUSPECT MATERIAL: SHOULD THE CONTRACTOR ENCOUNTER SUSPECTED ACM MATERIAL, THEY ARE TO STOP WORK IN THE AFFECTED AREA AND NOTIFY THE OWNER AND ENGINEER. THE OWNER WILL ARRANGE FOR TESTING IF THE EXISTING ACM DOCUMENTATION IS UNCLEAR. REMEDIATION OF ACM IS NOT INCLUDED IN THIS PROJECT SCOPE BY THE CONTRACTOR.

MATERIALS & METHODS

2.01 BEST INDUSTRY PRACTICES

A. Contractor will employ best industry practices and utilize the materials and methods found within the project drawings and specifications.

2.02 FIELD TESTING: VISUALLY INSPECT CONNECTIONS FOR LEAKS AT FREQUENT INTERVALS OVER ENTIRE DURATION OF TEST.

A. Domestic Water and Hydronic (Heating & Chilled Water):
   1. Hydraulic (air over water) pressure test maintained at 25 psi (172 kPa) above system operating pressure for minimum of 1 hour. Air only is not permitted.

END OF SECTION

SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Single phase electric motors.

C. Three phase electric motors.

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.

C. NEMA MG 1 - Motors and Generators; 2014.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

D. Operation Data: Include instructions for safe operating procedures.

E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for specified use, and their accessories, with minimum ten years documented product development, testing, and manufacturing experience.

B. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
   1. As scheduled

B. Nominal Efficiency:
   1. Open Motor with Two Poles: 82.5.
   2. Open Motor with Four Poles: 82.5.
   3. Open Motor with Six Poles: 50.0.

4. Enclosed Motor with Two Poles: 75.5.
5. Enclosed Motor with Four Poles: 82.5.
6. Enclosed Motor with Six Poles: 50.0.

C. Construction:
1. Open drip-proof type except where specifically noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Motors with frame sizes 254T and larger: Energy efficient type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.05 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.06 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

I. Sound Power Levels: To NEMA MG 1.

J. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

K. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 0519

METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

C. Project Record Documents: Record actual locations of components and instrumentation.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Pressure Gauges: One of each type and size.

1.04 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 LIQUID FLOW METERS

A. Manufacturers:
   1. Onicon.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Annular element flow stations with meter set.
   1. Measuring Station: Type 316 stainless steel twin turbine type flow element inserted through welded threaded couplet, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.
      a. Pressure rating: 275 psi.
      b. Maximum temperature: 400 degrees F.
      c. Accuracy: Plus 0.55 percent to minus 2.30 percent.

2.02 PRESSURE GAUGES

A. Manufacturers:
   1. Dwyer Instruments, Inc: www.dwyer-inst.com.
   2. Omega Engineering, Inc: www.omega.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Pressure Gauges: ASME B40.100, UL 393 drawn stainless steel case, stainless bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.

4. Scale: Psi.

2.03 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Lever handle ball valve, stainless ball, viton seat, for maximum 150 psi.

2.04 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Dwyer Instruments, Inc: www.dwyer-inst.com.
   2. Omega Engineering, Inc: www.omega.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Stem: 3/4 inch NPT brass.
   4. Accuracy: 2 percent, per ASTM E77.
   5. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.06 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide three pressure gauges per pump, installing taps on strainer inlet, and on suction and discharge of pump. Pipe to gauge.

C. Install two pressure gauges on AHU's one each on inlet and discharge of each coil.

D. Install thermometers in piping systems in dry well sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation. Install thermometers before and after chillers, before and after AHU heating and cooling coils on systems larger than 5 tons cooling coil capacity or 100,000 BTUH heating capacity. Install thermometer after chilled or hot water pumps.

E. Utilize heat conductive compound in all wells similar to Tradeline 107408, unless specifically prohibited by sensor mfr.

F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 0923.

G. Coil and conceal excess capillary on remote element instruments.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale, confirm with Engineer.

I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULE

A. Pressure Gauge Tappings, Location:
   1. Control valves 3/4 inch & larger - inlets and outlets.
   2. Major coils - inlets and outlets.
   3. Heat exchangers - inlets and outlets.
   4. Chiller - inlets and outlets.

B. Thermometer Sockets, Location:
   1. Control valves 1 inch & larger - inlets and outlets.

END OF SECTION

SECTION 23 0523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Applications.

B. General requirements.

C. Ball valves.

D. Butterfly valves.

E. Check valves.

1.02 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. PTFE: Polytetrafluoroethylene.

F. RS: Rising stem.

G. TFE: Tetrafluoroethylene.

H. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose (Inch); 2013.

B. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.

C. ASME B31.9 - Building Services Piping; 2014.

D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.

E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2014).

F. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).

G. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2015.

H. AWWA C606 - Grooved and Shouldered Joints; 2011.

I. MSS SP-67 - Butterfly Valves; 2011.

J. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.

K. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.06 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

B. Provide the following valves for the applications if not indicated on drawings:
   1. Throttling (Hydronic): Butterfly, Ball, and Globe.
   2. Isolation (Shutoff): Ball.
   3. Swing Check (Pump Outlet):
      a. Size 2 inch and Smaller: Bronze with bronze disc.
      b. 2-1/2 NPS and Larger: Iron with lever and weight or center-guided with resilient seat.
   4. Dead-End: Butterfly, single-flange (lug) type.

C. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

D. Chilled Water Valves:
   1. 2 NPS and Smaller, Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, one piece, stainless steel trim.
      c. Swing Check: Bronze disc, Class.
   2. Size 2-1/2 inch and Larger, Iron Valves:
      a. 2-1/2 NPS to 4 NPS: Flanged ends.
      b. Ball: 2-1/2 NPS to 10 inch, Class 150.
      c. Single-Flange Butterfly: 2-1/2 inch to 12 inch, ductile iron disc, EPDM seat, 200 CWP.
      d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
      e. Swing Check: Metal seats, Class 125.
      f. Grooved-End Check: 3 inch to 12 inch, 300 CWP.

E. Heating Hot Water Valves:
   1. 2 NPS and Smaller, Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, one piece, brass trim.
      c. Swing Check: Bronze disc, Class 125.
   2. Size 2-1/2 inch and Larger, Iron Valves:
      a. 2-1/2 NPS to 4 NPS: Flanged ends.
      b. Ball: 2-1/2 inch to 10 inch, Class 150.
      c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
      d. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
      e. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Gear Actuator: Quarter-turn valves 8 inch and larger.
   2. Hand Lever: Quarter-turn valves 6 inch and smaller.

D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
   1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   2. Butterfly Valves: Extended neck.
   3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
   1. Threaded End Valves: ASME B1.20.1.
   2. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
   3. Grooved End Connections: AWWA C606.

F. General ASME Compliance:
   1. Building Services Piping Valves: ASME B31.9.

G. Bronze Valves:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

H. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRONZE, BALL VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. One Piece, Reduced Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. Body: Bronze.
   3. Ends: Threaded.
   4. Seats: PTFE.
   5. Stem: Stainless steel.
   6. Ball: Stainless steel, vented.

2.04 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Wafer Style:
   1. Size: As indicated on drawings, or to match pipe size, Class 125.
   2. Comply with MSS SP-67, Type I.
   3. Wafer Style, CWP Ratings:

a. Sizes 2 to 12 inch: 200 psi.
b. Sizes 14 to 24 inch: 150 psi.
c. Vacuum Service: Down to 29.9 in-Hg.

4. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
5. Stem: One or two-piece stainless steel.
6. Seat: NBR.
7. Disc: Coated ductile iron.
8. Removable Manual Actuator: Lockable handle with open/close position indication.
9. Manufacturers:
   a. Apollo Valves; _____: www.apollovalves.com/#sle.
   b. FNW; 711: www.fnw.com/#sle.
   c. Substitutions: See Section 01 6000 - Product Requirements.

2.05 BRONZE, SPRING CHECK VALVES

A. Class 125:
   1. Pressure and Temperature Rating: MSS SP-80, Type 3.
   2. Design: Y-pattern, horizontal or vertical flow.
   3. WSP Rating: 200 psi.
   4. Body: Bronze, ASTM B62.
   5. End Connections: Threaded or soldered.
   6. Disc: Bronze.
   7. Manufacturers:
      a. Substitutions: See Section 01 6000 - Product Requirements.

2.06 IRON, GROOVED-END SPRING CHECK VALVES

A. Class 300:
   1. 10 NPS to 12 NPS.
   2. CWP Rating: 300 psi.
   3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
   4. Seal: EPDM or Nitrile.
   5. Disc: Ductile iron.
   6. Coating: Black, non-lead paint.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping; 2014 (Reapproved 2020).

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2014).

H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

K. FM (AG) - FM Approval Guide; current edition.

L. MFMA-4 - Metal Framing Standards Publication; 2004.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

N. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
      b. Thomas & Betts Corporation: www.tnb.com/#sle.
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
      d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2. Provide factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
3. Comply with MFMA-4.
4. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

C. Channel Nuts:
1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

D. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2 inch diameter.
   b. Piping up to 1 inch: 1/4 inch diameter.
   c. Piping larger than 1 inch: 3/8 inch diameter.
   d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

E. Thermal Insulated Pipe Supports:
1. General Requirements:
   a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
   b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
   c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch iron pipes.
   d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
2. PVC Jacket:
   a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
   b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
   c. Thickness: 60 mil.
3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

F. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F:
   a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
   b. Support From Below: MSS SP-58 Types 35 through 38.

G. Pipe Stanchions:
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

H. Beam Clamps:
1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
8. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
9. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

I. Riser Clamps:
1. Provide copper plated clamps for copper tubing support.
2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
5. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
6. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

J. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.

K. Strut Clamps:
1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

L. Insulation Clamps:
1. Two bolt-type clamps designed for installation under insulation.
2. Material: Carbon steel with epoxy copper or zinc finish.

M. Pipe Hangers:
1. Hangers:
   a. Provide hinged split ring and yoke roller hanger with zinc finish.
   b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
   c. Provide hanger rod and nuts of the same type and material for a given pipe run.
   d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
2. Clevis Hangers, Adjustable:
   a. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
3. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
4. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

N. Pipe Alignment Guides: Galvanized steel.
1. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.

O. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

P. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
   a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
   b. Shields Material: UV-resistant polypropylene with glass fill.
   c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
   d. Minimum Service Temperature: Minus 40 degrees F.
   e. Maximum Service Temperature: 178 degrees F.
   f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

Q. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
   2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   4. Hollow Masonry: Use toggle bolts.
   5. Hollow Stud Walls: Use toggle bolts.
   6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   7. Plastic and lead anchors are not permitted.
   8. Powder-actuated fasteners are not permitted.
   9. Hammer-driven anchors and fasteners are not permitted.
   10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
      a. Comply with MFMA-4.
      b. Channel Material: Use galvanized steel.
      c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
   11. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Unless specifically indicated or approved by Architect/ Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect/ Engineer, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Engineer.

G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

H. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Section 03 3000.
   5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

J. Secure fasteners according to manufacturer's recommended torque settings.

K. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Automatic Controls: Tags. Key to control schematic.

C. Control Panels: Nameplates.

D. Dampers: Ceiling tacks, where located above lay-in ceiling.

E. Heat Transfer Equipment: Nameplates.

F. Instrumentation: Tags.

G. Major Control Components: Nameplates.

H. Piping: Pipe markers.

I. Relays: Tags.

J. Small-sized Equipment: Tags.

K. Thermostats: Nameplates.

L. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Letter Color: White.

B. Letter Height: 1/4 inch.

C. Background Color: Black.

D. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame for valves added by project. Mount adjacent to original valve chart.

2.04 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Color code as follows:
   1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

D. Use tags on piping 3/4 inch diameter and smaller.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

E. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic systems.

C. Measurement of final operating condition of HVAC systems.

1.02 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.

B. AABC MN-1 - AABC National Standards for Total System Balance; 2002.

C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and job/ system specific approach for each system and component.
   1. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   2. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Engineer and other installers to sufficiently understand the design intent for each system.
   3. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Detailed step-by-step procedures for TAB work for each system and issue, including:
         1) Terminal flow calibration (for each terminal type).
         2) Diffuser proportioning.
         3) Branch/submain proportioning.
         4) Total flow calculations.
         5) Rechecking.
         6) Diversity issues.
      f. Details of how TOTAL flow will be determined; for example:
         1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
         2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
      g. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
      h. Confirmation of understanding of the outside air ventilation criteria under all conditions.
      i. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
      j. Method of checking building static and exhaust fan and/or relief damper capacity.

k. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
l. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
1. Revise TAB plan to reflect actual procedures and submit as part of final report.
2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/ Engineer and for inclusion in operating and maintenance manuals.
3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
7. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
8. Include the following on the title page of each report:
a. Name of Testing, Adjusting, and Balancing Agency.
b. Address of Testing, Adjusting, and Balancing Agency.
c. Telephone number of Testing, Adjusting, and Balancing Agency.
d. Project name.
e. Project location.
f. Project Engineer.
g. Project Contractor (Vendor).
h. Report date.
9. Proivde paper and digital copies of the final TAB report, bindinto O&M Manual.

E. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC (NSTSB), AABC National Standards for Total System Balance.
2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. SMACNA (TAB).

B. Profile air and CW/HW water performance of AHUs/RTU to be modified in the project prior to the start of any work on the project. Profile and record the same data that will be recorded at final TAB. Report the results to the Engineer in a neat, legible format upon completion of the TAB.

C. Measure each pump both at the operating condition and at the max flow condition. Report the results to the Engineer in a neat, legible format upon completion of the TAB.

D. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

E. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

F. TAB Agency Qualifications:
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of ten years documented experience.
   3. Certified by one of the following:
      a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
      b. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

G. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

H. Pre-Qualified TAB Agencies:
   1. HABCO. Gordon Harvey 304-687-4598
   2. Northstar Environmental. John Raught 724-775-2122
   3. Performance HVAC. John Husband 304-248-7222

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
   1. Systems are started and operating in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fans are rotating correctly.
   7. Fire and volume dampers are in place and open.
   8. Air coil fins are cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage is minimized.
   12. Hydronic systems are flushed, filled, and vented.
   13. Pumps are rotating correctly.
   14. Proper strainer baskets are clean and in place.
   15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. All TAB activities are to be scheduled with the Owner and Engineer one week prior to beginning TAB. All TAB work to be performed in the presence of Engineer. Any work without witness, will be subject to being performed again at the discretion of the Engineer, at no cost to the project.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

D. Immediately inform the Engineer, while on site, of any out of range systems or components so that the situation can be fully understood in real time.

3.05 RECORDING AND ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

C. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.

F. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

H. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.

I. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.

J. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings; 2014.

K. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers; 2015.

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

M. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

N. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.

O. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 1,200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

E. Outdoor Vapor Barrier Mastic:
   1. Manufacturers:
      a. Substitutions: See Section 01 6000 - Product Requirements.
   2. Vinyl emulsion type acrylic or mastic, compatible with insulation, white color.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
   1. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent.
   4. Maximum Density: 8.0 pcf.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

E. Indoor Vapor Barrier Finish:

1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
   1. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
   1. Manufacturers:
      a. Substitutions: See Section 01 6000 - Product Requirements.

D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.05 JACKETING AND ACCESSORIES

A. Aluminum Jacket:
   1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
   2. Manufacturer:
      a. Alumaguard: www.polyguardproducts.com.
   3. Thickness: 0.016 inch sheet.
   4. Finish: Smooth.
   5. Joining: Longitudinal slip joints and 2 inch laps.
   6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
   7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

B. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
   1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
   2. Thickness: 34 mil, 0.034 inch.
   3. Finish: Embossed.
   4. Color: Silver.
   5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
   6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
   7. Emissivity: 0.30 when tested in accordance with ASTM C1371.

2.06 DUCT LINER

A. Manufacturers:
   1. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 180 degrees F.
   3. Fungal Resistance: No growth when tested according to ASTM G21.
   4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
   5. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm when tested in accordance with ASTM C1071.
   6. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulated Ducts Conveying Air Below Ambient Temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated Ducts Conveying Air Above Ambient Temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with aluminum jacket.

F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with flexible jacketing specified above.

G. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Secure insulation without vapor barrier with staples, tape, or wires.
   3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
   4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3.03 SCHEDULES

A. All insulation type and thickness to be installed in compliance with IECC 2012 and ASHRAE 2010.

B. Combustion Air Duct: Rigid Glass Fiber, 1-1/2 inches thick.

C. Exhaust Ducts Within 10 ft of Exterior Openings: Rigid Glass Fiber; 1-1/2 inches thick.

D. Exhaust Ducts Exposed to Outdoor Air: Rigid Glass Fiber w/ Aluminum Jacket; 1-1/2 inches thick.

E. Outside Air Intake Ducts: Rigid Glass Fiber; 1-1/2 inches thick.

F. Supply Ducts: Rigid Glass Fiber; 1-1/2 inches thick.

G. Flexible duct take-offs to air terminals: Flexible Glass Fiber; 1-1/2 inches thick.

H. Ducts Exposed to Outdoors: Rigid Glass Fiber w/ Aluminum Jacket; 1-1/2 inches thick.

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jacketing and accessories.

1.02 REFERENCE STANDARDS

A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.

E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.

F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2019.

G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.

H. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than ten years of documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum ten years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturers:
   1. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 250 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive vapor barrier tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film with pressure-sensitive rubber-based adhesive.

2.03 GLASS FIBER, RIGID

A. Manufacturers:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville Corporation; _____: www.jm.com/#sle.
   3. Knauf Insulation: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. K Value: ASTM C177, 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

E. Fittings: premade or field fabricated from oversize pipe insulation. NO flexible faced insulation may be used on fittings.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.
   1. Compatible with insulation.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

H. Indoor Vapor Barrier Finish:
   1. Vinyl emulsion type acrylic, compatible with insulation, white color.

I. Outdoor: Alumigard Flexible wrap, white. Double manufacturer's recommended end lap.

2.04 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

A. Manufacturers:

1. Auburn Manufacturing Inc; Ever Green Cut 'n Wrap: www.auburnmfg.com/#sle.
2. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C553 Type V; flexible, noncombustible.
1. K Value: 0.37 at 100 degrees F, when tested in accordance with ASTM C177 or ASTM C518.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT): www.aeroflexusa.com/#sle.
2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Buried Chilled Water/ Glycol and Hot Water/ Glycol. Overwrap with Alumigard white. Transition to fiberglass, where permissible at least 18 inches above grade.

2.06 JACKETING AND ACCESSORIES

A. PVC Plastic.
1. Jacket: One piece molded type fitting covers and sheet material, off-white color. EPxosed interior pipiing and all fittings.
a. Minimum Service Temperature: 0 degrees F.
b. Maximum Service Temperature: 150 degrees F.
c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
d. Thickness: 10 mil, 0.010 inch.
e. Connections: Brush on welding adhesive.
2. Covering Adhesive Mastic: Compatible with insulation.
a. Compatible with insulation.

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
1. Alumagard - Exterior piping over 1-1/2" closed cell rubber foam.
a. Thickness: 0.016 inch sheet.
b. Finish: Smooth.
c. Joining: Longitudinal slip joints and 2 inch laps.
d. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Match existing insulation thicknesses for all types.

C. Install in accordance with NAIMA National Insulation Standards.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

F. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

G. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

H. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

I. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

J. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

K. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

M. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

A. All hydronic piping to be insulated in accordance with IECC 2012 and ASHRAE 2010.

B. Match existing insulation thicknesses for all types.

C. Insulate hot water and hot water recirculating piping with the following minimum type and thickness of insulaton for circulating mains and runouts:

D.	Pipe Size	100-140 (deg F)	141-200 (deg F)
E.	Up to 1-1/4"	3/4"	1"
F.	1-1/2" to 2"	1"	1-1/2"
G.	2" and up	1-1/2"	2"

H. Insulate chilled cold water piping with the following minimum type and thickness of insulation for circulating mains and runouts:

I.	Pipe Size	Cold Water
J.	Up to 1-1/4"	3/4"

K. 1-1/2" and up 1-1/2"

END OF SECTION

SECTION 23 0913

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Control Valves:
   1. Ball valves and actuators.
   2. Electronic operators.

B. Dampers.

C. Damper Operators:
   1. Pneumatic operators.
   2. Electric operators.
   3. Inlet vane operators.

D. Humidistats:
   1. Room humidistats.

E. Input/Output Sensors:
   1. Temperature sensors.
   2. Humidity sensors.
   3. Static pressure (air pressure) sensors.
   4. Equipment operation (current) sensors.
   5. Damper position indicators.
   6. Carbon dioxide sensors.

F. Thermostats:
   1. Electric room thermostats.
   2. Room thermostat accessories.
   3. Airstream thermostats.

G. Transmitters:
   1. Building static pressure transmitters.
   2. Pressure transmitters.
   3. Air pressure transmitters.
   4. Water pressure transmitters (liquid differential pressure transmitters).
   5. Temperature transmitters.
   6. Humidity transmitters.

1.02 REFERENCE STANDARDS

A. ANSI/FCI 70-2 - Control Valve Seat Leakage; 2013.

B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.

C. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013-08, with 2015 Corrigendum.

D. IEEE 802.3 - IEEE Standard for Ethernet; 2018 (Amended 2021).

E. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications ; 2016, with Errata (2017).

F. Modbus (PS) - The Modbus Organization Communications Protocol; Latest Update.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. ODVA (CIP) - The Common Industrial Protocol (CIP) Standards: EtherNet/IP, DeviceNet, ControlNet, and CompoNet; Current Edition.

I. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Manufacturer's Instructions: Provide for all manufactured components.

E. Designer's qualification statement.

F. Manufacturer's qualification statement.

G. Installer's qualification statement.

H. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

I. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.

J. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum ten years experience approved by manufacturer.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective work within a five year period after Substantial Completion.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Existing Products: Existing Trane Front End system is online and access will be made available for qualified personnel to integrate new controls systems into the front end for seemless full operability BACNET integration w/o the use of black boxes or translator programs. Front end is Trane Ensemble.

2.02 MANUFACTURERS

A. Trane.

B. Substitutions: See Section 01 6000 - Product Requirements.

2.03 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.04 CONTROL VALVES

A. Ball Valves and Actuators:
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   2. Service: Use for chilled water.
   3. Flow Characteristic: Include 2-way and 3-way mixing operation configured to fail normally open for heating and normally closed for cooling.
   4. Replacements in Kind: Provide pressure-independent type.
   5. Rangeability: 500 to 1.
   6. ANSI Rating: Class 150.
   7. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
   8. Body Size:
      a. Under 2-1/2 inches:
         1) Connection: NPT.
         2) Materials:
            (a) Body: Brass.
            (b) Flanges: Ductile iron.
            (c) Ball: 300 series stainless steel.
            (d) Stem: 300 series stainless steel.
            (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
            (f) Stem Seal: EPDM O-Rings.
            (g) Flow Control Disk: Thermoplastic synthetic-resin.
      b. 2-1/2 inches and Above:
         1) Connection Type: Flanged.
         2) Materials:
            (a) Body: Brass.
            (b) Flanges: Ductile iron.
            (c) Ball: 300 series stainless steel.
            (d) Stem: 300 series stainless steel.
            (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
            (f) Stem Seal: EPDM O-Rings.
            (g) Flow Control Disk: Thermoplastic synthetic-resin.
      c. Service Temperature:
         1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
         2) Ambient Side: From minus 4 to 122 degrees F.
   9. Actuator Requirements:
      a. Assembly: Factory-mounted.
      b. Input: 0 to 10 VDC configured for proportional control.
      c. Accessories: Provide with valve position indicator and manual override.

B. Butterfly Pattern:
   1. Manufacturers:
      a. Belimo.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   2. Iron body, stainless steel disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
   3. Hydronic Systems:
      a. Size for 1 psig maximum pressure drop at design flow rate.

C. Electronic Operators:
   1. Manufacturers:
      a. Belimo.
   2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
   3. Select operator for full shut off at maximum pump differential pressure.

2.05 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
   1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
   2. Provide one operator for maximum 36 sq ft damper section.

B. Electric Operators:
   1. Manufacturers:
      a. Belimo.
   2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.06 HUMIDISTATS

A. Room Humidistats:
   1. Wall mounted, proportioning type.
   2. Throttling Range: Adjustable 2 percent relative humidity.
   3. Operating Range: 30 to 80 percent.
   4. Maximum Temperature: 110 degrees F.
   5. Cover: blank face sensor only.

2.07 INPUT/OUTPUT SENSORS

A. Temperature Sensors:
   1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
   2. Temperature Sensing Device, thermistor or RTD: Compatible with project DDC controllers.
   3. Performance Characteristics:
      a. RTD:
         1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
         2) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
         3) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
         4) Range: Minus 40 degrees F through 220 degrees F minimum.
      b. Thermistor:
         1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
         2) Range: Minus 25 degrees F through 122 degrees F minimum.
      c. Temperature Transmitter:
         1) Output: 0 - 10 vdc.
      d. Sensing Range:
         1) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
         2) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
      e. Wire Resistance:
         1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.

f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.

h. Room Temperature Sensors:

1) Construct for surface or wall box mounting.

2) Provide the following:

(a) Setpoint reset slide or rotaary switch with an adjustable temperature range, no markings on setpoint.

(b) Individual heating/cooling setpoint slide switches.

(c) Momentary override request push button for activation of after-hours operation.

(d) NO local display,

B. Humidity Sensors:

1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.

a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.

b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.

c. Output Voltage Type: 3-wire observed polarity.

d. Output mA Type: 2-wire, not polarity sensitive (clipped and capped).

e. Humidity:

1) HS Element: Digitally profiled thin-film capacitive.

2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.

(a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi-point calibration, NIST traceable).

3) Scaling: 0 to 100 percent RH.

f. Temperature Effect:

1) Duct Mounted: Plus/minus 0.18 percent per degree F.

2) Outdoor Mounted: 0 to 5 V/0 to10V versions: (0015x%RHx(TdegreeC-25))-(%RHx0.0008xabs(TdegreeC-25)).

g. Hysteresis: 1.5 percent typical.

h. Linearity: Included in accuracy specification.

i. Reset Rate: 24 hours.

j. Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.

k. Temperature Monitoring:

1) Temperature Transmitter Output: 0-5V/0-10V output.

l. Operating Environment:

1) Operating Humidity Range: 0 to 100 percent RH noncondensing.

2) Operating Temperature Range: Minus 40 degrees F to 122 degrees F.

C. Static Pressure (Air Pressure) Sensors:

1. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.

2. Accuracy: One percent of full scale with repeatability 0.3 percent.

3. Output: 0 to 5 vdc with power at 12 to 28 vdc.

D. Equipment Operation (Current) Sensors:

1. Manufacturers:

2. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.

3. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.

4. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

E. Carbon Dioxide Sensors, Duct and Wall:
   1. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers and linear output.
   2. Air Temperature: Range of 32 to 122 degrees F.
   3. Relative Humidity: Range of 0 to 95 percent (non-condensing).
   4. Power Input: Class 2; 12 to 30VDC or 24VAC 50/60 Hz; 100mA max.
   5. Calibration Characteristics:
      a. Automatically compensating algorithm for sensor drift due to sensor degradation.
      b. Maximum Drift: 2 percent.
      c. User calibratable with a minimum calibration interval of 5 years.
   6. Construction:
      a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
      b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
      c. Housing: High impact plastic.

2.08 TRANSMITTERS

A. Building Static Pressure Transmitters:
   1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.

B. Pressure Transmitters:
   1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

C. Air Pressure Transmitters:
   1. General: Provide dry media differential pressure transducers to monitor duct and room pressure.
      a. Media Compatibility: Dry air.
      b. Input Power: Class 2; 24 VAC nominal; 3-wire: 30 mA max.
      c. Output: Field selectable, 3-wire 0 to 5 V/0 to 10V.
      d. Pressure Ranges: 4 and 7, field selectable.
      e. Response Time:
         1) Standard: T95 in 20 seconds.
         2) Fast: T95 in 2 seconds.
         3) Switch selectable.
      f. Mode: Switch selectable, unidirectional.
      g. Proof Pressure (pressure differential): 3 psid.
      h. Burst Pressure (pressure differential): 5 psid.
      i. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
      j. Temperature Effect (per transmitter size):
         1) 1 inch w.c.: 2.0 percent per degree C.
         2) 10 inch w.c.: 0.01 percent per degree C; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
      k. Zero Drift (1-year) (per transmitter size):
         1) 1 inch w.c.: 2 percent maximum.
         2) 10 inch: 0.05 percent maximum.
      l. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).
      m. Operating Environment:
         1) 32 degrees F to 140 degrees F.
         2) 0 to 90 percent RH noncondensing.
      n. Fittings:
         1) Brass barb.
         2) 0.24 inches outer diameter.

D. Water Pressure Transmitters (Liquid Differential Pressure Transmitters):
   1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow remote pressure sensing capability using existing plumbing runs.
      a. Input Power: Class 2; 15 to 30 VDC, 24VAC nominal, 50/60 Hz.
      b. Output: 3-wire transmitter; user-selectable, 4 to 20 mA (0 to 5V/0 to 10V).
      c. Sensor:
         1) Media Compatibility: 17 to 4 PH stainless steel.
         2) Proof Pressure: 2x max. F.S. range.
         3) Burst Pressure: 5x max. F.S. range.
      d. Pressure Ranges:
         1) 0 psi to 250 psi (Gauge): 25 psid/50 psid/125 psid/250 psid (pressure differential).
      e. Operating Conditions:
         1) Temperature Compensated Range:
            (a) 32 degrees F.
            (b) TC Zero less than 1.5 percent of product F.S. (full scale) per sensor.
         2) Sensor Operating Range: Minus 4 degrees F to 185 degrees F.
         3) Operating Environment: 14 degrees F to 122 degrees F; 10 to 90 percent RH noncondensing.
      f. Enclosure: NEMA 250, Type 4.

E. Temperature Transmitters:
   1. Manufacturers:
      a. Substitutions: See Section 01 6000 - Product Requirements.
   2. One pipe, directly proportional output signal to measured variable, linearity within plus or minus 1/2 percent of range for 200 degrees F span and plus or minus 1 percent for 50 degrees F span, with 50 degrees F. temperature range, compensated bulb, averaging capillary, or rod and tube operation on 20 psig input pressure and 3 to 15 psig output.

2.09 WCN SENSORS (AS PART OF ALTERNATE #1)

A. Temperature Sensor - Trane Wireless Zone Sensor (WSZ), or approved equal.

B. Carbon Dioxide (CO2) Sensor - Trane CO2 Zone Sensor, or approved equal.

C. Combination Temperature and Humidity Sensors - Trane Combination Zone Sensor, or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as pumps, fans, piping, air handling units, and air terminal units.

F. Ensure installation of components is complementary to installation of similar components.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide separable sockets for liquids and flanges for air bulb elements.

C. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

D. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment

room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

E. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

F. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical materials and installation shall be in accordance with appropriate requirements of NFPA 70.

3.03 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

D. In addition to normal service calls, make minimum of eight complete normal inspections of approximately 5 hours duration to inspect, calibrate, and adjust control. Document in detail and report condition, findings, repairs, and changes in writing to the Owner and Engineer.

END OF SECTION

SECTION 23 0923

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System description.

B. Operator interface.

C. Controllers.

D. Power supplies and line filtering.

E. System software.

F. Controller software.

G. HVAC control programs.

H. Chiller control programs.

1.02 RELATED REQUIREMENTS

A. Section 23 0913 - Instrumentation and Control Devices for HVAC.

B. Section 23 0993 - Sequence of Operations for HVAC Controls.

C. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.

B. CTA-709.1 - Control Network Protocol Specification; Revision D, 2014.

C. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications ; 2016, with Errata (2017).

D. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2015.

E. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; Revision G, 2014.

F. Modbus (PS) - The Modbus Organization Communications Protocol; Latest Update.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least two weeks prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:
   1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List connected data points, including connected control unit and input device.
   3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.

4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Indicate description and sequence of operation of operating, user, and application software. Submit a sequence of operations, for review and acceptance, which does not "parrot" the sequence found in the project documents and reflects the Vendors understanding of the project sequence requirements.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Designer's Qualification Statement.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

H. For wireless control devices to be utilized on the project (under Alternate 1), provide submittals with output from a computer model simulation of building layout with all devices, for review and acceptance by the Engineer. Provide network layout drawings over the building floorplan showing the mesh network hop paths for the devices.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
2. Include submittals data in final "Record Documents" form.

J. Operation and Maintenance Data:
1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

K. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

L. Maintenance Materials:
1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum ten years of documented experience.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Existing Products: Existing Trane Ensemble BAS front end system. Access will be provided to fully integarate the new systems into the front end, as part of this contract, for full BACNET operability. No black boxes or translator programs may be used to accomplish this requirement. The existing Andover system in building will be totally replaced, including a controll buss wiring, and the new system will fully integrate into the Trane Ensemble system.

2.02 MANUFACTURERS

A. Trane.

B. Substitutions: See Section 01 6000 - Product Requirements.

2.03 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 0913.

E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

G. The control system architecture may be a hybrid of wired control buss utilizing wireless sensors. Each floor of the building will have a minimum of two busses per floor, one for each half of the building with a common vertical dividing plane on all floors. The buss risers will extend back to the main BC and will not be spliced. The ground floor mechanical room and the rooftop mounted equipment will have a buss dedicated to ground floor AHU's, pumps, boilers, and the chiller.

H. The control buss wiring will be daisy chained point to point with no splices between devices. Buss wiring will extend directly up to the deck above and attach in hoop supports to the building structure. The buss must me run parallel and perpendicular to the walls. Precise record drawings of the installation will be prepared for review. Buss cabling will be foil shield plenum rated cable above ceilings and in conduit where exposed. Each individual buss run will bear a unique, readily legible, label on each end, within 6 inches of entering the device it serves. The buss wiring in the building will be a single unique color to be determined.

2.04 OPERATOR INTERFACE

A. Remote access, controllers, and control backbone to communicate using BACnet protocol and addressing via a Web interface.

B. Web based via the Owner's central Ensemble server.

C. BACnet protocol to comply with ASHRAE Std 135.
   1. Full operability and monitoring.

2.05 CONTROLLERS

A. Building Controllers:
   1. General:
      a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
      b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
      c. Share data between networked controllers.
      d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
      e. Utilize real-time clock for scheduling.

f. Continuously check processor status and memory circuits for abnormal operation.
g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
h. Communication with other network devices to be based on assigned protocol.

2. Communication:
   a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
   b. Perform routing when connected to a network of custom application and application specific controllers.
   c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.
4. Local Keypad and Display for each Controller:
   a. Use for interrogating and editing data.
   b. System security password prevents unauthorized use.
5. Provisions for Serviceability:
   a. Diagnostic LEDs for power, communication, and processor.
   b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
7. Power and Noise Immunity:
   a. Maintain operation at 90 to 110 percent of nominal voltage rating.
   b. Perform orderly shutdown below 80 percent of nominal voltage.
   c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. Custom Application Controller:
1. General:
   a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
   b. Share data between networked, microprocessor based controllers.
   c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
   d. Utilize real-time clock for scheduling.
   e. Continuously check processor status and memory circuits for abnormal operation.
   f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
   g. Communication with other network devices to be based on assigned protocol.
2. Communication:
   a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
   b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.

b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller: (not used on terminal devices or unitary devices with unit level BAS controller with display)
a. Use for interrogating and editing data.
b. System security password prevents unauthorized use.

5. Provisions for Serviceability:
a. Diagnostic LED's for power, communication, and processor.
b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

7. Power and Noise Immunity:
a. Maintain operation at 90 to 110 percent of nominal voltage rating.
b. Perform orderly shutdown below 80 percent of nominal voltage.
c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. Application Specific Controllers:
1. General:
a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
b. Customized for operation within the confines of equipment served.
c. Communication with other network devices to be based on assigned protocol.

2. Communication:
a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:
a. Outdoors and/or in Wet Ambient Conditions:
1) Mount within waterproof enclosures.
2) Rated for operation at 40 to 150 degrees F.
b. Conditioned Space:
1) Mount within dustproof enclosures.
2) Rated for operation at 32 to 120 degrees F.

4. Local Keypad and Display for each Controller:
a. Use for interrogating and editing data.
b. System security password prevents unauthorized use.

5. Provisions for Serviceability:
a. Diagnostic LEDs for power, communication, and processor.
b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

7. Power and Noise Immunity:
a. Maintain operation at 90 to 110 percent of nominal voltage rating.
b. Perform orderly shutdown below 80 percent of nominal voltage.
c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

D. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.

2. All Input/Output Points:

a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.
   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
      1) VAV terminal units.
      2) Zone dampers.
   c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.06 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
   1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
   2. Limit connected loads to 80 percent of rated capacity.
   3. Match DC power supply to current output and voltage requirements.
   4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
   5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.

6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all controllers.
2. Minimum surge protection attributes:
a. Dielectric strength of 1000 volts minimum.
b. Response time of 10 nanoseconds or less.
c. Transverse mode noise attenuation of 65 dB or greater.
d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

C. Uninterruptible Power Supply (UPS)
1. Provide an uninterruptiuble power supply (UPS) for each control panel and the System PC to permit operationf for a minimum of four hours.

2.07 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 19.2 Kb.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.08 WIRELESS CONTROL NETWORK (WCN)

A. Provide a wireless ("wifi") control network (WCN) meeting the requirements found herein.

B. The WCN portion of the BAS system will be used for sensing building parameters such as: temperature, humidity, CO2, pressure etc., as are available from the manufacturer's published catalog.

C. The WCN will incoporate the following:
1. A mesh topology consisting of
a. At least two Personal Area Network (PAN) Devices per floor.
b. Sufficient density to ensure system reliability, as determined by the Engineer during the project and warranty period.
c. Provide a fully planned and verified mesh layout.
d. Dynamic re-routing or self-healing in the event of device failure/orphanage.
e. At least two neighboring nodes or Full-Function Devices (FFDs) to ensure 2 alternate pathways for all end devices or Reduced-Function Devices (RFDs).
2. Data security ensured by AES-128 encryption or other industry standard encryption meeting the requirements of IEEE 802.15.4.
3. A submitted simulation of building layout with all devices prior to installation.
4. A submitted verification of wireless pathways, density, and self-healing post installation.
5. Device lifespan of 2 years, at a minimum with replaceable AA batteries.
6. No interference with the existing WIFI or cell services throughout the building.

7. Design basis is to be the Zigbee specification of IEEE 802.15.4.

D. Provide a fully planned and verified mesh layout in the form of:
   1. A digital simulation of all device connections prior to system installation
   2. A verification of the above layout post installation

2.09 SYSTEM SOFTWARE

A. Operating System:
   1. Concurrent, multi-tasking capability.
      a. Common Software Applications Supported: Microsoft Excel.
      b. Acceptable Operating Systems: Windows 11.
   2. System Graphics:
      a. Allow up to 20 graphic screens, simultaneously displayed for comparison and monitoring of system status.
      b. Animation displayed by shifting image files based on object status.
      c. Provide method for operator with password to perform the following:
         1) Move between, change size, and change location of graphic displays.
         2) Modify on-line.
         3) Add, delete, or change dynamic objects consisting of:
            (a) Analog and binary values.
            (b) Dynamic text.
            (c) Static text.
            (d) Animation files.
   3. Custom Graphics Generation Package:
      a. Create, modify, and save graphic files and visio format graphics in PCX formats.
      b. HTML graphics to support web browser compatible formats.
      c. Capture or convert graphics from AutoCAD.
   4. Standard HVAC Graphics Library:
      a. HVAC Equipment:
         1) Chillers.
         2) Boilers.
         3) Air Handlers.
         4) Terminal HVAC Units.
         5) Fan Coil Units.
      b. Ancillary Equipment:
         1) Fans.
         2) Pumps.
         3) Coils.
         4) Valves.
         5) Piping.
         6) Dampers.
         7) Ductwork.
         8) All ancillary as existing in the building.
      c. File Format Compatible with Graphics Generation Package Program.

B. Interface System Applications:
   1. Automatic System Database Save and Restore Functions:
      a. Current database copy of each Building Controller is automatically stored on hard disk.
      b. Automatic update occurs upon change in any system panel.
      c. In the event of database loss in any system panel, the first device to detect the loss automatically restores the database for that panel unless disabled by the operator.
   2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
      a. Save database from any system panel.
      b. Clear a panel database.

c. Initiate a download of a specified database to any system panel.

3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
   a. Context-sensitive system assists operator in operation and editing.
   b. Available for all applications.
   c. Relevant screen data provided for particular screen display.
   d. Additional help available via hypertext.
5. Security:
   a. Operator log-on requires user name and password to view, edit, add, or delete data.
   b. System security selectable for each operator.
   c. System supervisor sets passwords and security levels for all other operators.
   d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
   e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
   f. All system security data stored in encrypted format.
6. System Diagnostics:
   a. Operations Automatically Monitored:
      1) Modems.
      2) Network connections.
      3) Building management panels.
      4) Controllers.
   b. Device failure is annunciated to the operator.
7. Alarm Processing:
   a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
   b. Configurable Objects:
      1) Alarm limits.
      2) Alarm limit differentials.
      3) States.
      4) Reactions for each object.
8. Alarm Messages:
   a. Descriptor: English language.
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.
9. Configurable Alarm Reactions by interface and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
   e. Dialing out to remote locations.
   f. Paging.
   g. Providing audible annunciation.
   h. Displaying specific system graphics.
10. Custom Trend Logs:
    a. Definable for any data object in the system including interval, start time, and stop time.
    b. Trend Data:
       1) Sampled and stored on the building controller panel.
       2) Archivable on hard disk.
       3) Retrievable for use in reports, spreadsheets and standard database programs.

4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
    a. View all system alarms and change of states from any system location.
    b. Events listed chronologically.
    c. Operator with proper security acknowledges and clears alarms.
    d. Alarms not cleared by operator are archived to the Ensemble system.
12. Object, Property Status and Control:
    a. Provide a method to view, edit if applicable, the status of any object and property in the system.
    b. Status Available by the Following Methods:
        1) Menu.
        2) Graphics.
        3) Custom Programs.
13. Reports and Logs:
    a. Reporting Package:
        1) Allows operator to select, modify, or create reports.
        2) Definable as to data content, format, interval, and date.
        3) Archivable to hard disk.
    b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
    c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
    d. Set to be printed on operator command or specific time(s).
14. Reports:
    a. Standard:
        1) Objects with current values.
        2) Current alarms not locked out.
        3) Disabled and overridden objects, points and SNVTs.
        4) Objects in manual or automatic alarm lockout.
        5) Objects in alarm lockout currently in alarm.
        6) Logs:
            (a) Alarm History.
            (b) System messages.
            (c) System events.
            (d) Trends.
    b. Custom:
        1) Daily.
        2) Weekly.
        3) Monthly.
        4) Annual.
        5) Time and date stamped.
        6) Title.
        7) Facility name.
    c. Tenant Override:
        1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
        2) Annual report showing override usage on a monthly basis.
    d. Electrical, Fuel, and Weather:
        1) Electrical Meter(s):
            (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

(b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):
   (a) Monthly showing daily natural gas consumption for each meter.
   (b) Annual summary showing monthly consumption for each meter.
3) Weather:
   (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

e. Daily Operating Condition of Chiller(s) Based on ASHRAE Std 147:
   1) Chilled water inlet and outlet temperature by BAS sensor seperate from chiller.
   2) Chilled water flow by BAS flow meter seperate from chiller.
   3) Chilled water inlet and outlet pressure by pressure transducers seperate from chiller.
   4) Evaporator refrigerant pressure and temperature.
   5) Condenser refrigerant pressure and temperature.
   6) Condenser refrigerant pressure and liquid temperature.
   7) Condenser water flow.
   8) Refrigerant levels.
   9) Oil pressure and temperature.
   10) Oil level.
   11) Compressor refrigerant discharge temperature.
   12) Refrigerant suction temperature.
   13) Addition of refrigerant.
   14) Motor amperes per phase.
   15) Motor volts per phase.
   16) Ambient temperature (dry-bulb and wet-bulb).
   17) Date and time logged.

C. Interface Applications Editors:
   1. Provide editing software for each system application.
   2. Downloaded application is executed at controller panel.
   3. Full screen editor for each application allows operator to view and change:
      a. Configuration.
      b. Name.
      c. Control parameters.
      d. Set-points.
   4. Scheduling:
      a. Monthly calendar indicates schedules, holidays, and exceptions.
      b. Allows several related objects to be scheduled and copied to other objects or dates.
      c. Start and stop times adjustable from master schedule.
   5. Custom Application Programming:
      a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
      b. Programming Features:
         1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
         2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
         3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
         4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
         5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.10 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs in the interface.

B. System Security:
1. User access secured via user passwords and user names.
2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts are recorded.
4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
5. Provide Owner and Engineer each with username and password for the highest existing level of programming authority for entire system and do not delete them. this is a project requirement.

C. Object or Object Group Scheduling:
1. Weekly Schedules Based on Separate, Daily Schedules:
a. Include start, stop, optimal stop, and night economizer.
b. 10 events maximum per schedule.
c. Start/stop times adjustable for each group object.
2. Exception Schedules:
a. Based on any day of the year.
b. Defined up to one year in advance.
c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
3. Holiday or Special Schedules:
a. Capability to define up to 99 schedules.
b. Repeated annually.
c. Length of each period is operator defined.

D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

E. Alarms:
1. Binary object is set to alarm based on the operator specified state.
2. Analog object to have high/low alarm limits.
3. All alarming is capable of being automatically and manually disabled.
4. Alarm Reporting:
a. Operator determines action to be taken for alarm event.
b. Reporting Options:
1) Start programs.
2) Print.
3) Logged.
4) Custom messaging.
5) Graphical displays.

F. Demand Limiting:
   1. Building power consumption monitored from signals generated by a pulse generator, mounted at the building power meter.
   2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
   3. Demand Reduction Methods:
      a. Supply air temperature reset.
      b. Space temperature set-point reset.
      c. Equipment off/on prioritization.
   4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
   5. Operator On-Line Changes Allowed:
      a. Addition and deletion of loads controlled.
      b. Changes in demand intervals.
      c. Changes in demand limit for meter(s).
      d. Maximum equipment shutoff time.
      e. Minimum equipment shutoff time.
      f. Select rotational or sequential shedding and restoring.
      g. Shed/restore priority.
   6. Information and Reports available Hourly, Daily, and Monthly:
      a. Total electric consumption.
      b. Peak demand.
      c. Date and time of peak demand.
      d. Daily peak demand.

G. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

H. Sequencing: Application software based upon specified sequences of operation in Section 23 0993.

I. PID Control Characteristics:
   1. Direct or reverse action.
   2. Anti-windup.
   3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
   4. User selectable controlled variable, set-point, and PED gains.

J. Staggered Start Application:
   1. Prevents all controlled equipment from simultaneously restarting after power outage.
   2. Order of equipment startup is user selectable.

K. Energy Calculations:
   1. Accumulated instantaneous power or flow rates are converted to energy use data.
   2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
   3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

L. Anti-Short Cycling:
   1. All binary output objects protected from short-cycling.
   2. Allows minimum on-time and off-time to be selected.

M. On-Off Control with Differential:
   1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
   2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

N. Run-Time Totalization:
   1. Totalize run-times for all binary input objects.
   2. Provides operator with capability to assign high run-time alarm.

2.11 HVAC CONTROL PROGRAMS

A. General:
   1. Support Inch-pounds and SI (metric) units of measurement.
   2. Identify each HVAC Control system.

B. Optimal Run Time:
   1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
   2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
   3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
   4. Use outside air temperature to determine early shut down with ventilation override.
   5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
   6. Operator commands:
      a. Define term schedule.
      b. Add/delete fan status point.
      c. Add/delete outside air temperature point.
      d. Add/delete mass temperature point.
      e. Define heating/cooling parameters.
      f. Define mass sensor heating/cooling parameters.
      g. Lock/unlock program.
      h. Request optimal run time control summary.
      i. Request optimal run time mass temperature summary.
      j. Request HVAC point summary.
      k. Request HVAC saving profile summary.
   7. Control Summary:
      a. HVAC Control system begin/end status.
      b. Optimal run time lock/unlock control status.
      c. Heating/cooling mode status.
      d. Optimal run time schedule.
      e. Start/Stop times.
      f. Selected mass temperature point ID.
      g. Optimal run time system normal start times.
      h. Occupancy and vacancy times.
      i. Optimal run time system heating/cooling mode parameters.
   8. Mass temperature summary:
      a. Mass temperature point type and ID.
      b. Desired and current mass temperature values.
      c. Calculated warm-up/cool-down time for each mass temperature.
      d. Heating/cooling season limits.
      e. Break point temperature for cooling mode analysis.
   9. HVAC point summary:
      a. Control system identifier and status.
      b. Point ID and status.
      c. Outside air temperature point ID and status.
      d. Mass temperature point ID and point.
      e. Calculated optimal start and stop times.
      f. Period start.

C. Supply Air Reset:
   1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.

2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
    a. Raising cooling temperatures to highest possible value.
    b. Reducing heating temperatures to lowest possible level.
3. Operator commands:
    a. Add/delete fan status point.
    b. Lock/unlock program.
    c. Request HVAC point summary.
    d. Add/Delete discharge controller point.
    e. Define discharge controller parameters.
    f. Add/delete air flow rate.
    g. Define space load and load parameters.
    h. Request space load summary.
4. Control summary:
    a. HVAC control system status (begin/end).
    b. Supply air reset system status.
    c. Optimal run time system status.
    d. Heating and cooling loop.
    e. High/low limits.
    f. Deadband.
    g. Response timer.
    h. Reset times.
5. Space load summary:
    a. HVAC system status.
    b. Optimal run time status.
    c. Heating/cooling loop status.
    d. Space load point ID.
    e. Current space load point value.
    f. Control heat/cool limited.
    g. Gain factor.
    h. Calculated reset values.
    i. Fan status point ID and status.
    j. Control discharge temperature point ID and status.
    k. Space load point ID and status.
    l. Air flow rate point ID and status.

D. Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
2. Operator commands:
    a. Add/delete fan status point.
    b. Add/delete outside air temperature point.
    c. Add/delete discharge controller point.
    d. Define discharge controller parameters.
    e. Add/delete return air temperature point.
    f. Add/delete outside air dew point/humidity point.
    g. Add/delete return air dew point/humidity point.
    h. Add/delete damper switch.
    i. Add/delete minimum outside air.
    j. Add/delete atmospheric pressure.
    k. Add/delete heating override switch.
    l. Add/delete evaporative cooling switch.
    m. Add/delete air flow rate.
    n. Define enthalpy deadband.
    o. Lock/unlock program.
    p. Request control summary.

q. Request HVAC point summary.

3. Control summary:
   a. HVAC control system begin/end status.
   b. Enthalpy switchover optimal system status.
   c. Optimal return time system status.
   d. Current outside air enthalpy.
   e. Calculated mixed air enthalpy.
   f. Calculated cooling cool enthalpy using outside air.
   g. Calculated cooling cool enthalpy using mixed air.
   h. Calculated enthalpy difference.
   i. Enthalpy switchover deadband.
   j. Status of damper mode switch.

2.12 CHILLER CONTROL PROGRAMS

A. Fully monitor chiller by reading in all chiller points available through BACNET interface from chiller manufacturer. Utilize a 3rd party integrator if necessary.

B. Control chiller by means of a remote enable and setpoint control. do not interfere in the function of the chiller through its unitary controller.

C. Condenser Water Reset: Automatically reset controlled condenser water temperature using measured outside wet bulb temperature and load being handled.

D. Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 EXECUTION

A. Provide, install, starup, comission the BAS to meet the full requirements of the sequence of operation, project Narrative Scope of Work, and the project specification requirements. The Engineer will have final approval of the system, its operation, and graphics and the decisions of the Engineer are final.

3.03 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0993.

C. Demonstrate full remote web access outside the Owner's firewall as part of demonstration. provide all necessary hardware and obtain all necessary permissions to accomplish this demonstration of permanent remote access.

D. Provide a UPS for each controller and buss device that will operate the systems for 3 hours.

E. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of NFPA 70.

F. All programming of the new components will be by factory trained controls personnel. programming of the front end will be performed by Trane factory trained and certified personnel. acceptance of suitability of personnel performing programming and startup will be at the sole discretion of the Owner and Engineer. replacement personnel will be provided upon the request of the Owner or Engineer at any time in the project or warranty period.

G. Provide programmer level acces to all systems for Engineer via remote web interface.

3.04 MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.

C. Provide basic operator training for 10 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 24 hours dedicated instructor time. Provide training on site.

D. Provide basic operation training to Owner's staff on display, alarm and status descriptors, requesting data, excecution of comands and request of logs. Training to be a minimum of 2 hours. Training shall be on site, witnessed by the Engineer, and a attendance log will be taken and turned over to the Owner and Engineer.

3.05 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

B. Fully test the reliability and stability of the WCN, as configured in the original layout, and provide a detailed report indicating compliance with the standards set forth for the project, for review and acceptance by the Engineer. Engineer may witness testing.

C. Demonstrate the sufficiency of the WCN density required for the project, including the robustness of the WCN in terms of device failure/abandonment, to the Engineer, for review and acceptance.

3.06 MAINTENANCE

A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

B. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

C. Provide complete service of systems, including call backs. Make minimum of four complete normal inspections of approximately five hours duration, during the course of the warranty period, in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION

SECTION 23 0993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. Equipment falling under the sequence of operation, including all ancillary and supporting systems and equipment.

1.02 RELATED REQUIREMENTS

A. Section 23 0923 - Direct-Digital Control System for HVAC.

B. Section 23 0913 - Instrumentation and Control Devices for HVAC.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
   2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
   3. Include at least the following sequences:
      a. Start-up.
      b. Warm-up mode.
      c. Normal operating mode.
      d. Unoccupied mode.
      e. Shutdown.
      f. Capacity control sequences and equipment staging.
      g. Temperature and pressure control, such as setbacks, setups, resets, etc.
      h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
      i. Effects of power or equipment failure with all standby component functions.
      j. Sequences for all alarms and emergency shut downs.
      k. Seasonal operational differences and recommendations.
      l. Interactions and interlocks with other systems.
   4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
   5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
   6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
   1. Label with settings, adjustable range of control and limits.
   2. Include flow diagrams for each control system, graphically depicting control logic.

3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
5. Include all monitoring, control and virtual points specified in elsewhere.
6. Include a key to all abbreviations.

D. Points List: Submit list of all control points indicating at least the following for each point.
1. Name of controlled system.
2. Point abbreviation.
3. Point description; such as dry bulb temperature, airflow, etc.
4. Display unit.
5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
8. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.
9. Unique BACNET indentifier for eahc point.

E. Designer's Qualification Statement.

F. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SEE ATTACHED SEQUENCE OF OPERATION FOLLOWING THIS SECTION.

END OF SECTION

HVAC SEQUENCE OF OPERATION
BUILDING 54 HVAC RENOVATIONS

Replacement of Existing System:

The project will replace the existing BAS, with all equipment currently on the BAS incorporate into the new system. All the available information on the existing installation is provided as reference material for the purposes of bidding the project. In terms of the sequence of operation, the intent is to replicate the function of the existing BAS as defined in the reference material from the original and supplemented/ clarified in this sequence. During bidding, bidders are highly encouraged to review the requirements and ask for clarifications related to this requirement. Operators such as for valves and dampers may be re-used if compatible with the new system. Temperature sensors, pressure sensors, and water flow meters will be replaced.

Building Automation System:

Provide and Install a replacement for the existing building BAS system. Requirement is for a complete, new, building automation and control system (BAS) to meet the needs of the HVAC system equipment currently operating the building, and limited new equipment to be added. The building control system will utilize a building level controller and associated devices to control a mixture of AHUs (fan powered and non-fan powered (terminal) VAV), fan coils, exhaust fans, stairwell pressurization fans, along their associated pumps, etc. in accordance with the sequences of operation via a wired control system network buss and wireless sensors and thermostats. Three boilers, an air cooled screw chiller and their associated pumps, etc. are also included. All system set points will be adjustable, all input and output states will be capable of being overridden.

Summary:

This sequence provides the roadmap to the BAS for this project. There may be requirements in the plans and specifications which are not in this sequence, they will be in full effect for the project. Where they may conflict, the Engineer will be the sole authority of interpretation and discrepancy resolution. Provide a replacement for the existing building BAS system. It will be one, stand-alone, networked, building automation and control system for the project. The control system is to be a microprocessor based system utilizing DDC control and electric actuation. The system will include on site building Owner interface through the Owner's central Ensemble server, via a web browser. The BAS will integrate into the Owner's centralized monitoring system, which is a Trane ensemble system, operating on the Owner's server deployment, through the Owner's secure executive network. Trane Ensemble is basis of design.

Additionally, full operability Web (internet) interface will permit the Owner to read and acknowledge alarms, adjust the occupancy schedule, set points, trend data, review overall system status, all remotely. New controls shall be tied into owners existing Trane Ensemble System for a seamless user interface. Hotlinks/targets to other applications and/or separate web pages will be NOT accepted as a "seamless" interface to the

Ensemble System. Provide long term data logging and archiving of data for a minimum of 3 years. All data, alarms, and graphics shall be available for user interface from both local workstation(s) as well as mobile devices through either a mobile browser and/or mobile app. BAS shall provide any necessary controls hardware and/or software upgrades to the existing Ensemble System to meet the spec requirements of this project. All programming, devices, wiring, etc., required to access the BAS system through the web interface is included in this project.

The building level controller (BLC) and individual controllers must be fully capable of and programmed for operating independently of the Web based monitoring system and the building must continue to operate on loss of the BLC.

The existing BAS system will be replaced, both in terms of controls equipment, control buss wiring (pathway may be re-used), and coding to meet the performance requirements of this project. Control system enclosures may be re-used provided the re-use does not interfere with the continuous operation of both systems during changeover from old to new. Such coding may have to be custom to meet the requirements, and is included in the project. The BAS programming is expected to be an interactive process between the Engineer and the controls contractor. Tweaks and adjustments to the sequences to optimize the configuration, operation, and graphics are anticipated and will be part of the BAS requirement and warranty. All controls will be installed and programmed to the satisfaction of the Engineer. Proximate units and devices may be operated from common control panels wherever possible to minimize system architecture repetition but BAS system manufacturer's installed unitary controllers on smaller equipment are preferred where possible but all must continue to operate on loss of the BLC.

A hybrid wired/wireless will be installed for the BAS. The entire building control buss will be replaced with new wiring, no buss wiring will be re-used. The wiring will be installed tight to deck above ceilings and securely anchored to building structure using bridle rings every 10'. It will be routed only parallel and perpendicular to walls and floor, and will routed up and down from above to each device utilizing foil shielded plenum rated cabling. Where exposed in spaces or mechanical rooms it will be routed in conduits. Wiring will be point to point on devices terminal strips as required by system architecture and no intermediate splices will be permitted. At least two busses per floor will be installed to prevent loss of the entire floor or building due to a buss failure and will be oriented generally east-west.

No existing control devices or wiring will be abandoned in place. If not re-used, it will be removed in its entirety. All on site startup and assistance in startup, TAB, or training will be performed by the installing and programming technician. No third party may be used for installation or support work.

Phasing:
The existing BAS must remain in in place and operational while the new system is installed. New devices and control panels must be in place and operation before the existing panels may be removed. The new BAS systems installation must be planned such that the new controls may be brought online in an orderly planned manner but must not resulting significant negative impact on the building occupants. The sequence of the work will be submitted in a written plan and coordinated with the Owner and Engineer, who will review and ultimately accept the plan for execution.

Existing Ice Storage System:
The building currently has an ice storage system. The system, along with all its controls, will be removed and will not be replaced. All existing controls associated with the ice system will be totally removed.

Existing Boiler Plant:
The boilers will act as a stand-alone entities with the BAS providing a run command and 0-10V OA reset temp signal. BAS will monitor boiler status, operating temperatures and parameters, alarms, etc. via BACNET Interface but will not “force control” of the boilers. Likewise, the chiller will operate on its internal controls, receiving a run command from the BAS and will monitor status, operating temperatures and parameters, alarms, etc. via BACNET interface. The HW reset will be adjustable with an initial temperature range of 180F at 30F OAT (Outside Air Temp) to 90F at 65F OAT. Boilers will be enabled on any call for heating or reheat and hot water will be continuously available below 35F OAT.

New Chiller:
The new dual compressor variable speed screw chiller will act as a stand-alone entity, with the BAS providing a run command and 0-10V OA reset temp signal. BAS will monitor all possible chiller parameters such as status, operating temperatures and parameters, alarms, etc. via BACNET Interface but will not “force control” of the chiller. Likewise, the chiller will operate on its internal controls, receiving a run command from the BAS and will monitor status, operating temperatures and parameters, alarms, etc. via BACNET interface. The BAS will enable the chiller based on OA temperature and cooling demand.

The chilled water system will incorporate dynamic chilled water reset. Once the chiller is enabled by OAT or a call for cooling, the initial value for the chilled water system will be a 44 degree supply water temperature. The BAS will monitor the chilled water valve positions, discharge air temp on the AHUs, and the position of the VAV dampers. Based on the valve positions, the BAS will adjust the chilled water temp between 41 and 48 degrees (adjustable), so that the most open device is at or close to 85% max. If any chilled water valve or VAV damper exceeds 95% in cooling mode for more than 15 minutes, dynamic reset will lower the supply temperature by 1 degree in 20 minute increments until the device in question drops below 85% open. As the most open devices drops below 75% for 15 minutes, the chilled water will reset upward by 1 degree in 20 minute increments. Dynamic reset will also initiate if any AHU cooling DAT

exceeds 58 (adjustable). The dynamic reset process will be toggle-able off by an administrative password, to allow testing by setting a fixed chilled water supply temperature.

Startup/ Testing, TAB, and Training:
Startup and testing of the BAS will be performed separate from TAB and Training and will be scheduled as independent events on different days. BAS installer will be available ***on site*** to assist in equipment startup. The Engineer will be given all passwords to the BAS, including installer/ technician level passwords for full, unfettered access to the BAS. Such passwords may not be changed without the Engineer and Owner's consent. The Engineer will be provided with remote web based access to the BAS for review and evaluation during the project.

Balancing (TAB):
Due to the nature of the air systems and the modes of operation, integration of control system final adjustment and operational testing will have to occur during testing and balancing. The mechanical contractor will provide the same technician that performed initial programming and startup, **on site** and available to operate and adjust the control systems, for the entire test and balancing portion of the project. A detailed TAB Plan is required, for approval. The Engineer will witness all testing and balancing on this project. BAS subcontractor will provide the undisturbed services of the installing and programming technicians **on site** to assist the TAB contractor in the testing, adjusting, and balancing of the building HVAC systems. The Engineer has allotted 2 – 10 hour days to this task for the Engineer's representatives. The mechanical contractor and the TAB contractor are required to staff the TAB to be performed in 2 - 10 hour days. The TAB will be completed in the 2 – 10 hours days allotted or the Engineer will be compensated by the contractor for additional time related to TAB.

The AHUs and the RTU will be fully profiled for air and water, the VAV boxes will be fully profiled and calibrated for air. All air and water flow monitoring stations will be field verified/calibrated during TAB. All pumps will be profiled. The fancoil units under Alternate #2 will be profiled for water.

Partial System DDC Points List: (list is minimum, provide all points necessary to accomplish the sequence of operation and the original operation of the system from the supplemental materials)

A.	DO	AHU/(s) Supply/ Return Fan start/stop
B.	DI	AHU/(s) Supply/ Return Fan status
C.	AO	AHU(s) Supply/ Return Fan VFD Speed Control
D.	AI	AHU/(s) Supply/ Return VFD Alarm
E.	DO	Chiller(s) Enable
F.	DI	Chiller(s) Status
G.	DI	Chiller(s)Alarm
H.	DO	Chiller(s) Extraction Pump start/stop
I.	DI	Chillers(s) Extraction Pump Status
J.	AO	Chiller(s) VFD Speed Control
K.	AI	Chiller(s) VFD Alarm

L.	AI	Chiller Water Flow by dedicated Water Meter
M.	AI	CHW Supply Temp (system, chiller, each AHU)
N.	AI	CHW Return Temp (system, chiller, each AHU)
O.	DO	CHW/ HW Circulating Pump(s) Enable
P.	AO	CHW/ HW System Pumps VFDs
Q.	DI	CHW/ HW Circulating Pump(s) Status
R.	AI	CHW/HW Flowmeter
S.	AO	Boiler Plant Reset Signal
T.	DO	Boiler Plant Enable
U.	DI	Boiler Extraction Pump(s) Status
V.	DI	Boiler Status
W.	DI	Individual Boiler Alarms
X.	AI	HHW Supply Temp (system, each boiler, each AHU)
Y.	AI	HHW Return Temp (system, each boiler, each AHU)
Z.	DI	AHU Freezestat/ EM ckt status
AA.	AO	AHU(s) HW heating(s) coil position
BB.	AO	AHU(s) Chilled water valve position
CC.	AO	AHU(s) Outside air damper position
DD.	AO	AHU(s) Return air damper position
EE.	AI	AHUs Mixed air temperature
FF.	AI	AHU(s) Discharge air temperature
GG.	DO	Stairwell Pressurization Enable
HH.	DI	Stairwell Pressurization FA Input
II.	DO	Ducted Common Exhaust Fan Enable
JJ.	DI	Ducted Common Exhaust Fan Status
KK.	AI	Return Air CO2 (each AHU)
LL.	AI	Zone temperature (CD)
MM.	AI	Zone RH (CD)
NN.	AI	Zone CO2 (CD) (No local display)
OO.	AI	Zone CO2 (2 per system beyond zones, location by Engr, no display)
PP.	AI	Outside air temperature (dedicated, not from a system)
QQ.	AI	Outside air relative humidity (dedicated, not from a system)
RR.	AI	Return air relative humidity at AHU
SS.	AI	Return Air CO2 at AHU
TT.	AI	Building Pressurization Differential Pressure (1 per system)
UU.	**	VAV communication and control points as required

** Zone tempering coils are hot water

** VAV boxes are to be networked and will read in all available conditions, including airflow

** "CD" refers to common device being acceptable for the sensors to be part of a stat, as long as the requirements for all the device are fully met

Sequence of Operation – Existing VAV AHUs

Provide One Controller per Air handling system

1. AHU Operating Setpoint Values (adjustable):

    A. Occupied Mode:
        1. Cooling - 55°F with throttling range of +/- 3°F

2. Heating – 55 – 60; 60 – 90°F on a reset by zones out of range with throttling range of +/- 2°F

B. Unoccupied Mode:
   1. Winter - 55°F with throttling range of +/- 4°F
   2. Summer - 78°F with throttling range of +/- 4°F

C. Occupied and Unoccupied Mode start times: to be determined by the Owner but initially 6A – 6P M-F.

2. Warm-Up/Cool-Down Mode: The DDC system shall have the capability to perform an optimum start routine for morning warm-up/cool-down operation prior to entering occupied mode. This mode of operation shall continually "learn" by calculating the required start time for the unit based on outside air temperature and the differential between the actual discharge temperature and required discharge temperature setpoint at the start of the occupied mode. When this mode of operation is entered, the supply fan shall be started and a current sensor on the fan circuit shall prove fan operation. Once the fan operation is proved, the cooling or heating shall be cycled or modulated as required to achieve the required discharge air temperature. The outside air dampers shall remain in the fully closed position. The unit shall utilize a "coastdown" mode to reach unoccupied mode. A 30 minute morning purge of maximum AHU OA will initiate 60 minutes prior to morning start time.
3. Occupied Mode: When indexed to the occupied mode by the DDC controller, the supply fan shall be started if it is not already in operation, and a current sensor on the fan circuit shall prove fan operation. Once the fan is proved, the outside air damper shall be opened to its minimum position. The fan shall run continuously during the occupied mode of operation. The DDC system shall operate the unit, VAV boxes, and associated devices in a VAV w/ zone tempering mode utilizing CO2 based demand controlled ventilation as follows:

   A. Occupied Cooling Mode: On a rise call for cooling by any zone, the controls shall modulate the 2-way chilled water valve within range and in order to maintain the supply air set point to satisfy the requirements of each zone. The Supply Air temperature will be reset automatically based on an outdoor air or average zone temperature, but no less than 53 Degrees and no more than 58 Degrees in cooling mode.
   B. Occupied Heating Mode: The Supply Air temperature will be reset automatically based on an outdoor air or average zone temperature, but no less than 55 Degrees and no more than 120 in heating mode based on zone requirements. Each VAV box will modulate its Electric Heating coil to maintain the zone temperature to setpoint. If the zone electric heating coil remains in full heating for more than 15 minutes or the zone temperature is more than 4 degrees from setpoint, the BSA will modulate the AHU preheat valve to raise/reset the discharge air temperature to the minimum

necessary to satisfy the zone requirement. Once satisfied, the discharge temperature will return to normal for heating mode.

C. Air Side Economizer: The economizer mode of operation shall be determined and enabled by an enthalpy comparison between the return (as determined by the space and return duct sensors) and outside air when the outside air enthalpy is below the economizer lockout setpoint of 28.1 Btu/lb (adjustable). When outside air enthalpy is less than the return air enthalpy by 3 Btu/lb (adjustable), modulate the return and outside air dampers to maintain the space temperature setpoint with a minimum mixed air temperature setpoint of 55°F (adjustable). When the outside air enthalpy is greater than the return air enthalpy by 3 Btu/lb (adjustable), or the lockout setpoint, the economizer mode shall be disabled and the outside air damper returned to its minimum position. The economizer operation shall be controlled by the Unit DDC Controller.

4. Demand controlled ventilation VAV box and damper control will be by PI (proportion/integration) loop.
5. Dehumidification: When the space relative humidity rises above setpoint of 60% in either occupied or unoccupied mode (adjustable) the VAV boxes and the AHU shall enter a dehumidification mode. The outside air damper shall be repositioned to its minimum in occupied mode and closed in unoccupied mode, the cooling valve will modulate to lower the discharge air temperature and begin subcooling the air. The zone reheat coils will modulate to maintain space temperature until the relative humidity drops below 55%. When the VAV boxes return to normal operation at RH below 55% (adjustable), the unit shall be returned to normal operation.
6. Unoccupied Mode: When indexed to the unoccupied mode by the DDC controller the supply fan shall be de-energized. During the unoccupied mode the outside air dampers shall remain in their fully closed position and return air dampers in their fully open position and the electric heating coil shall modulate for maximum discharge temperature. On a rise in zone temperature by more than 35% of the zones above the unoccupied setpoint, the VAV boxes will call for cooling. The supply fan shall be energized and the 2-way chilled water valve shall be modulated until the zone temperature drops to 2°F (adjustable) below the setpoint. The supply fan and cooling shall then be de-energized.

   On a fall in zone temperature below the unoccupied setpoint, the VAV boxes will call for heating. The supply fan shall be energized and the AHU discharge air temperature shall raise to satisfy the zone temp. The supply fan shall be de-energized and the electric heating coil will return to normal controls.
   There shall be an unoccupied mode override button on the zone sensor that will enable the occupants to place the system in the occupied mode of operation for a timed duration (initially 2-hours (adjustable)).
7. Purge/Night Economizer: The purge mode shall turn on the fan and enable the economizer during unoccupied hours to cool a zone using cool night outdoor air. Through the BAS Time of Day Scheduling, the building personnel shall specify when the purge mode is to be initiated. During the purge mode, the cooling coil

will be enabled to maintain space temperature. In heating mode the heating coil and OA dampers shall modulate to maintain a minimum 60 discharge air temperature. The length of the purge shall permit at least one full air change is made during the purge. Volume measurement will not be used. A mixed air temperature calculation shall be used to estimate flow and the flow totalized over time to achieve one (adjustable) air change.

8. Coastdown Mode: Before the air handling unit is controlled to the Unoccupied mode, the
   BAS shall initiate the Coastdown or Optimal Stop mode. During the Optimal Stop mode, the supply fan shall remain on, but the VAV will begin to ramp down. The outdoor air damper shall remain open for ventilation; and the cooling and heating shall be disabled. The unit shall remain in the Coastdown mode until the scheduled Unoccupied time. The BAS shall turn equipment off as early as possible before the unoccupied time to reduce energy consumption, while still maintaining comfort in the zone.
9. Building Pressure Control: The BAS shall monitor the building static pressure sensor differential by a differential pressure transducer referenced to outside. The space pressure control shall modulate the return fan VFD and the relief damper to maintain a slightly positive indoor static pressure of approximately 0.1" WC. (adjustable)
10. Supply Air Pressure Control (VAV Units): The BAS shall send a supply air pressure signal to the AHU Variable frequency drive to modulate the drive based on the static pressure sensor located in the supply air duct (2/3 the length of the longest duct run as specified by the Engineer). The final operating pressure shall be determined during TAB and shall be the minimum pressure necessary to meet Tab airflows concurrently.
11. Freezestat activation: The unit shall contain a 20-foot freezestat temperature sensor run in a serpentine manner across the face of each heating coil. When any one foot section of the sensor detects a temperature below 36° F (adjustable) the unit fan shall be de-energized, outside air damper positioned fully closed, the 2-way heating valve opened fully to the coil, and an alarm initiated through the DDC system. The freezestat shall require manual reset.
12. Smoke Detector/ Alarm Interface: Smoke detectors required in air handling systems shall be hardwired in the fan control circuit and tied into the building alarm system. As per the WV Fire Code, in air handling systems of more than 15,000 cfm, both supply and return duct detectors are required, in air handling systems of 2,000 cfm to 15,000 cfm a smoke detector is required in the return air duct. When a smoke detector is activated, it shall de-energize the associated air handling unit through a hard wire connection in the fan control circuit and activate the building alarm system. On alarm by the duct detector, the control system shall fully close the supply, return, relief, and outside air dampers. Duct detectors shall have a test/ reset switch in location determined by Engineer.
13. Alarms: fan failure, freezestat activation, high humidity, Zone temperature too warm or too cool by 5 degrees, discharge out of limit, CO2 high, CO2 sensor failure (out of range), and dirty filters.

14. ZONE Setpoint Values (adjustable):

A. Occupied Mode:
   1. Cooling - 74°F with throttling range of +/- 2°F
   2. Heating - 72°F with throttling range of +/- 2°F

B. Unoccupied Mode:

   3. Winter - 63°F
   4. Summer - 80°F, max 60% relative humidity

Existing VAV Box Controls:

Each zone VAV box in the project will have an onboard controller which will be part of the BAS system. The VAV boxes will be re-used and have the appropriate BAS system controller installed by field retrofit. VAV flow measuring stations will be cleaned and re-calibrated as part of startup and TAB. NO zone stat or sensors will have a face display but will have an unmarked comfort slider, wheel, or local adjustment buttons. Each zone stat will have a setback bypass button to override setback for an adjustable time (typically 2 hours), activation of the button must give positive feedback of entering bypass mode.

Existing Tempering (Reheat) Coils:

The project includes VAV boxes both with and without reheat coils. VAV boxes which contain a tempering coil will have the coil controlled by the BAS via the VAV box controller. In cases where two VAV boxes are grouped for common control on the drawings, they shall operate in a synchronized manner. The VAV controller will communicate with the BAS to modulate the AHU discharge temperature to meet the highest cooling demand requirement. All other boxes will utilize the zone comfort coil, as necessary, to maintain space temperature. The boxes controls will respond to excess humidity in the space by modulating the heating coil to maintain space temperature, while lowering the fan discharge air temperature to a minimum of 53F, until relative humidity has returned to the acceptable range.

In heating mode, the VAV zone level comfort coil will be the primary heat source. In the event the zone level coil is not sufficient, the box will communicate with the BAS to adjust the RTU discharge temperature to meet the minimum heating demand requirement that will permit the zone level coils to maintain space temperature.

Each VAV zone shall have a zone level temperature and humidity sensor/ thermostat. for control of the individual zones. The sensors may be combination or separate. Each box will operate independently of the larger system. Stats will be non-display with a space temp and humidity sensor, comfort “slider” or “thumbwheel”, and momentary override pushbutton only. The slider or thumbwheel will work within an adjustable comfort range determined by the Engineer/Owner. The override button, when pressed, will send the particular zone into occupied mode, with corresponding response by the RTU.

Existing Fancoil Units, CRAC Units, Unit Heaters, Cabinet Unit Heaters, Convectors, and Radiant Ceiling Panels:

The existing units serving the building will operate on their internal controls, where so equipped but will be connected to the BAS for full monitoring and adjustment via BACNET interface. Units without internal controls will be directly controlled by the BAS using local controllers within 25 horizontally feet of the unit.

CO2 Operation (Demand Controlled Ventilation):

On AHU where CO2 operation is required, the CO2 level will be monitored by CO2 sensors at each zone stat location with no local display. Additionally, overall CO2 will be monitored with at least two sensors in the common area of any floor served by a system and one in the unit return. The zone sensors will be averaged with the return weighted at 50% of the total for display. As the CO2 level rises above 750 PPM in any zone, the VAV box serving the zone will modulate to increase airflow. If the response is not sufficient after 15 minutes, the BAS will begin to add OA to the AHU serving the zone. RTU will modulate the outside air/ relief/return damper to increase ventilation to the space by a proportional /integration (PI) loop to a maximum CO2 level of 1200 PPM. The sensors will be sensors only with no face display. Each AHU return trunk will have a duct mounted CO2 sensor close to the AHU return connection, verify location with Engineer.

CO2 Sensor Dynamic Calibration: The BAS shall initiate dynamic CO2 sensor calibration during the nighttime purge. Each sensor will be recalibrated to the base outdoor CO2 level. The level will be determined by logging the outdoor CO2 level through a night during startup and utilizing the lowest reasonable reading. The outdoor CO2 sensor will be calibrated by a hand meter prior to use for CO2 level operation. The controller shall utilize ventilation control based on the highest ventilation requirement. The control system shall interface with the VAV box controls in the space in question to assure that prior to initiation of ventilation override, the VAV boxes has been opened fully to max flow for heating or cooling respectively for 20 minutes. The ventilation override will be initiated if the CO2 level exceeds 1200 PPM on any sensor. The BAS control of the ventilation override mode shall be used to coordinate the entire HVAC system in response to system ventilation requests. Contractor will trend measure local CO2 ambient and review settings for DCV operation with Engineer prior to startup.

Boiler Control:

The design basis heating plant consists of HW condensing boilers which, through interconnected wiring of their internal controllers, allow the boilers to operate as a step modulating central heating plant. The internal algorithm determines the best firing sequence for fuel efficiency based on each boiler's inlet and discharge temperatures, and the primary HW loop supply and return temperature. The boilers are configured primary/ secondary decoupled, and each boiler has an associated VFD pump which must operate with the boiler firing. The boiler's controls perform HW loop outdoor air reset based on a remote OA sensor. The above performance requirements will be met

by any proposed system which deviates from the design basis equipment or sequence. The boiler plant will act as a stand-alone entity with the BAS providing a run command and a 0-10V outdoor air reset signal. Interface as necessary. BAS will monitor each boiler's status, alarms, etc. by mapping in all available interface parameters from the boilers. A BACNET interface module may be used for monitoring. However, the use of any interface will not "force" control of the boiler firing parameters or alter their internal firing sequence.

Hot Water/ Chilled Water Pumps – Constant Volume Pumping:

The HHW and CHW pumps, when constant volume, will be operated by a BAS panel located in the boiler room, controlling motor starters for all constant volume pumps. The control panel will operate any parallel pumps lead/ lag with time equalization. The panel will start/ stop the pumps and monitor the status of the lead pump and, in the event of failure, start the lag pump; where a lag pump exists. The BAS will monitor the supply and return temperatures of each source, the loop before and after the source, and the supply and return temperature of each AHU or MAU load coil.

Hot Water/ Chilled Water Pumps – Variable Volume Pumping:

The HHW and CHW pumps, when variable volume, will be operated by the BAS panels located in the new mechanical room, controlling motor starters for all constant volume pumps. The pump VFDs will control based on differential pressure utilizing differential pressure sensors at locations piped into the existing system. The control panels will operate any parallel pumps lead/ lag with time equalization. The panel will start/ stop the pumps and provide 0-10V speed control signal to each VFD. The BAS will monitor the appropriate system parameters for pump control as verified with the Engineer prior to the start of work. The BAS will monitor the status of the lead pump and VFD and, in the event of failure, start the lag pump; where a lag pump exists. The BAS will monitor the supply and return temperatures of each source, the loop before and after the source, and the supply and return temperature of each AHU load coil.

Fire Alarm Interface:

The BAS will interface with the fire alarm system to shut down air systems when the fire alarm is activated. The BAS will interface to the stairwell pressurization system to operate the two rooftop mounted stairwell pressurization fans and AHU 1 for corridor pressurization in the event of a fire alarm.

Email Notification:

An inherent function of the BAS will be that it can email multiple email addresses on selected alarms by alarm priority level. The new BAS sending voice messages will not be considered as a substitute or approved equal for this requirement.

Alternate #1 - **New Fancoil Units**

The addition of 6 new fancoil units will we included in Alternate #1. The controls for the 6 units will be included in Alternate#1.

End of Sequence of Operations

SECTION 23 2113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water and glycol piping, above grade.

C. Chilled water piping, above grade.

D. Equipment drains and overflows.

E. Pipe hangers and supports.

F. Unions, flanges, mechanical couplings, and dielectric connections.

G. Valves:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.
   4. Pressure independent temperature control valves and balancing valves.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturers catalog information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

C. Project Record Documents: Record actual locations of valves.

D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Valve Repacking Kits: One for each type and size of valve.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum ten years of documented experience.

B. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

C. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.

D. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
   1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Grooved mechanical joints may be used in accessible locations only.
      a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect/ Engineer.
      b. Grooved mechanical connections and joints comply with AWWA C606.
         1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
         2) Steel: Comply with ASTM A106/A106M, Grade B or ASTM A53/A53M.
      c. Use rigid joints unless otherwise indicated.
      d. Use flexible joints at equipment with motors.
      e. Depending on pipe size, three or four flexible joints may be used in lieu of a flexible connector.
      f. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
   4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
   1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
   2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
   3. For throttling, bypass, or manual flow control services, use ball valves.
   4. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
   5. For shut-off and to isolate parts of systems or vertical risers, use ball valves.
   6. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded. If agreed to by the Engineer due to issues with specific grooved connections.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
    a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
    b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
    c. Braze: 1 BCuP copper/silver alloy.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
4. Copper is only allowed on piping 2 inches and smaller.

2.03 CHILLED WATER PIPING AND GLYCOL, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
    1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded. If agreed to by the Engineer due to issues with specific grooved connections.
    2. Threaded Joints: ASME B16.3, malleable iron fittings.
    3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
    1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
        a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
        b. Braze: 1 BCuP copper/silver alloy.
    2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
    3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
    4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
    5. Copper in only allowed on piping 2 inches and under.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

A. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
    1. Fittings: ASTM D2466 or D2467, PVC.
    2. Joints: Solvent welded in accordance with ASTM D2855.

2.05 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
    1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
    2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
    3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
    4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
    5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
    6. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
    7. Vertical Support: Steel riser clamp.
    8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
    9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches and Less:
    1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
    2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick, preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
4. Gasket Material: Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 degrees F.
5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
7. Manufacturers:
   a. Victaulic Company: www.victaulic.com.
   b. Substitutions: See Section 01 6000 - Product Requirements.

D. Dielectric Connections:
1. Waterways:
   a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
   b. Dry insulation barrier able to withstand 600-volt breakdown test.
   c. Construct of galvanized steel with threaded end connections to match connecting piping.
   d. Suitable for the required operating pressures and temperatures.
2. Flanges:
   a. Dielectric flanges with same pressure ratings as standard flanges.
   b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
   c. Dry insulation barrier able to withstand 600-volt breakdown test.
   d. Construct of galvanized steel with threaded end connections to match connecting piping.
   e. Suitable for the required operating pressures and temperatures.
3. Unions:
   a. 1/2 to 1 Inches: Brass solder to galvanized FPT.
   b. 1/2 to 2 Inches: Brass solder to galvanized FPT.
   c. 1/2 to 1 Inches: Brass to galvanized FPT or FIP (Female Iron Pipe).
   d. 3/4 to 1/2 Inch Reducer: Brass solder to galvanized FPT.
   e. Service: 250 psi, minus 20 to 180 deg F.

2.07 BALL VALVES

A. Manufacturers:
1. Apollo Valves: www.apollovalves.com/#sle.
2. Conbraco Industries: www.apollovalves.com.
3. Nibco, Inc: www.nibco.com.
4. Victaulic Company: www.victaulic.com.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Up To and Including 2 Inches:
1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

C. Over 2 Inches:
1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends, rated to 800 psi.

2.08 BUTTERFLY VALVES

A. Manufacturers:
   1. Apollo Valves: www.apollovalves.com/#sle.
   2. Conbraco Industries: www.apollovalves.com.
   3. Nibco, Inc: www.nibco.com.
   4. Victaulic Company: www.victaulic.com.

B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or grooved ends, extended neck.

C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, or Buna-N encapsulation.

D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.

E. Operator: 10 position lever handle.

2.09 SPRING LOADED CHECK VALVES

A. Manufacturers:
   1. Conbraco Industries: www.apollovalves.com.
   2. Nibco, Inc: www.nibco.com.
   3. Victaulic Company: www.victaulic.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.10 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES AND BALANCING VALVES

A. Manufacturers:
   1. Hays.

B. Control Valves: Factory-fabricated pressure independent with internal differential pressure regulator (DPRV), which automatically adjusts to normal changes in system pressure and provides 100 percent control valve authority at all positions of the valve.
   1. Maintain proportional and linear flow coil characteristics.
   2. PICV to accurately control the flow from 0 to 100 percent full rated flow with an operating pressure differential range of 3 to 60 psig.
   3. Provide ANSI/FCI 70-2 Class 4 shut-off on all sizes and field serviceable.
   4. Provide control valve to incorporate system balancing. Hydronic system pressure independent control valve bodies to comply with ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure and have the following characteristics:
      a. 2 NPS and Smaller: Class 150 bronze or brass body with union connections, stainless steel trim, stainless steel rising stem, stainless steel disc or ball, and screwed ends with backseating capacity repackable under pressure.
      b. 2-1/2 NPS and Larger: Class 125 iron or ductile iron body, stainless steel trim, stainless steel rising stem, stainless steel disc or ball, flanged ends with backseating capacity repackable under pressure.
      c. Pressure Control Seat: Brass construction with vulcanized EPDM.
      d. Sizing: Line-size or with CV aligned to CV of coil/ equipment.

C. Provide stand alone valve independent of the BAS systenm control valve.

D. Proivde with temperature rating to exceed limits of system heating and cooling devices.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install piping to ASME B31.9 requirements.

C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

D. Route piping in orderly manner, parallel to building structure, and maintain gradient.

E. Install piping to conserve building space and to avoid interference with use of space.

F. Group piping whenever practical at common elevations.

G. Sleeve pipe passing through partitions, walls, and floors.

H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.

I. Slope piping and arrange to drain at low points.

J. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.
   2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

K. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

L. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.

N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds. repair firestopping materials on structural steel with alike kind and thickness of material.

O. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.

1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

C. Hanger Spacing for Plastic Piping.
1. 1/2 Inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 Inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 Inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
4. 1-1/4 Inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
5. 1-1/2 Inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
6. 2 Inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 2114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air vents.

B. Strainers.

C. Pressure-temperature test plugs.

D. Automatic flow control valves.

E. Flow meters.

F. Glycol system.

1.02 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

C. Project Record Documents: Record actual locations of flow controls.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Glycol Solution: One container, 55 gallon size.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

A. Manufacturers:
   1. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   2. Taco, Inc: www.taco-hvac.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass ball valve at top of chamber, with square head plug.

C. Float Air Vent:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

D. Maximum Fluid Pressure: 150 psi.

E. Maximum Fluid Temperature: 250 degrees F.

2.02 STRAINERS

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
   2. Viataulic.
   3. Taco
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Size 2 inch and Under:
   1. Provide 175 psi, threaded, or grooved brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch, or 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

E. Basket-Type, Size 1 to 30 inch for Liquid Service:
   1. Flanged carbon steel body with 1/8 inch stainless steel perforated basket screen, bottom drain and capped air vent.
   2. Fluid Service: Up to 285 psi at 100 degrees F.

F. Accessories: Provide air vent, hanging tag, outlet ball valve, and PT test plug extension.

2.03 PRESSURE-TEMPERATURE TEST PLUGS

A. Manufacturers:
   1. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

C. Application: Use extended length plugs to clear insulated piping.

2.04 AUTOMATIC FLOW CONTROL VALVES

A. Manufacturers:
   1. Hays Fluid Controls; Mesurflo Balancing Valve: www.haysfluidcontrols.com/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction:
   1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
   2. Built-in lug-type outlet butterfly valve with 2-position handle.

C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

D. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

E. Size: Match coil/ equipment/ system flow capacity.

F. Accessories: Provide hanging tag, inlet in-line strainer, outlet ball valve, and PT test plug extension.

2.05 FLOW METERS

A. Manufacturers:

1. Onicon.
    a. Direct insert, twin turbine style flow meter, stainless steel with threaded connection of suitable length for instertion through a ball service valve, allowing service and removal without draining the system, integrate into BAS such that flow reads as 0 - 10 VDC

2.06 GLYCOL SYSTEM

A. Manufacturers:
    1. Dow. Specifically Dowtherm, dyed to match existing.
    2. Substitutions: See Section 01 6000 - Product Requirements.

B. Glycol Solution:
    1. Water-based solution mix containing 35 percent propylene glycol, factory premixed with distilled water, by volume, required for cooling or heating system operating temperature range.
    2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of 3 and 220 degees F at 14.7 psia.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. Provide drains at all low point, with ball valve hose connection, chain and cap.

D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

E. Install tee prior to inlet on automatic air vents. Provide pipe and manual air vent in parallel with automatic air vent.

F. Provide valved drain and hose connection on strainer blowdown connection.

G. Perform tests determining strength of glycol and water solution and submit written test results.

H. Replace any glycol lost during installation and install additional glycol as necessary to fill the hydronic piping system.

END OF SECTION

SECTION 23 6426
ROTARY-SCREW WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Factory-assembled packaged chiller.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Chilled water connections.

E. Electrical power connections.

1.02 REFERENCE STANDARDS

A. AHRI 550/590 (I-P) - Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle; 2020.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2019, with All Amendments and Errata.

C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.

E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

F. IEEE 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems; 2014.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

H. NEMA MG 1 - Motors and Generators; 2014.

I. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

J. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Manufacturer's Certificate: Certify that components furnished but not produced by manufacturer meet or exceed manufacturer's requirements.

E. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers, in increments of 10%. Submit IPLV data across operating range, to the satisfaction of the Engineer.

F. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

G. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

H. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years of documented experience.

B. When required, provide certification of inspection in compliance with the requirements of Authority Having Jurisdiction.

C. An operational test will be performed at the factory, during which the unit is run under load, general operation as well as functionality of controls and safeties are verfied. Provide a subsequent certificate indicating passing said test. Engineer will witness test.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.

B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials only for compressor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Corporation: www.carrier.com/#sle. Design Basis chiller.

B. Trane Technologies, PLC: www.trane.com/#sle. Acceptable manufacturer, but subject to substitution approval under "C" below.

C. Substitutions: See Section 01 6000 - Product Requirements.
   1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
   2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Architect/ Engineer that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substituted equipment.
   3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs incurred by the Engineer due to re-design and provisions of different related equipment.
   4. The chiller location is very limited in terms of footprint, code clearance, service clearance, air clearances, and coil pull. In general, the new chiller must "fit" on the existing pad with only minor modification. All the applicable code clearances, and manufacturers published clearances, must be fully adhered to for a substitution to be considered; no manufacturer's waivers of the published clearances will be considered. Rejection of a substitution request for non compliance to such conditions will not be reconsidered. The chiller performance is based on the chiller being placed in the architectural chiller surround with two louver as indicated on the General project sheets and the gate considered as solid wall, and the performance must be demonstrated by a detailed computer model incorporating the surround. The design basis performance and efficiency must be met or exceeded by the substitution unit, to the satisfaction of the Engineer. Any alterations to the equipment pad due to the substitutions will be part of the project cost and not subject to requests for change orders.

2.02 CHILLER PERFORMANCE REQUIREMENTS

A. Chiller CH-1: Air-cooled.
   1. Basis of Design: Carrier. As scheduled.

a. The chiller location is very limited in terms of footprint, code clearance, service clearance, air clearances, and coil pull. In general, the new chiller must "fit" on the existing pad with only minor modification. All the applicable code clearances, and manufacturers published clearances, must be fully adhered to for a substitution to be considered; no manufacturer's waivers of the published clearances will be considered. Rejection of a substitution request for non compliance to such conditions will not be reconsidered. The chiller performance is based on the chiller being placed in the architectural chiller surround with two louver as indicated on the General project sheets and the gate considered as solid wall, and the performance must be demonstrated by a detailed computer model incorporating the surround. The design basis performance and efficiency must be met or exceeded by the substitution unit, to the satisfaction of the Engineer.

2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
3. Refrigerant: HFC-134a.
4. Evaporator:
   a. Fouling Factor: 0.0001.
5. Packaged Air-Cooled Condenser:

2.03 SCREW CHILLERS - GENERAL

A. Factory tested enclosed packaged assembly consisting of electrically driven compressor(s), compressor variable frequency drive(s), evaporator, condenser, refrigeration circuits(s) and specialties, interconnecting piping, microprocessor-based controls, readouts, and diagnostics.
   1. Rating: AHRI 550/590 (I-P).
   2. Safety: ASHRAE Std 15 and UL 1995.
   3. Construction & Testing: ASME BPVC-VIII-1.
   4. Compliance: 1 listed as suitable for purpose specified and indicated.
   5. Energy Efficiency: 1.
   6. Enclosures:
      a. Chiller Structural Framing:
         1) Mount structural steel on welded steel base.
         2) Factory apply hot-dip galvanized finish.
      b. Steel Chiller Cabinets:
         1) Factory apply baked on enamel finish.
      c. Steel Control Panels:
         1) Factory apply baked on powder paint or applied corrosion resistant paint prior to assembly.
         2) Provide gasketing and weather-proofing to panels with fully opening doors containing starters or variable frequency drives, terminal blocks, through-the-door type disconnects and circuit breaker with lockable handles indicating "power-on" or "power-off".
         3) Provide door stays.
      d. Electrical Equipment: NEMA 250, breaker. Single point power connection.
      e. Provide a readily accesible GFCI receptacle served by control powered transformer.
   7. Motors: NEMA MG 1. See Section 23 0513 for additional requirements.

2.04 SCREW CHILLER COMPRESSORS AND EVAPORATOR

A. Compressors: Rotary-screw type.
   1. Unit: Semi-hermetic type with two, direct drive compressors with multiple independent refrigeration circuit(s), internal muffler, discharge, check, suction, and liquid line service valves.
   2. Oil Lubrication System: Positive pressure system, oil heater, oil separator, check valves, solenoid valves, and filtration devices.
   3. Valves: Check valves in compressor discharge. Load control may not be through the use of slide valves, or auxillary compressors.

4. Capacity Reduction System: Variable speed control down to 15 percent of full load without the activation of hot gas by-bass.
5. Motor(s): 6300 rpm, factory-installed permanent magnet type, suction gas-cooled, hermetically sealed, protection via internal motor temperature sensors, squirrel cage induction with 3-phase, 460 VAC, 60 Hz VFD (variable frequency drive) controlled.

B. Evaporator: Shell and tube type.
1. Two pass brine type, with two independent refrigeration circuits. Uprate chiller to meet scheduled performance with 35% propylene glycol.
2. Shell, Removable Heads and Tube Support Sheets: Carbon steel.
3. Tubes: Mechanically expand and fasten, seamless, externally or internally enhanced, copper tubes into intermediate tube support sheets along the length of shell to avoid contact and relative motion between tubes with the capability of being cleanable.
4. Tube Size: 1.0 inches diameter.
5. Comply with ASME BPVC-VIII-1 as applicable.
6. Refrigerant Working-Side Pressure Rating: 220 psig.
7. Connections: Flanged and designed for 300 psig waterside working pressure.

C. Insulation for All Cold Surfaces:
1. Factory install on shell and all other cold surfaces.
2. 0.75 inches minimum thick, closed cell, expanded closed cell tubular rubber insulation with a maximum K value of 0.28.

D. Provide tubular,closed shell suction line insulation where leaving temperature is less than 30 F and areas of notably high dewpoints.

E. Provide vents and water drain connections.

F. Provide a factory-installed flow switch.

G. Provide fittings for temperature control sensors.

H. Freeze Protection: Provide evaporator heater with thermostat to protect from freezing at ambient temperatures down to minus 20 degrees F.

I. Thermistors installed to measure evaporation intake, discharge, and outside air temperatures.

2.05 AIR-COOLED CONDENSER AND FANS

A. Heat Exchanger:
1. Tubes: Round.
2. Arrangement: Two pass.
3. Mechanically bond aluminum fins to internally enhanced, seamless copper tubing and protect with corrosion resistant materials or coatings.
4. Clean, dehydrate and test.
5. Leak Test: 506 psig.
6. Seal: Refrigerant holding charge.

B. Coil Guards: Provide expanded metal with lint screens. Provide coil protection for shipping by enclosing entire condenser coil with heavy plastic to prevent inadvertent damage to coil during shipping or rigging.

C. Fans and Motors:
1. Fans: Dynamically and statically balanced propeller type, direct drive airfoil fans of reinforced polymer corrosion resistant construction and equip with sealed, permanently lubricated ball bearings.
2. Discharge Fan Guards: Coated steel wire.
3. Discharge Direction: Vertical.
4. Motors: Totally enclosed, high efficiency, suitable for outdoor use, max. 99 dB at 30 feet sound rating, three phase, permanent split capacitor, variable speed with analog and digital protection.

D. Coil Access
1. All piping connections entering and leaving the unit shall be on one side of the condenser.

2. Coil access for all coils will be available on the side opposite to the piping connections.

2.06 REFRIGERATION CIRCUITS

A. Provide two independent refrigeration circuit(s) with one compressor(s) per circuit.

B. Minimum Refrigerant Specialties per Circuit:
   1. Isolation and service valves for refrigerant removal and charging.
   2. Removable-core filter driers.
   3. ASHRAE Std 15 compliant relief valves.
   4. Liquid line sight glass with moisture indicator.
   5. Refrigerant expansion valves or metering devices.
   6. Complete operating charge of both refrigerant and oil.
   7. Chilled water circuit will be rated for 300 psig.

2.07 STARTERS AND DRIVES

A. Variable Frequency Drives: Completely assemble, wire, pipe, and factory test, factory or field mounted variable frequency drives (VFD) on compressors and condenser fans. Limit the field electrical connections for compressor motor power to the main power leads to the VFD.
   1. Characteristics:
      a. Air cooled. No glycol cooling permitted.
      b. Microprocessor based pulse width modulation (PWM) with input/output power devices, DC voltage rectifier, and inverter/control regulator to convert DC voltage to sinusoidal PWM waveform.
      c. Isolate low voltage control physically from main power sections.
      d. Control motor speed by integrated controls over wide range of operating conditions.
      e. Provide short circuit interrupt and withstand rating suitable for available current.
   2. Performance:
      a. Do not exceed IEEE-519 requirements for voltage total harmonic distortion (THD) and harmonic current total demand distortion (TDD) using VFD circuit breaker input terminals as the point of common coupling (PCC).
      b. Full Load Efficiency: Minimum 97 percent at 100 percent VFD rated capacity.
      c. Unity Displacement Power Factor: 0.99 minimum.
      d. Voltage Boost Capability: Full motor voltage at reduced line voltage conditions.
      e. Soft start, linear acceleration, and coast to stop capabilities.
      f. Base Motor Adjustable Frequency Range: Control to 15 percent capacity at nameplate voltage.
      g. Torque Generation: 150 percent instantaneous.
      h. Enclosures shall meet or exeed IP-55 rating.
   3. Suitable Ratings:
      a. Operation at plus or minus 10 percent nameplate voltage.
      b. Continuous Operation at:
         1) 100 percent of nameplate amperes and 5 seconds at 15 percent.
         2) Ambient temperature range of 32 to 105 degrees F, 95 percent humidity non-condensing for altitudes up to 6000 feet.
      c. Comply with NEMA 250 and NEMA MG 1.
   4. User Interface for Programming and Display of the Following Parameters:
      a. Operating, configuration and fault messages.
      b. Hertz frequency.
      c. VFD load, line side voltage, and current.
      d. kW.
      e. Input/output power devices temperature.
   5. Electrical Service (single point power):
      a. Input Circuit Breaker: Suitable for the available current indicated.
      b. Provide power for chiller oil pump via factory wired standard branch circuit breaker.
      c. Provide power for oil heater, VFD and controls via 3 KVA control power transformer and factory wired circuit breaker.

6. Discrete Contact Outputs (115 volt):
    a. Circuit breaker shunt trip.
    b. Chilled water pump.
    c. Alarm status.
7. Analog Outputs: (4 to 20 mA) for head pressure reference and condenser water control valve as applicable.
8. Provide protection for under/over-voltage, phase loss/reversal/unbalance, ground fault, single cycle voltage loss, programmable auto restart after power loss, and motor overload/over temperature protection.

2.08 SAFETIES AND CONTROLS

A. Safeties:
1. Unit shall include all components in coordination with the control system to protect against the following.
    a. High pressure.
    b. Electrical overload.
    c. Loss of phase.
    d. Loss of chilled water flow.
    e. Low chilled fluid temperature.
    f. Motor overtemperature.
2. Interal overcurrent protection shall be provided for the condenser-fan motors.
3. Unit shall be able to perform a full capacity recovery in the event of power loss and subsequent resupply in less than 5 minutes.

B. Controls:
1. Unit controls shall incorporate the following.
    a. Dedicated ON/OFF switch.
    b. Independent terminal block for controls.
    c. Independent 115V supply for all control components and relays.
    d. Controllers that are replaceable and solid-state.
    e. Microprocessors that utilize non-volatile memory, a battery backup is not acceptable.
    f. Thermistors for measuring entering and existing fluid and outside air temperatures.
    g. Sensors to measure oil, economizer, discharge, suction and liquid pressures.

2.09 INTEGRATED DDC CONTROLLER

A. Control Components for Preventing Shutdown:
1. Provide high pressure limit with indicating light for each compressor, set lower than factory pressure switch to automatically unload compressor and prevent nuisance high pressure condenser control trip.
2. Provide one protector with indicating light for each compressor, with current limit set point of 120 percent of compressor running load amperage to automatically unload compressor preventing over-current trip.
3. Provide low refrigerant limit to automatically unload each compressor preventing a low evaporator temperature trip.

B. Chiller Operation in Abnormal Operating Conditions:
1. Unloaded Running: Adequate chilled water production.
2. Trip-out Limit Reached: Chiller goes off-line and manual reset is required for continued operation.

C. Touchscreen-based Control Panel Display:
1. Evaporator pressure.
2. Condenser refrigerant pressure.
3. Entering and leaving evaporator water temperature.
4. Chiller operating mode and chilled water set-point.
5. Electrical 3 phase amp draw, current limit, and percent RLA setpoint.
6. Condenser refrigerant temperature.

7. Elapsed time and number of starts counter.
8. Chiller compressor run status relay.
9. Minimum of 20 diagnostics with time and date stamp.
10. Identification of the fault, date, time and operating mode at time of occurrence, type of reset required, and help message.

D. BAS, Modbus, BMS, SCADA or other Integrated Automation Interface: BACnet IP in accordance with 1.

E. Data Log and Report Interface: Include RS-232 port and BACNET module.

F. Hardwired Points for BAS Control and Monitoring:
1. Relay output energized upon detecting a fault requiring manual reset.
2. Relay output energized whenever unit is operating in a limit mode for an extended period of time.
3. Analog input to control leaving chilled water temperature set-point based upon a 4-20ma or 0-10 VDC signal from the building automation system.
4. Programmable soft during pull-down period via ramped current limit or fully adjustable, temperature pull-down rate.
5. Leaving chilled water reset based upon return water temperature.

G. Provide capacity control base on exit chilled water temperature and the return fluid temperature rate of change with a set point accuracy of 0.1 F.

H. Avoid excess startup demand by limiting the chilled water decrease rate to 0.2 to 2 F per minute during startup.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on vibration isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

F. Arrange piping for easy dismantling to permit tube cleaning and removal.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

3.03 MANUFACTURER'S FIELD SERVICES

A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.

B. Supply initial charge of refrigerant and oil if not completely factory charged.

C. Demonstrate system operations and verify specified performance.

3.04 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Demonstration: Demonstrate operation of system to Owner's personnel.
1. Use operation and maintenance data as reference during demonstration.
2. Briefly describe function, operation, and maintenance of each component.

E. Training: Train Owner's personnel on operation and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

2. Provide minimum of one day of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

3.05 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.

END OF SECTION

SECTION 23 8200

CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fan-coil units.

1.02 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.

B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addendum (2011).

C. AHRI 440 - Performance Rating of Room Fan-Coils; 2008.

D. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; 2015.

E. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.

F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.

H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.

I. Modbus (PS) - The Modbus Organization Communications Protocol; Latest Update.

J. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications ; 2016, with Errata (2017).

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

N. UL 674 - Electrical Motors and Generators for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide typical catalog of information including arrangements.

C. Shop Drawings:
   1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
   2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
   3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
   4. Submit the following for blower-coil units indicating:
      a. Overall dimensions including installation, operation, and service clearances.
      b. Lift points, recommendations, and center of gravity.
      c. Unit shopping, installation, and operating weights including dimensions.
      d. Fan curves with specified operating point clearly plotted.
      e. Safety and start-up instructions.
   5. Submit the following for valance heating and cooling units indicating:

a. Scaled layouts showing valance type, capacity, coil and panel lengths.
b. Installation and construction details for all valance types.
c. Capacity flow and pressure drops for all coils.

6. Indicate mechanical and electrical service locations and requirements.

D. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.

E. Manufacturer's Instructions: Indicate installation instructions and recommendations.

F. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

H. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 6000 - Product Requirements for additional provisions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 FAN-COIL UNITS

A. Manufacturers:
1. Vertical Cabinet, Horizontal Exposed, or Horizontal Recessed:
a. Carrier Corporation: www.commercial.carrier.com/#sle.
b. Substitutions: See Section 01 6000 - Product Requirements.

B. Performance Data and Safety Requirements:
1. Unit capacities certified in accordance with AHRI 440.
2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
4. Equipment wiring to comply with requirements of NFPA 70.

C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

D. Coils:
1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
2. Water Coil: Suitable for working temperatures not less than 200 degrees F. Copper tube, bonded aluminum fin.
3. Provide drain pan under cooling coil easily removable for cleaning.

E. Coil Piping Packages:
1. Manufacturers:
a. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
b. Substitutions: See Section 01 6000 - Product Requirements.
2. Automatic Balancing Valves:
a. Brass body for shutoff and hydronic balancing.
b. Manufacturers:
1) Hays Fluid Controls; Automatic Balancing Valves: www.haysfluidcontrols.com/#sle.
2) Substitutions: See Section 01 6000 - Product Requirements.

3. Ball Valves:
    a. Brass body for shutoff and hydronic balancing.
    b. Provide pressure/temperature ports.
4. Y Strainers:
    a. Bronze body.
    b. "Y" type configuration with brass cap.
    c. Maximum Operating Pressure: Minimum 450 psi.
    d. Screen: Stainless steel.

F. Vertical Cabinet and Horizontal Exposed Units: Minimum 18 gauge, 0.0478 inch thick sheet steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, angled integral air outlet, and inlet grilles. Provide field installed bottom inlet filter rack for ready filter change.

G. Finish: Factory applied baked enamel of beige, tan, or grey color on visible surfaces of enclosure or cabinet.

H. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

I. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.

J. Controls:
1. Provide units with control valves furnished by the fan coil unit manufacturer.
2. Fan Coil Unit Manufacturer's Controls:
    a. Fan speed switch for unit mounting.
    b. Disconnect switch.
    c. Programmable thermostat, independent of BAS, NO BAS REQUIRED.

K. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

L. Electrical Characteristics:
1. 120 VAC, single phase, 60 Hz.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Do not damage equipment or finishes.

C. Fan-Coil Units:
1. Install as indicated. Proivde bracketing to mount in a high wall position as indicated.
2. Coordinate to ensure correct recess size for recessed units.

D. Units with Hydronic Coils:
1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve as specified on return piping.
2. Provide float operated automatic air vents with stop valve for fan coil units outside of unit.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

3.04 CLEANING

A. After construction and painting is completed, clean exposed surfaces of units.

B. Vacuum clean coils and inside of units.

C. Install new filters.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

3.06 PROTECTION

A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

SECTION 23 8216
AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glycol coils.

B. Water cooling coils.

C. Refrigerant coils.

1.02 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addendum (2011).

B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

D. Certificates: Certify that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.

B. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. SFI Coils - Basis of Design.

B. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GLYCOL HEATING COILS

A. Tubes: OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.

B. Fins: Aluminum continuous plate type with full fin collars.

C. Casing: Die formed channel frame of 16 gauge, 0.0598 inch stainless steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

D. Headers: Seamless copper tube with silver brazed joints. Threaded copper stub outs of sufficient length to extend at least 10" beyond the air handling unit exterior wall.

E. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.

F. Headers: Seamless copper tube with silver brazed joints.

G. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.

H. Configuration: Drainable, with threaded plugs in headers for drain and vent; threaded plugs in return bends and in headers opposite each tube. Valves on drains and vents.

I. Fin Spacing: as scheduled

2.03 WATER (GLYCOL) COOLING COILS

A. Tubes: OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.

B. Casing: Die formed channel frame of 16 gage, 0.0598 inch stainless steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

C. Headers: Seamless copper tube with silver brazed joints.Threaded copper stub outs of sufficient length to extend 10" beyond the outside air handling unit wall.

D. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.

E. Configuration: Drainable, with threaded plugs in headers for drain and vent; threaded plugs in return bends and in headers opposite each tube. Valves on drains and vents.

F. Fin Spacing: as scheduled

2.04 REFRIGERANT COILS

A. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.

B. Fins: Aluminum or copper continuous plate type with full fin collars. Solder coat copper fin coils.

C. Casing: Die formed channel frame of 16 gauge, 0.0598 inch galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

D. Headers: Seamless copper or brass tubes with silver brazed joints.

E. Liquid Distributors: Brass or copper venturi type distributor with seamless copper distributor tubes, 5/16 inch outside diameter; maximum 12 circuits per distributor.

F. Testing: Air test under water at 300 psi for working pressure of 250 psi; clean, dehydrate, and seal with dry nitrogen charge.

G. Configuration: Down feed with bottom suction to prevent trapping of oil.

H. Fin Spacing: 8 fins per inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Retrofit installation in existing air handling units. Install in units in accordance with SMACNA (DCS).
   1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
   2. Arrange supports to avoid piercing drain pans.
   3. Provide airtight seal between coil and ahu septum wall to withstand 2 times maximum unit pressure.

C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

D. Install coils level.

E. Make connections to coils with unions and flanges.

F. Hydronic Coils:
   1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).

2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
3. Provide isolation valves on both supply and return, other hydronics specialties as required in the project documents.
4. Locate water supply at bottom of supply header and return water connection at top.
5. Provide manual air vents at high points complete with stop valve, per details and specifications.
6. Ensure water coils are drainable and provide drain connection at low points.

G. Cooling Coils:
1. Provide three break moisture eliminators of 24 gauge, 0.0239 inch stainless steel, where air velocity exceeds 500 ft/min.
2. Provide drain pan and drain connection; fabricate from 20 gauge, 0.0359 inch galvanized steel, extend 3 inches from face of entering air side, 6 inches from face of leaving air side, and 4 inches from face of eliminators. Pipe drain pans individually to floor drain with water seal trap.
3. Provide intermediate stainless drain pan, with drain fittings on both end and the middle, on each coil section of a stacked coil. minimuum pan depth is 4 inches.

H. Insulate headers located outside air flow or beyond drain pan, extend insulation at least 1" into airstream.

END OF SECTION

SECTION 26 0001

BASIC ELECTRICAL MATERIALS AND METHODS

GENERAL REQUIREMENTS

1.01 CONFORM TO THE CURRENT REQUIRMENTS OF THE NEC - 2020

1.02 PERFORM ALL WORK UNDER THIS SECTION IN ACCORDANCE WITH APPLICABLE CODES & STANDARDS AND BEST INDUSTRY AND TRADE PRACTICES.

1.03 COORDINATE ALL WITH WITH OTHER TRADES PRIOR TO BIDDING. THIS IS A RENOVATION PROJECT.

1.04 SUSPECT MATERIAL: SHOULD THE CONTRACTOR ENCOUNTER SUSPECTED ACM MATERIAL, THEY ARE TO STOP WORK IN THE AFFECTED AREA AND NOTIFY THE OWNER AND ENGINEER. THE OWNER WILL ARRANGE FOR TESTING IF THE EXISTING ACM DOCUMENTATION IS UNCLEAR. REMEDIATION OF ACM IS NOT INCLUDED IN THIS PROJECT SCOPE BY THE CONTRACTOR.

MATERIALS & METHODS

2.01 BEST INDUSTRY PRACTICES

A. Contractor will employ best industry practices and utilize the materials and methods found within the project drawings and specifications.

2.02 WIRING METHODS (UNLESS SPECIFIED ELSEWHERE)

A. **Conductors And Cables:**
   1. Insulated Single Conductors (600 Volts And Below):
      a. Temperature Rating: 75 deg C.
      b. Stranded Conductor Branch Circuits: Larger than 10 AWG: copper, 600 volt, THHN insulation.
      c. Solid Conductor Branch Circuits 10 AWG and smaller: copper, 600 volt, THHN insulation.
      d. Control Circuit Conductors: Copper, stranded, 300 volt, THHN insulation.
   2. Insulated Multiple Conductor Cable:
      a. Jacketed:
         1) Unshielded.
   3. Armored Cable:
      a. Type MC.
   4. Terminating Devices:
      a. Cable lugs.
      b. Cable connectors.
      c. Splices and terminals:
         1) Spring wire for sizes #10 and smaller.
   5. Accessories:
      a. Cable grips.
      b. Conductor harness.
      c. Wire pulling lubricant.
      d. Electrical insulating tape.
      e. Conductor identifying markers.

B. Raceways And Boxes:
   1. Conduit And Electrical Tubing:
      a. Electrical Metallic Tubing (EMT) And Fittings:
         1) EMT: Thin wall ferrous steel tubing, hot dipped, galvanized, smooth interior reamed ends.
         2) Fittings and Conduit Bodies: Steel set-screw.
      b. Plastic Conduit and Fittings:
         1) Conduit: Schedule 40 PVC.

2) Fittings And Conduit Bodies: PVC.
c. Conduit Supports, Clamps, and Straps: Steel.
d. Enclosures And Cabinets: Steel.

2. Junction Boxes: Rated for application, galvanized steel with conduit knockouts and threaded holes for mounting wiring devices. Conform to requirements of NEMA 250.
   a. Minimum Sizes:
      1) Octagonal: 4 inch (102 mm) wide by 1.5 inch (38 mm) deep.
      2) Square: 4 inch (102 mm) square by 1.5 inch (38 mm) deep.
      3) Dry Locations: Galvanized sheet steel, NEMA 1, welded seams and cover held by stainless steel fasteners.
      4) Damp or Wet Locations: Cast malleable iron with corrosion finish, NEMA 3R, threaded conduit entries, neoprene coverplate gasket, and coverplate held by stainless steel fasteners.
3. Outlet Boxes: Rated for application, galvanized steel with conduit knockouts and threaded holes for mounting wiring devices. Conform to requirements of NEMA 250.
   a. Minimum Sizes:
      1) Single Device: 3 inch (76 mm) high by 2 inch (51 mm) wide by 2 inch (51 mm) deep.
      2) Gang Device: 3 inch (76 mm) high by 2 inch (51 mm) wide (per gang) by 2 inch (51 mm) deep.
      3) Dry Locations: Galvanized sheet steel, NEMA 1, welded seams and cover held by stainless steel fasteners.
      4) Damp or Wet Locations: Cast malleable iron with corrosion finish, NEMA 3R, threaded conduit entries, neoprene coverplate gasket, and coverplate held by stainless steel fasteners.
4. Pull Boxes: Comply with requirements of NEMA 250.
   a. Dry Locations: Galvanized sheet steel, NEMA 1, welded seams and cover held by stainless steel fasteners.
   b. Damp or Wet Locations: Cast malleable iron with corrosion finish, NEMA 3R, threaded conduit entries, neoprene coverplate gasket, and coverplate held by stainless steel fasteners.
5. Masonry Boxes: Galvanized steel with conduit knockouts and threaded holes for mounting devices. Designed and rated for mounting in masonry walls.
6. Plumbing fixture requirements: Provide boxes, wiring, devices as required to properly install plumbing devices with electrical requirements. Items include but not limited to: lavatories, water closet flush valves, pumps, etc. Verfiy requirements prior to bidding.
7. Mechanical System Requirements: Provide boxes, disconnects, starters, wiring, devices, etc as required by all mechanical systems. Verify requirements prior to bidding.
8. Conduit application schedule:
   a. Schedule 40 Plastic (PVC) Conduit: Concealed under slab on grade and Exterior underground.
   b. Electrical Metallic Tubing (EMT): Concealed interior locations and Mechanical Areas.
   c. Flexible Metal Conduit: Connections between accessible junction boxes and lighting fixtures, in dry locations and Equipment connections.

2.03 LOW-VOLTAGE DISTRIBUTION

A. Enclosed Switches: Steel dead front enclosure.

B. Enclosed Circuit Breakers: Steel deadfront enclosure.

2.04 LIGHTING

A. Interior Luminaires: As indicated on drawings.

END OF SECTION

SECTION 26 0505

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 3 EXECUTION

2.01 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

B. Demolition drawings are based on casual field observation and existing record documents.

C. Report discrepancies to Engineer before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

2.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

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: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner before partially or completely disabling system.
   2. Notify local fire service.
   3. Make notifications at least 72 hours in advance.
   4. Make temporary connections to maintain service in areas adjacent to work area.

F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner at least 72 hours before partially or completely disabling system.
   2. Notify telephone utility company at least 72 hours before partially or completely disabling system.
   3. Make temporary connections to maintain service in areas adjacent to work area.

2.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

2.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or that 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.

C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 26 0519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Metal-clad cable.

C. Wiring connectors.

D. Electrical tape.

E. Heat shrink tubing.

F. Oxide inhibiting compound.

G. Wire pulling lubricant.

H. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

H. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.

I. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

L. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

O. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

P. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

Q. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Metal-clad cable is permitted only as follows:
   1. Where not otherwise restricted, may be used:
      a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
         1) Maximum Length: 6 feet.
      b. Where concealed in hollow stud walls and above accessible ceilings for branch circuits up to 20 A.
         1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
   2. In addition to other applicable restrictions, may not be used:
      a. Where not approved for use by the authority having jurisdiction.
      b. Where exposed to damage.
      c. For damp, wet, or corrosive locations.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 0526.

H. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

I. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
   2. Control Circuits: 14 AWG.

J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

K. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. Equipment Ground, All Systems: Green.
      d. Travelers for 3-Way and 4-Way Switching: Purple.
      e. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
      f. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller: Solid.
      b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Installed Underground: Type THHN/THWN or THHN/THWN-2.

2.04 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
   1. Size 10 AWG and Smaller: Solid.
   2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Grounding: Full-size integral equipment grounding conductor.

F. Armor: Steel, interlocked tape.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use compression connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
   5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
   6. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

H. Mechanical Connectors: Provide bolted type or set-screw type.

I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.06 ACCESSORIES

A. Electrical Tape:
   1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
   2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight;

conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
      c. Size raceways, boxes, etc. to accommodate conductors.
   8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install metal-clad cable (Type MC) in accordance with NECA 120.

E. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

H. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

I. Install conductors with a minimum of 12 inches of slack at each outlet.

J. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

M. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.

3. Wet Locations: Use heat shrink tubing.

O. Insulate ends of spare conductors using vinyl insulating electrical tape.

P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

1. Do not use conductors smaller that #6 AWG for grounding electrode system.

D. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect/ Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.

E. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.

2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
1. Use insulated copper conductors unless otherwise indicated.
    a. Exceptions:
        1) Use bare copper conductors where installed underground in direct contact with earth.
        2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

D. Oxide Inhibiting Compound: Comply with Section 26 0519.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 26 0553.

END OF SECTION

SECTION 26 0529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

C. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   7. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
   3. Manufacturers:
      a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
      b. Erico International Corporation: www.erico.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com/#sle.
      d. Substitutions: See Section 01 6000 - Product Requirements.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:
      a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
      b. Erico International Corporation: www.erico.com/#sle.
      c. Thomas & Betts Corporation: www.tnb.com/#sle.
      d. Substitutions: See Section 01 6000 - Product Requirements.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
   4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
   5. Manufacturers:

a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
b. Thomas & Betts Corporation: www.tnb.com/#sle.
c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
d. Substitutions: See Section 01 6000 - Product Requirements.
e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
a. Equipment Supports: 1/2 inch diameter.
b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
e. Outlet Boxes: 1/4 inch diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Powder-actuated fasteners are not permitted.
8. Hammer-driven anchors and fasteners are not permitted.
9. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
a. Comply with MFMA-4.
b. Channel Material: Use galvanized steel.
c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
10. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
11. Manufacturers - Mechanical Anchors:
a. Hilti, Inc: www.us.hilti.com/#sle.
b. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Unless specifically indicated or approved by Architect/ Engineer, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect/ Engineer, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Engineer.

H. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: Also comply with Section 26 0533.13.

J. Box Support and Attachment: Also comply with Section 26 0533.16.

K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

L. Secure fasteners according to manufacturer's recommended torque settings.

M. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect support and attachment components for damage and defects.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0533.13

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Stainless steel rigid metal conduit (RMC).

C. Stainless steel intermediate metal conduit (IMC).

D. Flexible metal conduit (FMC).

E. Liquidtight flexible metal conduit (LFMC).

F. Galvanized steel electrical metallic tubing (EMT).

G. Stainless steel electrical metallic tubing (EMT).

H. Conduit fittings.

I. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.

C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

D. Section 26 0529 - Hangers and Supports for Electrical Systems.

E. Section 26 0533.16 - Boxes for Electrical Systems.

F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

J. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

K. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

L. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

M. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

N. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.

O. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

P. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
   5. Notify Architect/ Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

C. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).
   1. EMT conduit is permitted only in damp locations if compression fittings are used.

E. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).

F. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
      b. Where exposed below 20 feet in warehouse areas.

G. Exposed, Exterior: Use galvanized steel rigid metal conduit.

H. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

I. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
   1. Maximum Length: 6 feet.

J. Flexible Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit (FMC).
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

K. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Fittings for Grounding and Bonding: See Section 26 0526 for additional requirements.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4-inch trade size.
   3. Control Circuits: 1/2-inch trade size.
   4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
   2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.08 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.
   4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.09 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Connectors and Couplings: Use compression/gland or set-screw type.

2.10 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

C. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   5. Unless otherwise approved, do not route exposed conduits:
      a. Across floors.
      b. Across roofs.
      c. Across top of parapet walls.
      d. Across building exterior surfaces.
   6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   7. Arrange conduit to maintain adequate headroom, clearances, and access.
   8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
   9. Arrange conduit to provide no more than 150 feet between pull points.
   10. Route conduits above water and drain piping where possible.
   11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
   12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
      a. Heaters.
      b. Hot water piping.
      c. Flues.
   13. Group parallel conduits in same area on common rack.

F. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 0529.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
   4. Use conduit strap to support single surface-mounted conduit.
      a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
   5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
   6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
   7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
   8. Use of wire for support of conduits is not permitted.
   9. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

G. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
8. Secure joints and connections to provide mechanical strength and electrical continuity.

H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 8400.

I. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 18 inches.
   b. Under Slab on Grade: 12 inches to bottom of slab.
2. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length.

J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

K. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
   a. Where conduits enter building from outside.
   b. Where service conduits enter building from underground distribution system.
   c. Where conduits enter building from underground.
   d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

L. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   1. Where conduits pass from outdoors into conditioned interior spaces.
   2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

M. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

N. Provide grounding and bonding; see Section 26 0526.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
   6. Coordinate the work with other trades to preserve insulation integrity.
   7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
   8. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use suitable concrete type boxes where flush-mounted in concrete.
   4. Use suitable masonry type boxes where flush-mounted in masonry walls.
   5. Use raised covers suitable for the type of wall construction and device configuration where required.
   6. Use shallow boxes where required by the type of wall construction.
   7. Do not use "through-wall" boxes designed for access from both sides of wall.
   8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
   11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   3. Junction and Pull Boxes Larger Than 100 cubic inches:
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

G. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes as required for devices installed under other sections or by others.
   4. Locate boxes so that wall plates do not span different building finishes.
   5. Locate boxes so that wall plates do not cross masonry joints.
   6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
   8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
   9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
      a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
      b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
   10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
   11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
      a. Concealed above accessible suspended ceilings.
      b. Within joists in areas with no ceiling.
      c. Electrical rooms.
      d. Mechanical equipment rooms.

H. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

I. Install boxes plumb and level.

J. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.

3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

K. Install boxes as required to preserve insulation integrity.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide grounding and bonding in accordance with Section 26 0526.

Q. Identify boxes in accordance with Section 26 0553.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Warning signs and labels.

1.02 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.

B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for identification labels, underground warning tape, and warning signs and labels.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Panelboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
         5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Enclosed switches:
1) Identify voltage and phase.
2) Identify power source and circuit number. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.

2. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
3. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
4. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
5. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
a. Service equipment.
b. Industrial control panels.
c. Motor control centers.
d. Elevator control panels.
e. Industrial machinery.
6. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
a. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. Within boxes when more than one circuit is present.
b. Within equipment enclosures when conductors and cables enter or leave the enclosure.
4. Use underground warning tape to identify direct buried cables.

C. Identification for Raceways:
1. Use color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
1) Color Code:
(a) Fire Alarm System: Red.
2) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.

D. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

a. For exposed boxes in public areas, use only identification labels.

E. Identification for Devices:
1. Use identification label to identify fire alarm system devices.
a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
1. Materials:
a. Indoor Clean, Dry Locations: Use plastic nameplates.
b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
a. Use only for indoor locations.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
a. System designation where applicable:
1) Fire Alarm System: Identify with text "FIRE ALARM".
b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
a. System Designation: 1 inch.
b. Equipment Designation: 1/2 inch.
5. Color:
a. Normal Power System: White text on black background.
b. Fire Alarm System: White text on red background.

D. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.04 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
      a. Do not use labels designed to be completed using handwritten text.
   2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conduits: Legible from the floor.
   8. Boxes: Outside face of cover.
   9. Conductors and Cables: Legible from the point of access.
   10. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION

SECTION 26 0583
WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
   2. Determine connection locations and requirements.

B. Sequencing:
   1. Install rough-in of electrical connections before installation of equipment is required.
   2. Make electrical connections before required start-up of equipment.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MATERIALS

A. Flexible Conduit: As specified in Section 26 0533.13.

B. Wire and Cable: As specified in Section 26 0519.

C. Boxes: As specified in Section 26 0533.16.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Provide receptacle outlet to accommodate connection with attachment plug.

E. Provide cord and cap where field-supplied attachment plug is required.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 2813
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

B. Section 26 2816.16 - Enclosed Switches: Fusible switches.

1.03 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
      a. Fusible Enclosed Switches: See Section 26 2816.16.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Fuses: One set(s) of three for each type and size installed.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.

B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.

C. Littelfuse, Inc: www.littelfuse.com.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 APPLICATIONS

A. General Purpose Branch Circuits: Class RK1, time-delay.

B. Individual Motor Branch Circuits: Class RK1, time-delay.

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

SECTION 26 2816.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

A. Section 26 0526 - Grounding and Bonding for Electrical Systems.

B. Section 26 0529 - Hangers and Supports for Electrical Systems.

C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

D. Section 26 2813 - Fuses.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Architect/ Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

C. Project Record Documents: Record actual locations of enclosed switches.

D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Substitutions: See Section 01 6000 - Product Requirements.

E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
   1. Minimum Ratings:
      a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

K. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

L. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

M. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

N. Heavy Duty Switches:
   1. Comply with NEMA KS 1.
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required support and attachment in accordance with Section 26 0529.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

I. Identify enclosed switches in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

E. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SUPPLEMENTAL MATERIALS

The following materials are provided for information to assist in the preparation of a bid. They are part of the project documents.

Stuart-McMunn Company

Air Conditioning • Refrigeration • Heating • Plumbing • Medical Gas • Digital Controls
Serving West Virginia, Virginia and Ohio Since 1917 !

Monday, August 18, 2014

PROJECT:	**NEW STATE OFFICE BUILDING**
ARCHITECTS:	**Omni Associates**
CONTRACTOR:	Stuart-McMunn Company 137 North Sixth Street Clarksburg WV 26301 Mechanical Contractor
MANUFACTURER:	**Andover Controls**
SPECIFICATION SECTION:	**230900 BUILDING AUTOMATION SYSTEM** **- Revision #2**

STUART-McMUNN COMPANY
SMCO JOB # 2013 CD
SMCO SUBMITTAL # 230900-3
WE HEREBY STATE THAT THIS DOCUMENT HAS BEEN REVIEWED FOR CONFORMANCE WITH THE DESIGN CONCEPT AND GENERAL COMPLIANCE WITH THE CONTRACT DOCUMENTS. THIS IN NO WAY RELEASES THE SUBCONTRACTOR/SUPPLIER FROM HIS RESPONSIBILITY TO ADHERE TO THE REQUIREMENTS OF THE CONTRACT DRAWINGS AND SPECIFICATIONS, INCLUDING ALL DIMENSIONS, QUANTITIES AND PERFORMANCE CRITERIA.
V APPROVED AS SUBMITTED
_____ APPROVED AS NOTED
_____ REJECTED - REVISE AND RESUBMIT
BY: LMW
DATE: 8/18/14

137 North Sixth Street • Clarksburg, WV 26301
Voice: 304.623.6666 • Fax: 304.623.4646 • email: leeanne@smco.us

CONTROLS SUBMITTAL

Building Automation System
for
State Office Building at Fairmont

New State Office Building

Architect

Omni Associates Architects

Engineer

Tower Engineering

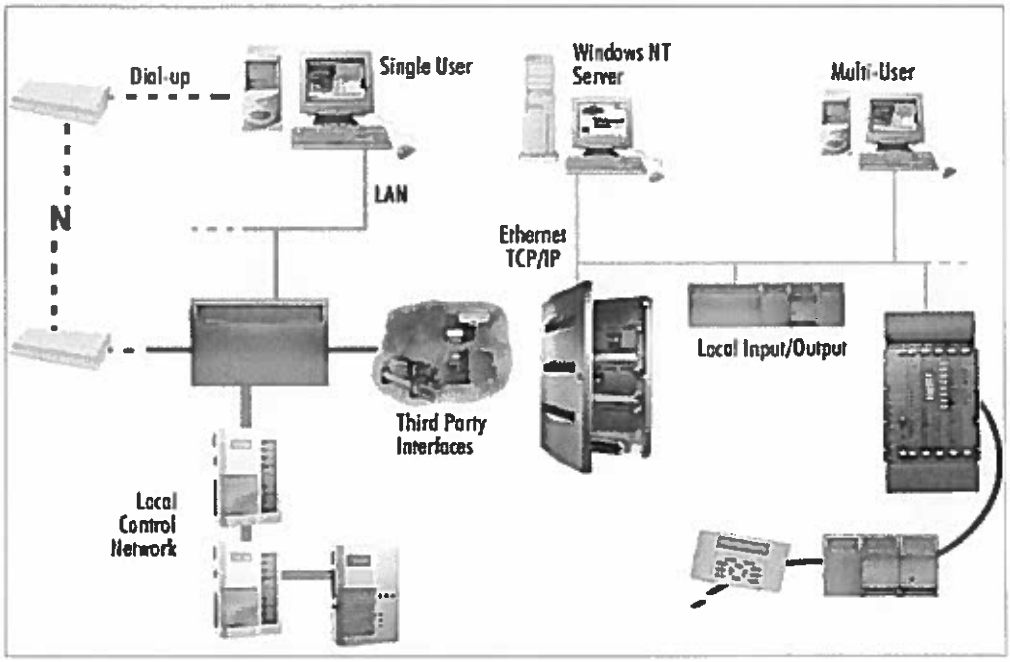
Mechanical Contractor

Stuart McMunn Company

Provided By
Mason & Barry, Inc.
101 Smiley Drive
St. Albans, WV 25177
Phone: (304) 755-0781
Fax: (304) 755-4010
E-Mail: controls@masonbarry.com

MASON & BARRY INC

Andover Controls
Certified Representative



Section 1: Andover Controllers

Controllers

SCHNEIDER ELECTRIC B3 810 CONTROLLER
SCHNEIDER ELECTRIC B3 850 SERIES CONTROLLER
SCHNEIDER ELECTRIC B3 887 CONTROLLER
SCHNEIDER ELECTRIC B3800 CONTROLLER
SCHNEIDER ELECTRIC B3865-V B3866-V CONTROLLER
SCHNEIDER ELECTRIC B3920 CONTROLLERS SUBMITTAL
SCHNEIDER ELECTRIC CONTROLLER B3 867

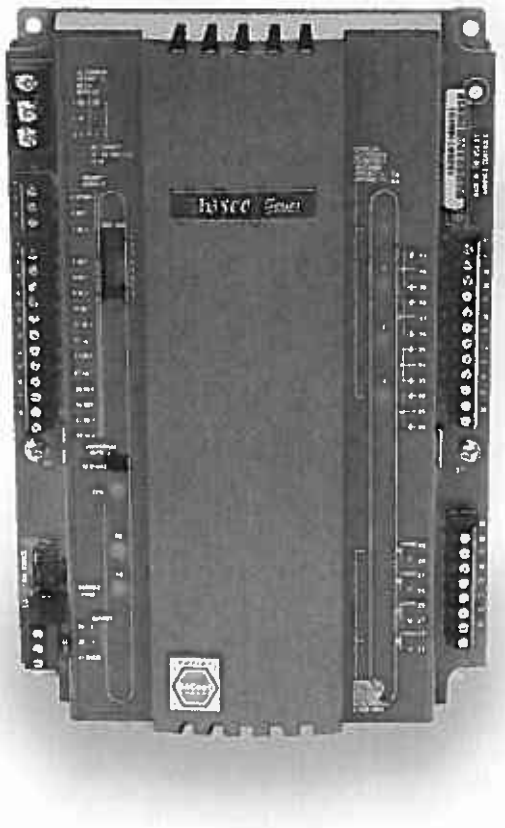
Controller Expansion Modules

SCHNEIDER ELECTRIC XP EXPANSION MODULES

Andover Continuum™

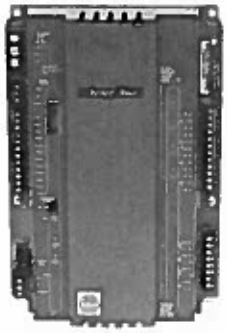
b3800 Series
Local Controllers

The Andover Continuum™ b3800 series controllers are native BACnet controllers that communicate on an RS-485 field bus as Master devices using the MS/TP BACnet protocol.



Schneider Electric

Andover Continuum
b3800 Series Local Connectors
Features



The b3800 series are designed for control of small Air Handling Units, Unit/ Roof Top, and other mechanical plant equipment. Choose the b3800 series controller with the configuration that matches your application:

- The b3800, designed for stand-alone equipment control of Roof Top or Air Handling Units, features eight Universal Inputs, one Smart Sensor/Room Sensor input, plus eight program-controlled Digital Outputs.
- The b3804, designed for stand-alone equipment control of Roof Top or Air Handling Units, features eight Universal Inputs, one Smart Sensor/Room Sensor input, plus four program-controlled Digital Outputs and four Analog Outputs for direct control of devices requiring 0-10 volt control signals.

Both models feature an additional room sensor input, which supports Andover Continuum Smart Sensor, or any standard room temperature sensor.

The b3800 series also features Flash memory, increased user memory, and a fast (32-bit) processor for faster scan times, with plenty of memory available for data logging of your critical data.

As a native BACnet controller, the b3800 series can communicate with other BACnet devices on the MS/TP network, in strict accordance with ANSI/ASHRAE standard 135-2004, and are listed with the BACnet Testing Labs (BTL) as BACnet Advanced Application Controllers (B-AAC). By connecting to an Andover Continuum b4920 device or bCX1 Network Controller, the b3800 series and other MS/TP devices can share data from the wider Ethernet/IP network of controllers.

PRODUCT AT A GLANCE

- Native BACnet MS/TP Communications for Interoperability to Third-Party Systems
- Supports 18 BACnet Object Types including Trends, Schedules, Calendars, and Loops
- Powerful, Flexible System Controller for the Most Demanding Applications
- Non-Volatile Flash Memory Provides Utmost Reliability – Stores Both Application Program and Operating System
- Universal Inputs can be Configured as a Supervised Input for Monitoring Open Wires or Short Circuits
- Local, Extended Storage of Log Data
- View and Modify Information with Optional Smart Sensor Display
- BTL Listed B-AAC Controller with Local Trends

Schneider Electric One High Street, North Andover, MA 01845 USA Telephone: +1 978 975 9600 Fax: +1 978 975 9674 www.schneider-electric.com/buildings

SDS-B3800-A4.BU.N.EN.1.2009.0.00.CC

Andover Continuum
b3800 Series Local Connectors
Features (continued)

Increased Reliability with Flash Memory

The b3800's non-volatile Flash memory stores your operating system and application programs, so that in the event of a power loss, your application will be restored when power is returned. In addition, the Flash memory allows for easy upgrades of your operating system via software downloads, eliminating the need to swap out proms.

The b3800 controllers include an on-board battery to safeguard your runtime data — protecting all point data and log data from being lost if power is removed.

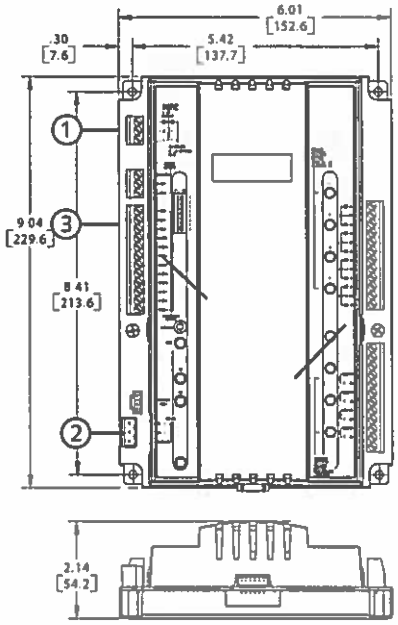
Inputs

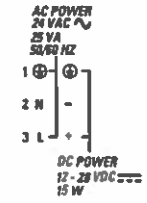
The input configuration on the b3800 series consists of eight full range, 10-bit Universal inputs that accept voltage (0-5VDC), digital (on/off), counter signals (up to 4Hz), temperature signals, or supervised alarm circuits for security applications or broken wire detection. The b3800 series offers an additional input to support the Andover Continuum Smart Sensor, or any standard room temperature sensor.

Outputs

The b3800 contains eight Form C relay outputs, each rated for 24 VAC/VDC, 3 amp, while the b3804 contains four Form C relay outputs and four analog outputs (0-10V).

Dimension Drawings





① Power Drawing

② Communications Drawing

Andover Continuum
b3800 Series Local Connectors
Features (continued)

Software Capabilities

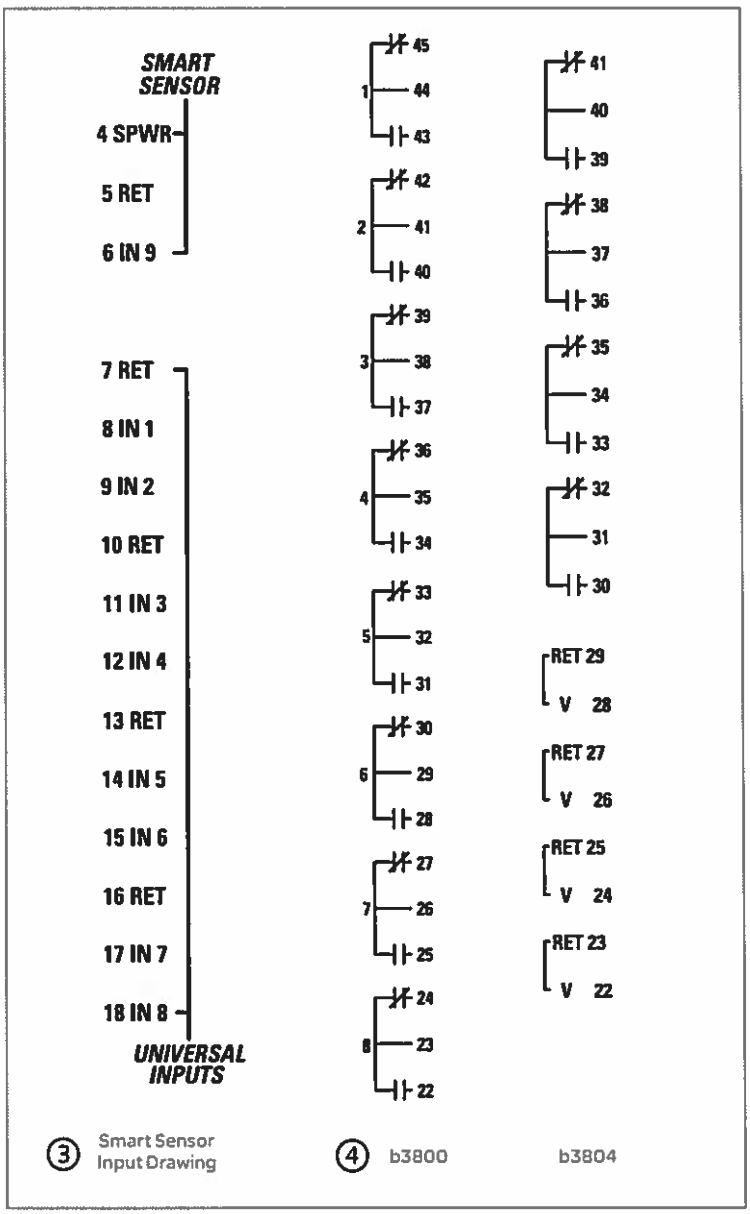
The dynamic memory of the b3800 can be allocated for any combination of programs, scheduling, alarming, and data logging using the powerful Andover Plain English programming language. Our object-oriented Plain English language with intuitive keywords provides an easy method to tailor the controller to meet your exact requirements. Programs are entered into the b3800 using the Andover Continuum CyberStationTM. Programs are then stored and executed by the b3800 controllers.

Programming multiple b3800 series controllers is inherently easy with Plain English. A complete copy of one b3800's programs can be loaded directly into other b3800s without changing any point names or programs.

Smart Sensor Interface

The b3800 provides a built-in connection for the Andover Continuum Smart Sensor. The Smart Sensor provides a 2-character LED display and a 6-button programmable keypad that enables operators and occupants to change setpoints, balance VAV boxes, monitor occupancy status, and turn equipment on and off. An enhanced version of the Smart Sensor is also available with a 4-digit custom LCD that provides the following icons: PM, %, °, Setpoint, Cool, Heat, CFM, Fan, OA, and SP.

Input Drawings



③ Smart Sensor Input Drawing ④ b3800 b3804

Andover Continuum
b3800 Series Local Connectors
Specifications

b3800 Series Local Connectors

Electrical

Power
24VAC, 12-24VDC - auto sensing, +10% -15%, 50/60 Hz

Power Consumption
25 VA

Overload Protection
Fused with 3 amp fuse. MOV protected

Software Real-Time Clock
Synchronized through MS/TP via BACnet

Mechanical

Operating Environment
-10°–140°F (-23–60°C), 10–95% RH (non-condensing)

Size
9.03"H x 6.01" W x 2.14"D (229 H x 153 W x 54 D) mm

Weight
1.34 lbs. (0.61 kg)

Enclosure Type
UL Open class, IP 10. Flammability rating of UL94-5V

Mounting
Panel mount

Battery

Battery Backup
Replaceable, non-rechargeable, lithium battery. Provides 5 years typical accumulated power failure backup of RAM memory

Communications

Communications Interface
RS-485 BACnet, MS/TP
127 devices maximum

Communications Speed
9600, 19.2K, 38.4K, 76.8K baud

BACnet Device Profile
B-AAC, BACnet Advanced Application Controller

Bus Length
4,000 ft. (1,220m) standard; BACnet repeater allows extension to longer distances.

Bus Media
Twisted, shielded pair, low capacitance cable

BTL Listed
B-AAC with Local Trends

Inputs

Inputs
8 Universal inputs: Voltage (0-5.115 VDC); Temperature -30°F to 230°F (-34°C to 110°C), Digital (on/off), Counter (up to 4Hz at 50% duty cycle, 125 ms min. pulse width). Supervised Alarm (single or double resistor). Current input (0 - 20 mA) using external 250 ohm resistor.
1 Smart Sensor Temperature Input (32°F to 105°F) (0°C to 41°C)

Input Voltage Range
0-5.115 volts DC

Input Impedance
10K ohm to 5.120V or 5M ohm with pull-up resistor disabled

Input Resolution
5.0 mV

Input Accuracy
±15mV (±0.56°C from -23°C to +66°C or ±1°F from -10°F to +150°F)

Digital Outputs

8 single pole single throw (SPST) Form C relays (4 Form C on b3804) (Any two consecutive Form C outputs can be configured as one Form K Tri-state)

Output Rating
Maximum 3A, 24VAC/VDC, ±1500V transients (Tested according to EN61000-4-4)

Output Accuracy
0.1 sec. for pulse width modulation

Analog Outputs

4 analog outputs (b3804 only)

Output Rating
For 0-10V: 5mA maximum, 2K ohm minimum impedance, ±1000V transients (Tested according to EN61000-4-4)

Output Resolution
0.1V for 0-10V

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Andover Continuum
b3800 Series Local Connectors
Specifications (continued)

b3800 Series Local Connectors

Connections

Power

3-position fixed screw terminal connector

Inputs

12-position fixed screw terminal connector

Outputs

b3800: 2- 12-position fixed screw terminal connector b3804: 1-12-position fixed screw terminal connector and 1- 8-position fixed screw terminal connector

Smart Sensor

3-position fixed screw terminal connector

Communications

3-position removable screw terminal connector

Service Port

4-position shrouded connector

User LEDs/Switches

Status Indicator LEDS:

CPU	CPU Active
TD	Transmit Data
RD	Receive Data
Output	Output Status (per output) (Digital only)

Switches

RESET

Input Pull-up Resistor Switch (per input)

General

Power

Memory: 128K SRAM, 1MB FLASH

Processor: Motorola 32-bit Coldfire

Agency Listings

UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, Class A, CE

Options

UL864, Smoke Control System Equipment, UUKL (b3800-S, b3804-S)

On October 1st, 2009, TAC became the Buildings Business of its parent company Schneider Electric. This document reflects the visual identity of Schneider Electric, however there remains references to TAC as a corporate brand in the body copy. As each document is updated, the body copy will be changed to reflect appropriate corporate brand changes.

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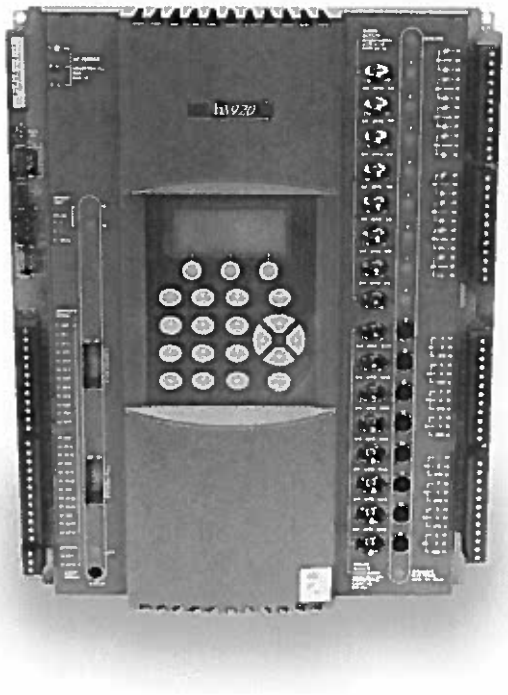
January 2009 pdw

Andover Continuum™

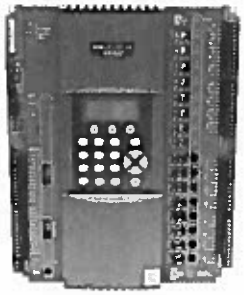
b3920 System Controllers

The Andover Continuum™ b3920 series controllers are native BACnet controllers that communicate on an RS-485 field bus as Master devices using the MS/TP BACnet protocol.



Schneider Electric

Andover Continuum b3920 System Controllers Features



The b3920, which is designed for control of large Air Handling Units, chillers, boilers, and other mechanical plant equipment, features plenty of dynamic memory for application programs as well as for expanded local data logging of critical data. The b3920 also features a fast 32-bit processor, universal inputs, override switches on all outputs, two-piece removable connectors, and an optional 4-line display with keypad. The b3920, similar to other Andover Continuum BACnet controllers, has an additional room sensor input, which supports Andover's Smart Sensor, or any standard room temperature sensor.

PRODUCT AT A GLANCE

- Native BACnet MS/TP Communications for Interoperability to Third-Party Systems
- Supports 18 BACnet Object Types including Trends, Schedules, Calendars, and Loops
- Powerful, Flexible System Controller for the Most Demanding Applications
- Expandable I/O Meets Additional Point Count Needs
- Non-Volatile Flash Memory Provides Utmost Reliability – Stores Both Application Program and Operating System
- Optional Local Display/Keypad Provides Easy Operator Interface
- Local, Extended Storage of Log Data
- View and Modify Information with Optional Smart Sensor Display
- BTL Listed B-AAC Controller with Local Trends

As a native BACnet controller, the b3920 series can communicate with other BACnet devices on the MS/TP network, in strict accordance with ANSI/ASHRAE standard 135-2004, and are listed with the BACnet Testing Labs (BTL) as BACnet Advanced Application Controllers (B-AAC). By connecting to Andover's Continuum b4920 device or bCX1, the b3920 and other MS/TP devices can share data from the wider Ethernet/IP network of controllers.

Increased Reliability with Flash Memory

The b3920's non-volatile Flash memory stores your operating system and application programs, so that in the event of a power loss, your application will be restored when power is returned. In addition, the Flash memory allows for easy upgrades of your operating system via software downloads, eliminating the need to swap out proms.

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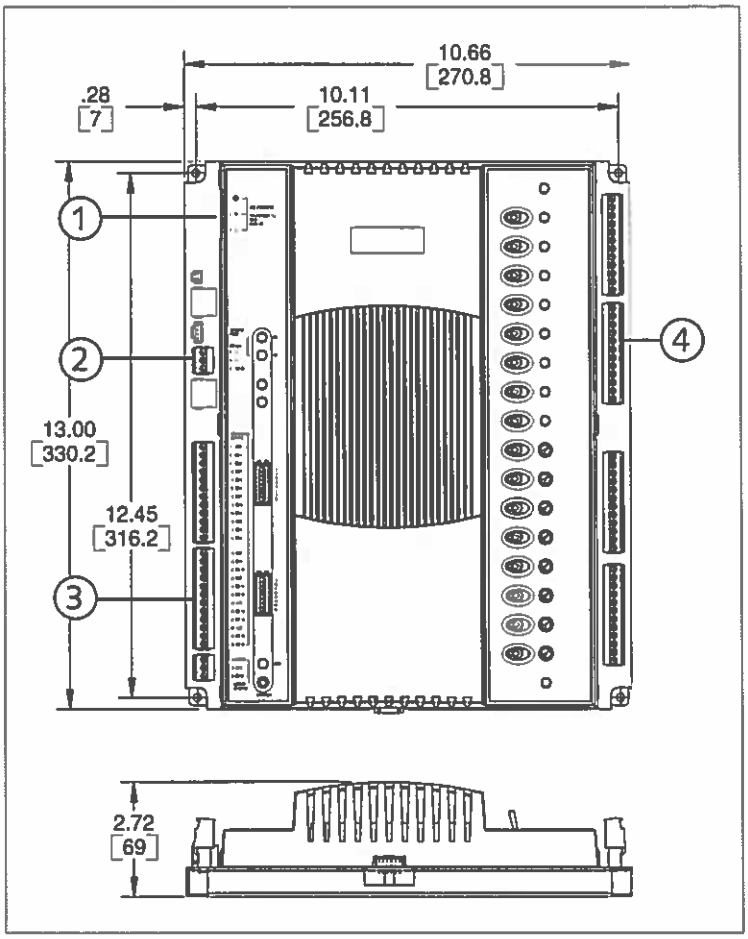
Andover Continuum
b3920 System Controllers
Features (continued)

Inputs
The input configuration on the b3920 series consists of sixteen full range, 12-bit Universal inputs that accept voltage (0-10VDC), digital (on/off), counter signals (up to 4Hz), temperature signals, or supervised alarm circuits for security applications. The b3920 offers an additional input to support the Andover Smart Sensor or any standard room temperature sensor.

Outputs
The b3920 contains 16 outputs - eight Form C relay outputs, each rated for 24 VAC/VDC, 3 amp, and eight analog outputs (0-10V, 4-20mA). Both the relay and analog outputs have manual override switches, with software feedback of the switch position.

I/O Expansion
The b3920 contains an I/O expansion port for the addition of up to two Andover xP expansion modules directly on the bottom of the controller. The xP family of modules includes the DI-8, DO-2, DO-4, UI-4, AO-2, and AO-4. In addition, the I/O bus supports the xP Local Display Module, which allows the user to view and change point values. The Local Display Module is also available factory-mounted directly onto the b3920.

Dimensional Drawings



Andover Continuum b3920 System Controllers Features (continued)

Software Capabilities

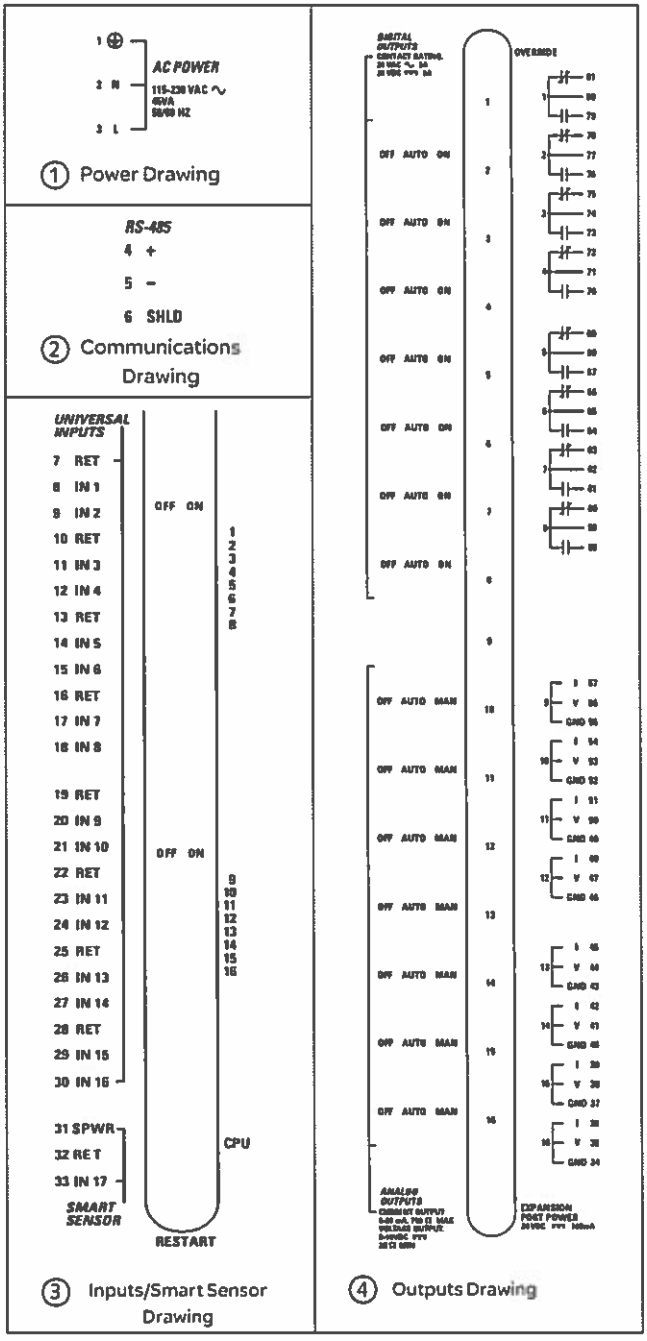
The dynamic memory of the b3920 can be allocated for any combination of programs, scheduling, alarming, and data logging using the powerful Andover Plain English programming language. Our object-oriented Plain English language with intuitive keywords provides an easy method to tailor the controller to meet your exact requirements. Programs are entered into the b3920 using the Andover Continuum CyberStation™. Programs are then stored and executed by the b3920 controllers.

Programming multiple b3920 controllers is inherently easy with Plain English. A complete copy of one b3920's programs can be loaded directly into other b3920s without changing any point names or programs.

Smart Sensor Interface

The b3920 provides a built-in connection for Andover Continuum Smart Sensor. The Smart Sensor provides a 2-character LED display and a 6-button programmable keypad that enables operators and occupants to change setpoints, balance VAV boxes, monitor occupancy status, and turn equipment on and off. An enhanced version of the Smart Sensor is also available with a 4-digit custom LCD that provides the following icons: PM, %, °, Setpoint, Cool, Heat, CFM, Fan, OA, and SP.

Dimensional Drawings



① Power Drawing

② Communications Drawing

③ Inputs/Smart Sensor Drawing

④ Outputs Drawing

Andover Continuum b3920 System Controllers Specifications

b3920 System Controllers

Electrical

Power
115/230 VAC, +10% -15%, 50/60 Hz
Power Consumption
45 VA
Overload Protection
Fused with 3 amp fuse, MOV protected
Real-Time Clock
Battery-backed real-time clock

Mechanical

Operating Environment
32°–120°F (0–49°C),
10–95% RH (non-condensing)
Size
13.00˝ H x 10.66˝ W x 2.72˝ D
(330.2H x 270.8 W x 69.0 D) mm
Weight
3.5 lbs. (1.58 kg)
Enclosure Type
UL Open class, IP 10.
Flammability rating of UL94-5V
Mounting
Panel mount

Battery Backup

Replaceable, non-rechargeable, lithium battery. Provides 5 years typical accumulated power failure backup of RAM memory

Communications

Communications Interface
RS-485 BACnet, MS/TP
127 devices maximum
Communications Speed
9600, 19.2K, 38.4K, 76.8K baud
Bus Length
4,000 ft. (1,220m) standard;
BACnet repeater allows extension to longer distances.
Bus Media
Twisted, shielded pair, low capacitance cable
BACnet Device Profile
B-AAC, BACnet Advanced Application Controller
BTL Listed
B-AAC with Local Trends

Inputs

16 Universal inputs: Voltage (0-10 VDC); Temperature -30°F to 230°F (-34°C to 110°C), Digital (on/off), Counter (up to 4Hz at 50% duty cycle, 125 ms min. pulse width). Supervised Alarm (single or double resistor). Current input (0 - 20 mA) using external 500 ohm resistor
1 Smart Sensor Temperature Input (32°F to 105°F) (0°C to 41°C)
Input Voltage Range
0-10 volts DC
Input Impedance
30.1K ohm to 10V or 5M ohm with pull-up resistor disabled
Input Protection
24 VAC or 24 VDC temporarily on any single channel, ±1000V transients (Tested according to EN61000-4-4)
Input Resolution
2.5 mV
Input Accuracy
±7.5mV (±0.25°C from -23°C to +54°C) or (±0.46°F from -10°F to +130°F)

Digital Outputs

8 single pole single throw (SPST) Form C relays (Any two consecutive Form C outputs can be configured as one Form K Tri-state)
Output Rating
Maximum 3A, 24VAC/VDC, ±1500V transients (Tested according to EN61000-4-4)
Output Accuracy
0.1 sec. for pulse width modulation

Analog Outputs

8 analog outputs
Output Rating
0-10V (5mA maximum, 2K ohm minimum impedance), or 4-20mA per channel. Fuse-protected. ±1000V transients (Tested according to EN61000-4-4)
Output Resolution
0.1V for 0-10V; 0.1mA for 4-20mA
Output Overrides
Each output is equipped with a manual override switch. Software feedback of the switch position is provided, for display and alarming
Expansion Bus
Interfaces to optional xP I/O Expansion Modules

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Andover Continuum
b3920 System Controllers
Specifications (continued)

b3920 System Controllers

Connections

Power
3-position fixed screw terminal connector

Inputs
Removable two-piece terminal strip

Outputs
Removable two-piece terminal strip

Smart Sensor
Removable two-piece terminal strip

Communications
Removable two-piece terminal strip

Expansion Port
6-position shrouded connector

Service Port
4-position shrouded connector

User LEDs/Switches

Status Indicator LEDs

CPU	CPU Active
TD	Transmit Data
RD	Receive Data
Output	Output Status (per output)
EXPANSION	
PORT PWR	Power Status
OVERRIDE	Override Status

Switches
RESET
Input Pull-up Resistor Switch (per input)
Individual Output Override Switches

General

Memory
1MB SRAM, 2MB FLASH

Processor
Motorola 32-bit Coldfire

Agency Listings

UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, Class A, CE

Options

UL864, Smoke Control System Equipment, UUKL (b3920-S)

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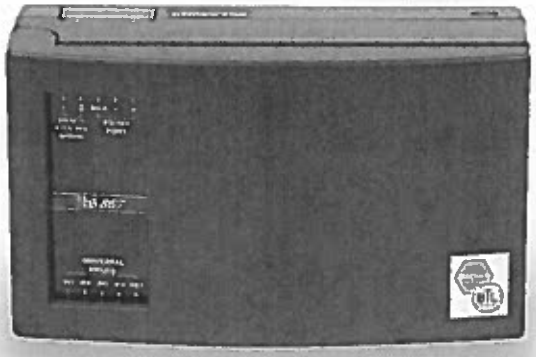
October 2005 pdw

BACnet

b3867 Terminal Controllers

The Andover Continuum™ b3867 is a native BACnet controller that communicates on an RS-485 field bus as a Master device using the MS/TP BACnet protocol.



Schneider Electric

BACnet b3867 Terminal Controllers
Features

The b3867 provides cost-effective DDC control of package units, heat pumps, unit ventilators, and other terminal unit applications. Its versatile mix of I/O – Universal inputs, Triac outputs, plus an interface to Andover's Continuum Smart Sensor room temperature sensor with programmable keypad – allows for flexible control solutions. The b3867 also features two analog outputs to control reheat valves, dampers, lighting ballasts, etc. And because the b3867 is enclosed in a sleek, modular casing, it can be mounted in a small area – perfect for retrofit applications.

PRODUCT AT A GLANCE

- Native BACnet MS/TP Communications for Interoperability to Third-Party Systems
- Supports 18 BACnet Object Types including Trends, Schedules, Calendars, and Loops
- Compact Terminal Controller Provides Low-cost DDC Control of Package Units,Heat Pumps, Unit Ventilators
- Universal Inputs with Form A, Form K, and Analog Outputs for Flexible Control Options
- Non-Volatile Flash Memory Provides Utmost Reliability – Stores Both Application Program and Operating System
- Flash Memory Allows Easy On-Line Software Updates
- Local Extended Storage of Log Data
- On-Board Service Port
- Modular, Sleek Design SimplifiesInstallation in Small Areas
- View and Modify Information with Optional Andover Smart Sensor Display
- BTL Listed B-AAC Controller with Local Trends

The b3867 features Flash memory, increased user memory, and a fast (32-bit) processor for faster scan times, with plenty of additional memory available for data logging of your critical data.

As a native BACnet controller, the b3867 can communicate with other BACnet devices on the MS/TP network, in strict accordance with ANSI/ASHRAE standard 135-2004, and are listed with the BACnet Testing Labs (BTL) as BACnet Advanced Application Controllers. (B-AAC). By connection to the Andover Continuum b4920 or bCX1 controller, the b3867's and other MS/TP devices can share and gather data from the wider Ethernet/IP network of controllers. Among those Ethernet controllers can be Andover Continuum controllers (BACnet or Andover Continuum Infinet) or third-party BACnet/IP devices. All Andover Continuum devices, both BACnet and Andover Continuum Infinet, are fully compatible with the Andover Continuum CyberStation front-end software, a fully native BACnet Operator Workstation (B-OWS) application.

Increased Reliability with Flash Memory

The b3867's non-volatile Flash memory stores your operating system and application programs, so that in the event of a power loss, your application will be restored when power is returned. In additon, the Flash memory allows for easy upgrades of your operating system via software downloads, eliminating the need to swap out proms. The b3867 includes an on-board battery to safeguard your runtime data – protecting all point data and log data from being lost if power is removed.

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BACnet b3867 Terminal Controllers
Features (continued)

Inputs
The input configuration on the b3867 consists of four full range Universal inputs that accept voltage (0-5VDC), digital (on/off), counter signals (up to 4Hz), or temperature signals. The b3867 also offers a fifth input to support the Andover Smart Sensor, or any standard room temperature sensor.

Outputs
The b3867 contains five Form A Triac-based outputs. Each Triac is ground referenced. These outputs can be used separately for on/off or pulsed control of lighting, heat, and fan units or be configured into Form K Tri-state outputs (2-max) for bi-directional control of dampers and valves, with a free Triac output remaining.

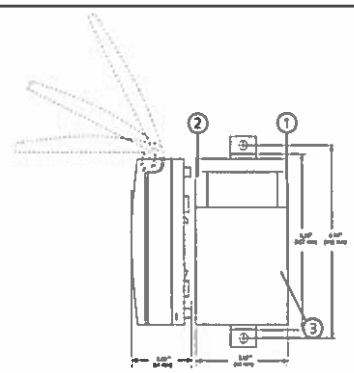
(Note: Any two consecutive Triac outputs can be configured as a Form K output.) Outputs are rated for AC loads only. The b3867 also offers two (0-10V) analog outputs.

Software Capabilities
The dynamic memory of the b3867 can be allocated for any combination of programs, scheduling, alarming, and data logging using the powerful Andover Plain English programming language. Our object-oriented Plain English language with intuitive keywords provides an easy method to tailor the controller to meet your exact requirements. Programs are entered into the b3867 using the Andover Continuum CyberStation™. Programs are then stored and executed by the b3867.

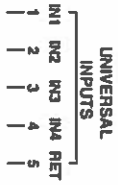
Programming multiple b3867s is inherently easy with Plain English. A complete copy of one b3867's programs can be loaded directly into other b3867s without changing any point names or programs.

Smart Sensor Interface
The b3867 provides a built-in connection for Andover Continuum Smart Sensor. The Smart Sensor provides a 2-character LED display and a 6-button programmable keypad that enables operators and occupants to change setpoints, balance VAV boxes, monitor occupancy status, and turn equipment on and off. An enhanced version of the Smart Sensor is also available with a 4-digit custom LCD that provides the following icons: PM, %, °, Setpoint, Cool, Heat, CFM, Fan, OA, and SP.

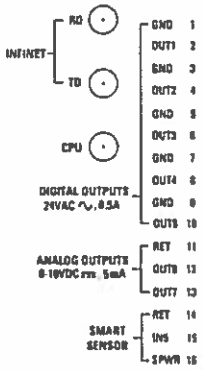
Dimensional Drawings



① Power and Communications Drawing



② Inputs Drawing



③ Outputs/Smart Sensor Drawing

BACnet b3867 Terminal Controllers Specifications

b3867 Terminal Controllers

Electrical

Power
24 VAC, +10% -15%, 50/60 Hz
Power Consumption
4 VA
Overload Protection
Fused with 2 amp fuse. MOV protected
Software Real-Time Clock
Synchronized through MS/TP

Mechanical

Operating Environment
32°–120°F (0–49°C),
10–95% RH (non-condensing)
Size
6.20˝ H x 3.50˝ W x 2.50˝ D
(157H x 89W x 64) mm
Weight
0.64 lbs. (0.29 kg)
Enclosure Type
UL Open class, IP 10.
Flammability rating of UL94-5V

Battery

Battery Backup
Replaceable, non-rechargeable, lithium battery. Provides 5 years typical accumulated power failure backup of RAM memory.

Communications

Communications Interface
RS-485, BACnet MS/TP
Communications Speed
9600, 19.2K, 38.4K, 76.8K baud
Bus Length
4,000 ft. (1,220m) standard; Andover Continuum Infinet repeater module allows extension to longer distances.
Bus Media
Twisted, shielded pair, low capacitance cable
Andover Continuum Infinet Device Profile
Advanced Application Controller
BTL Listed
B-AAC with Local Trends

Inputs/Outputs

Inputs
4 Universal inputs: Voltage (0-5.115 VDC); Temperature -30°F to 230°F (-34°C to 110°C), Digital (on/off), Counter (up to 4Hz at 50% duty cycle, 125 ms min. pulse width). Current input (0 - 20 mA) using external 250 ohm resistor
1 Smart Sensor Temperature Input (32°F to 105°F) (0°C to 41°C)
Input Voltage Range
0-5.115 volts DC
Input Impedance
10K ohm to 5.120V or 5M ohm with pull-up resistor disabled
Input Protection
24 VAC or 24 VDC temporarily on any single channel, ±1000V transients (Tested according to EN61000-4-4)
Input Resolution
5.0 mV
Input Accuracy
±15mV (±0.56°C from -23°C to +66°C or ±1°F from -10°F to +150°F)
Outputs
5 single pole single throw (SPST) Form A Triacs (Any two consecutive outputs can be configured as one Tri-State Form K). 2 analog outputs (0-10V)
Output Rating
For SPST: Maximum 0.5A, 24VAC, ±2000V transients (Tested according to EN61000-4-4) Minimum: 20 mA AC
Each Triac is ground referenced, DC loads not permitted.

For 0-10V: 5 mA maximum, 2K ohm minimum impedance, ±1000V transients (Tested according to EN61000-4-4)
Output Accuracy
For SPST: 0.1 sec. for pulse width modulation
For 0-10V: 50 mV resolution/100mV accuracy

BACnet b3867 Terminal Controllers
Specifications (continued)

b3867 Terminal Controllers

Connections

Power/Communications

5-position removeable screw terminal connector

Inputs

5-position removeable screw terminal connector

Outputs/Smart Sensor

16-position removeable screw terminal connector

Service Port

4-position shrouded connector

Uwer LEDs/Switches

Status Indicator LEDs

CPU CPU Active

TD Transmit Data

RD Receive Data

Switches

RESET

Input Pull-up Resistor Switch (per input)

General

Memory

128K SRAM, 1MB FLASH

Processor

Motorola 32-bit Coldfire

Agency Listings

UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, and VCCI Class A, CE

Options

UL864, Smoke Control System Equipment, UUKL (i2867-S)

Wireless BACnet b3867 version (b3867-WL)

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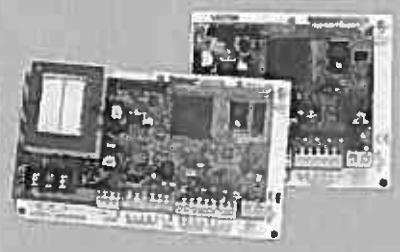
August 2007 pdw



Continuum™
b3887 Terminal Controllers

- Native BACnet MS/TP Communications for Interoperability to Third-Party Systems
- Supports 18 BACnet Object Types including Trends, Schedules, Calendars, and Loops
- Compact Terminal Controller Provides Low-cost Fan Coil and Heat Pump Control
- Three Universal Inputs and One Smart Sensor/Room Sensor Input
- Four Form A Triac Outputs, One Form A Relay, 277 VAC @3A
- Non-Volatile Flash Memory Provides Utmost Reliability — Stores Both Application Program and Operating System
- Removable Terminal Blocks for Easy Serviceability
- Flash Memory Allows Easy On-Line Software Updates
- View and Modify Information with Optional Andover Continuum Smart Sensor Display
- Local On-Board Service Port
- BTL Listed B-AAC Controller with Local Trends

The Andover Continuum™ b3887 is a native BACnet controller that communicates on an RS-485 field bus as a Master device using the MS/TP BACnet protocol. With its unique mix of three Universal inputs, one Smart Sensor/room sensor input, four Triac outputs, and one relay output, the b3887 is designed to be a general purpose terminal controller for low-cost heat pump, fan coil, or AC unit control. Use the b3887 for direct control of fans, staged heating and cooling and monitoring of room temperature, outside air temperature, return air temperature, or occupancy status.

The b3887 is compact so it can be installed in tight locations with three mounting screws, and its removable terminal connectors allow for easy servicing.

While the standard b3887 version uses 24 VAC input power, the b3887-L model accepts incoming line voltage at 115 or 230 VAC, has an onboard transformer, and the same versatile I/O configuration.

Similar to all b3 controllers, the b3887 features Flash memory and a fast (32-bit) processor for faster scan times, with plenty of additional memory available for data logging of your critical data.

As a native BACnet controller, the b3887 can communicate with other BACnet devices on the MS/TP network, in strict accordance with ANSI/ASHRAE standard 135-2004, and is listed with the BACnet Testing Labs (BTL) as BACnet Advanced Application Controller (B-AAC). By connection to the Continuum b4920 or bCX1 controller, the b3887's and other MS/TP devices can share and gather data from the wider Ethernet/IP network of controllers. Among those Ethernet controllers can be Continuum controllers (BACnet or Infinet) or third-party BACnet/IP devices. All Andover Continuum devices, both BACnet and Infinet, are fully compatible with the Continuum CyberStation front-end software, a fully native BACnet Operator Workstation (B-OWS) application.

INCREASED RELIABILITY WITH FLASH MEMORY

The b3887's non-volatile Flash memory stores your operating system and application programs, so that in the event of a power loss, your application will be restored when power is returned. In addition, the Flash memory allows for easy upgrades of your operating system via software downloads, eliminating the need to swap out proms.

The input configuration on the b3887 consists of three full range Universal inputs that accept voltage (0-5VDC), digital (on/off), counter signals (up to 4Hz), or temperature signals. The b3887 also offers a fourth input to support the Continuum Smart Sensor, or any standard room temperature sensor.

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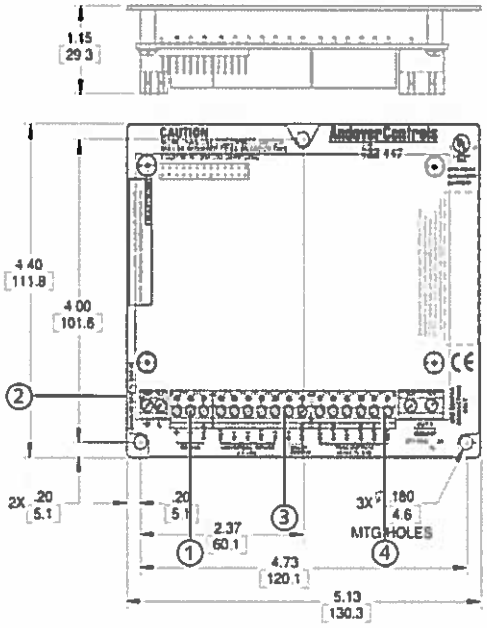
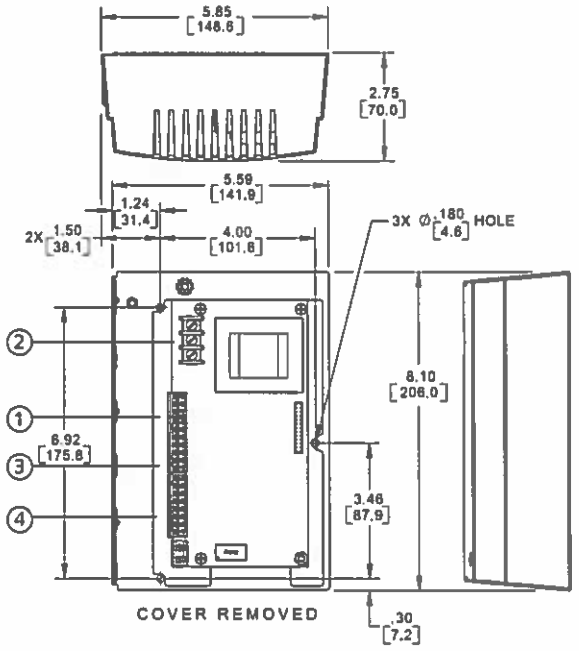
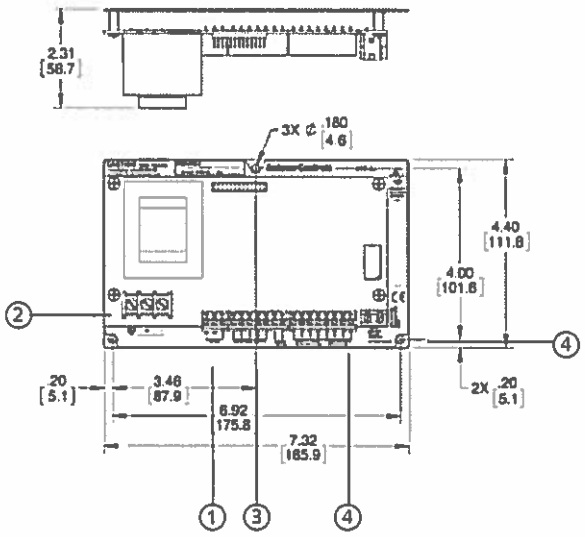
b3887 Terminal Controllers



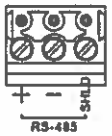
b3887 Dimensional Drawing



b3887-L Closed Class

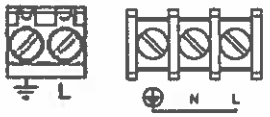


b3887-L-xxx Dimensional Drawing

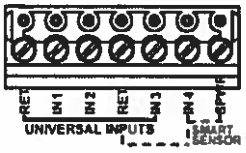


① Communications Drawing

b3887 b3887-L-xxx

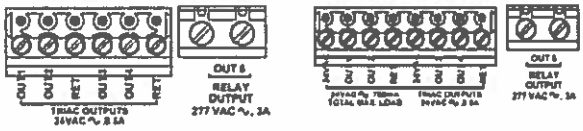


② Power Drawing



Inputs Drawing

b3887 b3887-L-xxx



④ Outputs Drawing

SPECIFICATIONS

b3887 Terminal Controllers

ELECTRICAL

Power
b3887: 24 VAC, +10% -15%, 50/60 Hz or b3887-L-xxx: 115/230 VAC, +10% -15%, 50/60 Hz

Power Consumption
b3887: 10 VA
b3887-L-xxx: 32 VA
b3887-L-xxx-C 32 VA

Overload Protection
Fused with 1 amp fuse. MOV protected

Software Real-Time Clock
Synchronized through MS/TP via BACnet

MECHANICAL

Operating Environment
32°–120°F (0–49°C), 10–95% RH (non-condensing)

Size
b3887: 4.40"H x 5.13"W x 1.15"D (111H x 130W x 30D) mm
b3887-L-xxx: 4.40"H x 7.32" W x 2.31"D (111H x 186W x 59D) mm

Weight
b3887: 0.5 lbs. (0.23 kg)
b3887-L-xxx: 1.9 lbs. (0.86 kg)
b3887-L-xxx-C: 2.63 lbs. (1.19 kg)

Enclosure Type
UL Open class, IP 10. Flammability rating of UL94-5V
b3887-L-xxx-C
UL Close class, IP20
Flamibility rating of UL-94-5V

Mounting
Panel mount

COMMUNICATIONS

Communications Interface
RS-485, BACnet MS/TP

Communications Speed
9600, 19.2K, 38.4K, 76.8K baud

Bus Length
4,000 ft. (1,220m) standard; BACnet repeater module allows extension to longer distances

Bus Media
Twisted, shielded pair, low capacitance cable

BACnet Device Profile
B-AAC, BACnet Advanced Application Controller

BTL Listed
B-AAC with Local Trends

INPUTS/OUTPUTS

Inputs
3 Universal inputs: Voltage (0-5.115 VDC); Temperature -30°F to 230°F (-34°C to 110°C), Digital (on/off), Counter (up to 4Hz at 50% duty cycle, 125 ms min. pulse width). Current input (0 - 20 mA) using external 250 ohm resistor

1 Smart Sensor Temperature Input (32°F to 105°F) (0°C to 41°C)

Input Voltage Range
0-5.115 volts DC

Input Impedance
10K ohm to 5.120V

Input Protection
24 VAC or 24 VDC temporarily on any single channel, ±1000V transients (Tested according to EN61000-4-4)

Input Resolution
5.0 mV

Input Accuracy
±15mV (±0.56°C from -23°C to +66°C or ±1°F from -10°F to +150°F)

Outputs
4 single pole single throw (SPST) Form A Triacs (any two consecutive outputs can be configured as one Tri-state Form K)
1 Form A Relay, 277 VAC @3A

Triac Output Rating
Maximum 0.3A, 24VAC, ±2000V transients (Tested according to EN61000-4-4)
Minimum: 30 mA AC
Each Triac is ground referenced, DC loads not permitted

Output Accuracy
0.1 sec. for pulse width modulation

CONNECTIONS

Power
2-position fixed screw terminal connector
(b3887-L: 3-position fixed)

Communications
3-position removable screw terminal connector

Inputs/Smart Sensor
7-position removable screw terminal connector

Outputs
6-position removable screw terminal connector (b3887-L: 8-position)

Relay
2-position fixed screw

Service Port
4-position connector

USER LEDS/SWITCHES

Status Indicator LEDS

CPU	CPU Active

GENERAL

Memory
512K SRAM, 1MB FLASH

Processor
Motorola 32-bit Coldfire

USER LEDS/SWITCHES

b3887:	Power: 24 VAC
b3887-L-115:	Power: 115 VAC
b3887-L-230:	Power: 230 VAC
b3887-L-115-C:	Power: 115 VAC-Closed Class
b3887-L-230-C:	Power: 230 VAC-Closed Class

Note: b3887-L models provide onboard 24 VAC @750 mA for external loads.

AGENCY LISTINGS

UL/CUL 916, FCC CFR 47 Part 15, ICES-003, EN55022, AS/NZS 3548, and VCCI Class A, CE

OUTPUTS

The b3887 contains five digital outputs — four Form A Triac-based outputs plus one Form A relay output, capable of switching line voltage.

These outputs can be used separately for on/off or pulsed control of lighting, heat, and fan units can be configured into Form K Tri-state outputs (2-max) for bi-directional control of dampers and valves. (Note: Any two consecutive Triac outputs can be configured as a Form K output.) All Triac outputs are ground referenced and rated for AC loads only.

SOFTWARE CAPABILITIES

The dynamic memory of the b3887 can be allocated for any combination of programs, scheduling, alarming, and data logging using the powerful Andover Plain English programming language. Our object-oriented Plain English language with intuitive keywords provides an easy method to tailor the controller to meet your exact requirements. Programs are entered into the b3887 using the Continuum CyberStation™. Programs are then stored in, and executed by, the b3887.

Programming multiple b3887s is inherently easy with Plain English. A complete copy of one b3887's programs can be loaded directly into other b3887s without changing any point names or programs. In addition, channel assignments for the b3887 are similar to other Continuum devices such as the b3851 for easy program conversion.

SMART SENSOR INTERFACE

The b3887 provides a built-in connection for Andover Continuum's Smart Sensor. The Smart Sensor provides a 2-character LED display and a 6-button programmable keypad that enables operators and occupants to change setpoints, balance VAV boxes, monitor occupancy status, and turn equipment on and off. An enhanced version of the Smart Sensor is also available with a 4-digit custom LCD that provides the following icons: PM, %, °, Setpoint, Cool, Heat, CFM, Fan, OA, and SP.

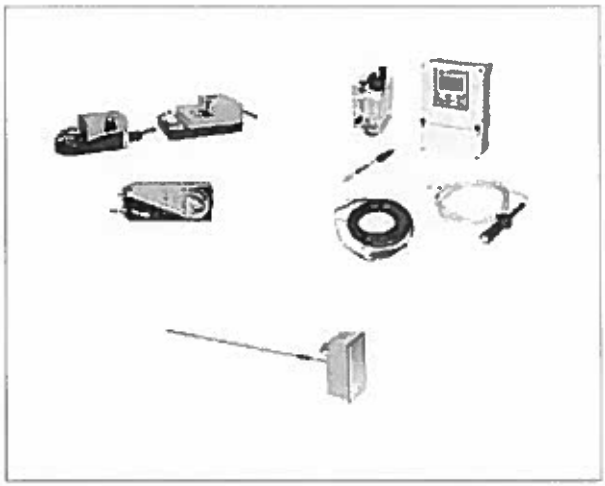
SDS-B3887
10/05

a company of Schneider Electric

N1831

www.tac.com

t.a.c



Section 2: Field Devices

Current & Voltage Sensors

SENVA C-1220 MICRO SOLID CORE CURRENT SENSOR
VERIS H708 CURRENT SENSOR
VERIS H735 CURRENT SENSOR
VERIS H800 CURRENT SENSOR
VERIS H904 VFD CURRENT SWITCH

Dampers & Damper Actuators

BELIMO DAMPER ACTUATOR AF24
BELIMO DAMPER ACTUATOR AFB24-SR AFX24-SR

Flow Sensors

EBTRON GTA116PC GOLD SERIES AIRFLOW MEASUREMENT
ONICON DISPLAY DB-1200 SERIES BI-DIR FLOW

Gas & Specialty Sensors

KELE KCD SERIES CO2 SENSOR
SENVA OA CO2 SENSOR
VERIS G SERIES CO SENSOR

Humidity Sensors

SCHNEIDER ELECTRIC EH SERIES HUMIDITY SENSOR

Operator Switches & Indicating Lights

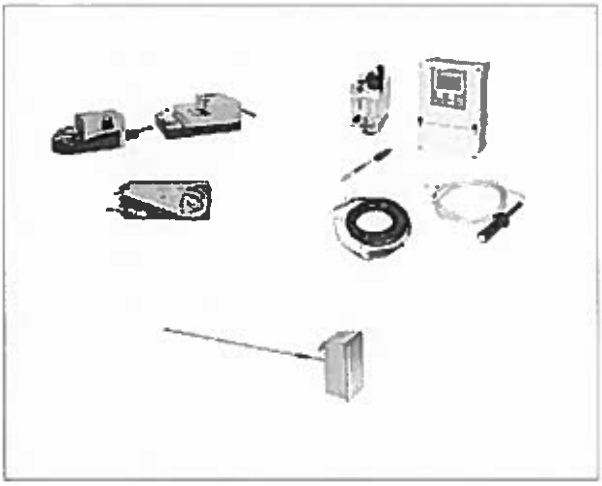
KELE APW PILOT LIGHTS

Pressure Sensors

KELE RPS ROOM STATIC PRESSURE SENSOR
MAMAC PR-274 AND PR-275 LOW PRESSURE TRANSDUCER
SCHNEIDER ELECTRIC EPW-104 WATER DIFFERENTIAL PRESSURE

Switches & Stats

KELE ASW SELECTOR SWITCH
KELE JMP SERIES FLOAT SWITCHES
KELE ST120 EMERGENCY OPERATOR STATION



Section 2: Field Devices

Temperature Sensors

SCHNEIDER ELECTRIC ET SERIES TEMP SENSORS
SCHNEIDER ELECTRIC TC-5242 FREEZESTAT
SCHNEIDER ELECTRIC TTS-S-1 WALLMOUNT TEMPERATURE SENSOR
SCHNEIDER ELECTRIC TTS-SD TEMP SENSOR

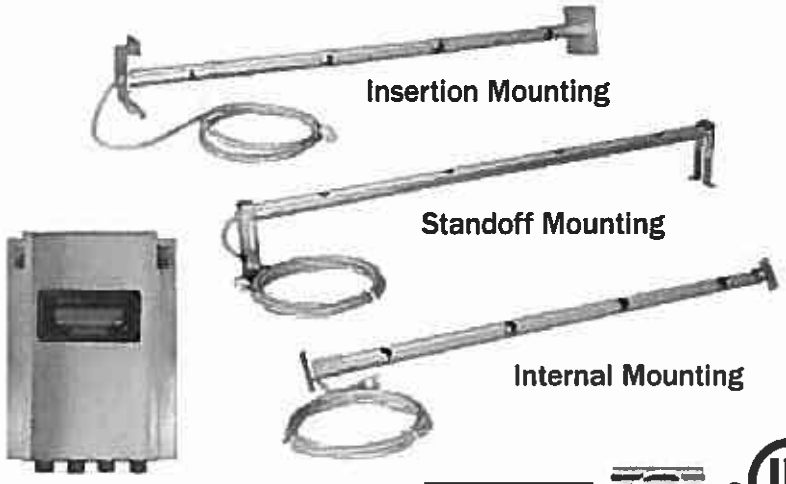
Advantage GOLD Series by Ebtron

Model GTx116-**Pc**

Technical Data I-P Units

GTx116PC.TECH.3

High Density Airflow Measurement Systems



LONWORKS® c UL us LISTED

System Features

- Each sensor is factory calibrated to NIST traceable airflow and temperature standards.
- Accurate and repeatable measurement from still air (0 ft./min.).
- High sensor density (up to 16 independent sensors per duct).
- True average, independent multi-point sensing.
- Versatile mounting options for placement in traditionally difficult field locations.
- Advanced Thermal Dispersion (TD) airflow measurement technology.
- Sensor and transmitter diagnostics with intelligent sensor detection system.
- Gold anodized sensor probes.
- Stable, hermetically sealed "bead in glass" thermistor sensors.
- Exclusive "plug and play" SMART sensor design.
- Microprocessor based digital circuitry with FLASH memory.
- Fully temperature compensated.
- Provides direct signal(s) to all B.A.S.

Contents:

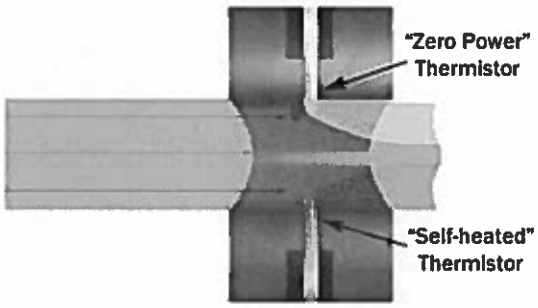
EBTRON

Thermal Dispersion Airflow Measurement

1663 Hwy. 701 S., Loris, SC 29569 USA
Toll Free: 800-2EBTRON (232.8766) Fax: 843.756.1838
Internet: www.ebtron.com e-mail: ebtron@ebtron.com

What is Thermal Dispersion?

Thermal dispersion technology was pioneered by ***EBTRON*** in the early 1980's. Thermal dispersion determines airflow by relating the heat transfer rate of a heated element to the airflow rate. As the velocity across the sensor increases, the heat transfer rate increases. Each sensor is calibrated in a wind tunnel to NIST-traceable airflow standards.



EBTRON **Thermistor Sensor Assembly**

EBTRON technology uses two biomedical grade thermistors to determine the airflow rate at each sensing location. One "zero-power" thermistor measures the ambient air temperature while a second thermistor is heated above ambient by providing enough power to "self-heat" the device. The raw signals are then multiplexed and measured by a microprocessor-based transmitter using a precision analog-to-digital (A/D) converter. All complex algorithms are processed digitally to determine the true average airflow and temperature. Accuracy is *percent of reading* (not *percent of full scale).* Performance is assured throughout the entire calibrated range. The results are then converted to analog signals that the host Building Automation System (B.A.S.) can utilize for control **(consult the *GTx116 Transmitter Installation & Configuration Guide* for RS-485, Ethernet and LonWorks options).**

EBTRON manufactures the only sensing system that provides true average airflow (actual CFM) and temperatures over the entire range of 0 to 5,000 FPM from -20° F to 160° F. The company has been a leader in airflow measurement and control since 1984.

Application

High density airflow measurement systems are ideal for applications requiring accurate and repeatable airflow measurement when **no field adjustment** is desired. Thermal dispersion technology can accurately determine airflow in traditionally difficult locations since each sensor is independent and does not require that a stable total and static pressure profile be developed. **Laboratory test data demonstrates that thermal dispersion airflow measurement can be applied closer to duct fittings and accessories than any other technology[1].**

The **GTx116-PC** is well suited for the direct measurement of outdoor air intake flow rates for dilution air control and ***ASHRAE* 62** compliance. Sensor probes can be located immediately upstream of intake dampers and a special standoff bracket option allows for the direct mounting to the intake damper frame when there is no ductwork immediately upstream.

[1] Contact EBTRON for more information.

The **GTx116-PC** is also ideal for precise volumetric tracking and space pressure control, as well as any applications where controlling the number of airflow changes is critical.

For detailed application information refer to ***EBTRON*** application notes, available in your engineer's catalog, online at **www.ebtron.com** or from your local ***EBTRON*** **Representative.**

Selection

The **GTx116-PC** has been developed with most "traditional" options included standard. Each transmitter serves a single duct location. The transmitter requires 24 VAC and provides the host controls with linear output signals for airflow and temperature.

Each transmitter is fully independent of the sensor probes. "Smart" sensor technology embeds the calibration data of each sensor in the probe cable assembly. The **GTA116** transmitter is provided with field selectable, isolated 4-20 mA and 0-10 VDC analog output signals for airflow and temperature. Output scales can be configured easily in the field (see product specifications for factory default settings). All **GTx116-PC** transmitters include a 16 character LCD display which indicates both airflow and temperature. The display is also used during configuration and diagnostic modes. Field configuration is accomplished using a simple four-button interface on the main circuit board. Individual airflow and temperature measurements can also be displayed from the diagnostic mode. In addition, each transmitter is provided with "digital potentiometers" for airflow signal filtering (transient wind filter), plus output signal offset and gain adjustment.

Gold anodized sensor probes are available with three mounting options: insertion, internal, and standoff. Insertion mounting probes are installed through one side of the duct. Probes greater than 18 inches will have a 1-1/2" terminal mounting stud which protrudes out of the opposite side of the duct. Internal mounting probes are installed inside of a duct or plenum and have ± 3/4" adjustability between the nominal duct size. Standoff mounting probes are installed upstream of intake dampers, directly on the damper frame or housing so that the trailing edge of the probe is 2 inches upstream of the leading edge of the fully open position of the intake damper. Each mounting option is provided with a standard 10 foot plenum rated cable to connect to the remote transmitter with a small circular terminal connector. Mounting brackets are constructed of corrosion resistant 304 stainless steel. The model **GTx116-PC** has a typical installed accuracy of ± (2% to 3%) of reading when installed in accordance with ***EBTRON*** installation guides (see: ***Locating Probes***).

Simple Selection Process

- Determine the duct size, shape and any internal insulation.
- Check that your installation location meets minimum placement requirements on page 3.
- Select the mounting configuration for each installation (insertion, internal, or standoff).
- Check that the 10 ft. standard cable length is adequate to connect the furthest sensor probe to the transmitter (additional cable, up to 50' maximum, can be ordered).

Locating Probes

Ducts and Plenums

EBTRON thermal dispersion probes can be applied in duct locations traditionally considered to be a poor choice for other airflow measurement technologies. When placing airflow measurement probes, select a location that meets or exceeds the total upstream and downstream requirements from the **"Minimum Placement Guidelines"** below. Maintain the distance ratio between the up and downstream minimums when distances exceed minimum requirements.

Maintain the distance ratio between the up and downstream minimums when distances exceed minimum requirements.

Contact *EBTRON* if the placement guidelines below are not representative of your application.

Avoid locating the airflow station immediately downstream of modulating damper.

Do not locate the airflow station where it will be exposed to rain, or condensate from a humidifier or coil. Consult humidifier or coil manufacturer for absorption distance recommendations.

EBTRON placement guidelines are the result of rigorous laboratory and field testing. The sensor density tables on the next page for *Precision* HVAC applications were developed to simplify product selection. For installations that either do not meet *or* significantly exceed minimum installation requirements, ***EBTRON*** application engineers can determine the optimized sensor density (higher or lower) and performance that meets specific application needs.

Outside Air Intakes

Outside air intakes present unique challenges for airflow measurement. Velocities are often low (<400 FPM) and space limitations are generally severe. ***EBTRON*** has specialized in airflow measurement for control of outside air intake flow rates since the late 1980's. The **GTx116-PC** is ideal for the direct measurement of outside airflow rates since the device excels at low air velocities and its multi-point independent thermal dispersion sensing can provide accurate airflow measurement in most applications.

Airflow measuring probes should be mounted upstream of the outside air intake damper. Probes should be mounted at least one damper blade width upstream of the fully open position of the intake damper (exception: mount "standoff" probes 2" upstream of the damper and allow for an additional 3% to 5% of measurement uncertainty). Probes can be mounted directly in most intake hoods but should be mounted at least 12 inches downstream of intake louvers.

Locate the airflow station upstream of the intake damper.

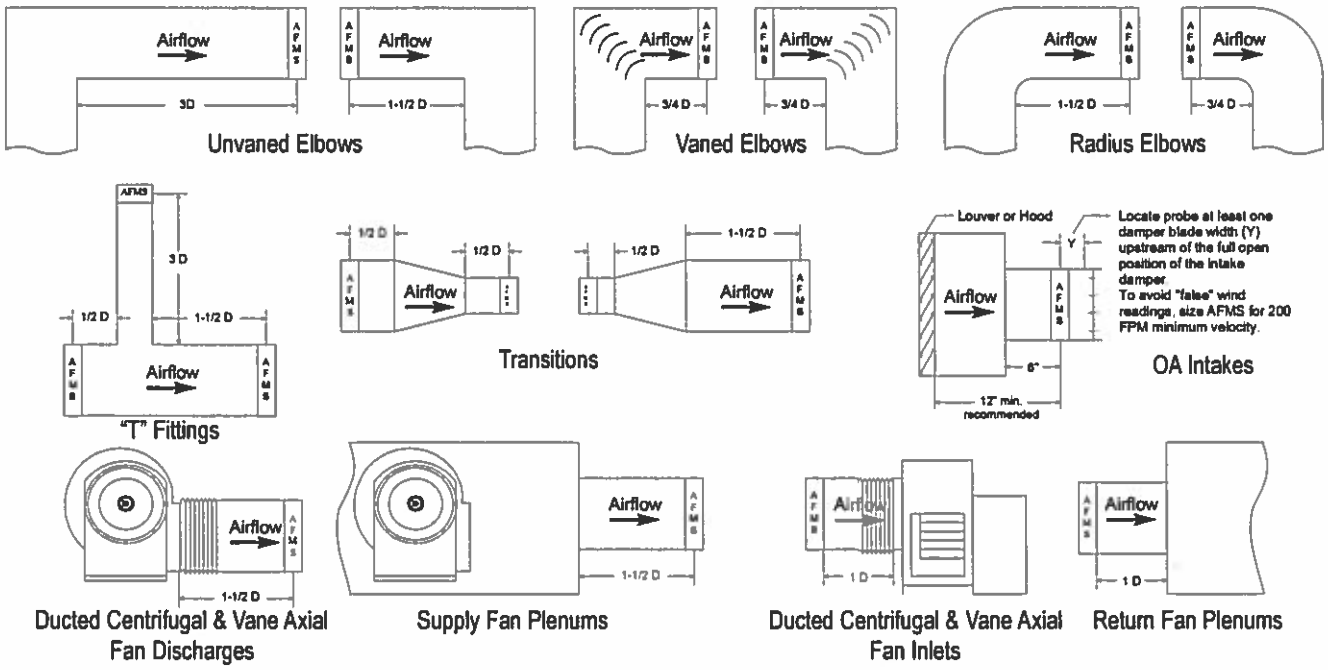
To avoid "false" wind readings and improve control, maintain a minimum velocity of 200 FPM or higher.

Although GTx116-PC sensor probes are water resistant, avoid locating stations where they will be subject to frequent water exposure.

Contact ***EBTRON*** or your ***EBTRON*** **Representative** to speak to an application specialists for installations that do not meet these installation guidelines, or for more information on sensor density requirements and installed system accuracy.

Minimum Placement Requirements

Typical GTx116-PC High Sensor Density Applications



D = Simple Equivalent Diameter = (width + height)/2

Probe and Sensor Density

Probe and sensor density is determined by the tables below. For applications requiring either a lower or higher installed accuracy consult ***EBTRON*** or your local ***EBTRON*** **Representative.** Sensor probes can be mounted either horizontally or vertically. Where condensing moisture is a concern, vertically mounted probes should be installed with the "wire out" end towards the top of the duct. Rectangular probes are ordered as *Probe Length x Adjacent Side Length* (not necessarily duct width x height). Internal insulation should be specified so that the proper sensor spacing can be achieved.

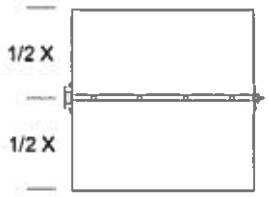
Rectangular probe mounting configurations are illustrated below. Probe mounting configurations for round and oval ducts are designated by the letter following the number of probes in the tables below. Refer to the figures to the right for proper mounting in round and oval ducts.

Rectangular Probe Sensor Density (# Probes / # Sensors per Probe)

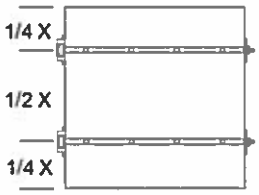
GTx116-PC - typical system accuracy +/-(2% to 3%) of reading

ADJACENT SIDE LENGTH \ PROBE LENGTH	12	18	24	36	42	48	60	72	96	120
12	1/2	2/2	1/4	1/4	1/4	1/6	1/6	1/6	1/8	1/8
18	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/4	2/6	2/6
24	2/2	2/2	2/3	2/3	2/3	2/4	2/4	2/6	2/8	2/8
36	2/2	3/2	3/2	2/4	2/4	2/6	2/6	2/8	2/8	2/8
42	2/2	3/2	3/2	4/2	3/4	3/4	4/4	4/4	2/8	2/8
48	3/2	3/2	4/2	4/3	4/3	4/4	4/4	4/4	2/8	2/8
60	3/2	3/2	4/3	4/3	4/4	4/4	4/4	4/4	4/4	2/8
72	3/2	4/2	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
96	4/2	4/3	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
120	4/2	4/3	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4

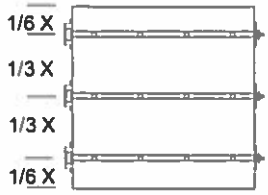
☐ One Probe



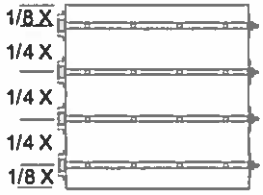
☐ Two Probe



☐ Three Probe



☐ Four Probe

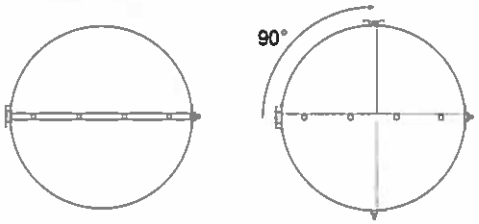


GTx116-PC - typical system accuracy +/-(2% to 3%) of reading

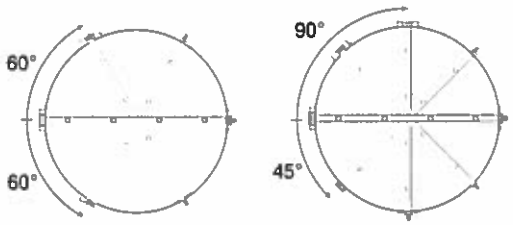
DUCT HEIGHT \ DUCT WIDTH	12	18	24	36	42	48	60	72	96	120
12	1a/2	2b/2	1a/2	1a/4	1a/4	1a/4	1a/6	1a/6	1a/6	4c/2
18		2b/2	1a/4	1a/6	1a/6	1a/6	1a/6	2c/4	2c/4	3c/4
24			2b/2	2b/4	2b/4	2b/4	2b/4	2b/4	3c/4	4c/4
36				2b/4	2b/4	2b/4	2b/6	2b/8	2b/8	2b/8
42					2b/4	2b/4	2b/6	2b/8	2b/8	2b/8
48						3b/4	2b/8	2b/8	2b/8	2b/8
60							4b/4	2b/8	2b/8	2b/8
72								4b/4	2b/8	2b/8
96									3b/4	2b/8
120										4b/4

#Probes letter suffix defines installation configuration. See data sheet.

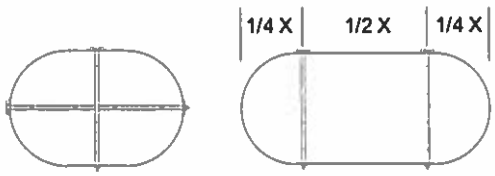
☐ One Probe Round/Oval - 1a Å Two Probe Round - 2b*



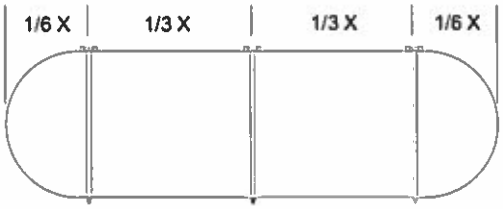
☐ Three Probe Round - 3b* Å Four Probe Round - 4b*



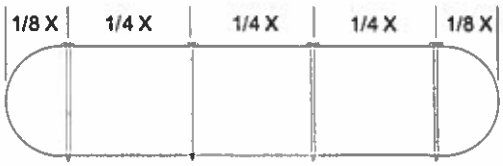
☐ Two Probe Oval - 2b* Å Two Probe Oval - 2c



☐ Three Probe Oval - 3c



☐Four Probe Oval - 4c



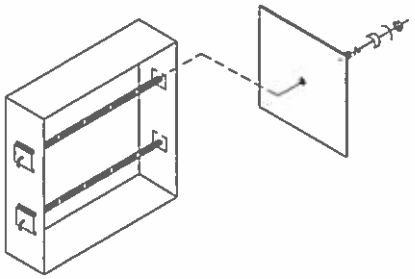
Probe Installation

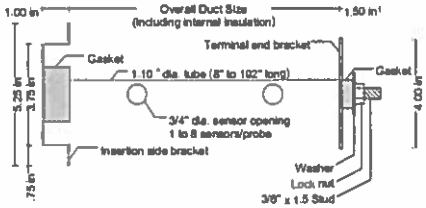
GTx116-PC probes have three mounting options for field installation flexibility. All probes have a standard 10 foot plenum rated cable (optionally up to 50 feet) for connection to the remotely located transmitter (required). Each Sensor probe is connected to the transmitter with a simple, positive locking, circular plastic connector. The connector is 7/8" O.D. The length of the cable is measured from the end of the sensor probe and is the same length for each probe in a given location. All probes should be installed with the airflow arrow pointing in the appropriate direction and fastened with suitable hardware.

The cable length ordered must be long enough to accommodate the distance between the transmitter and furthest sensor probe.

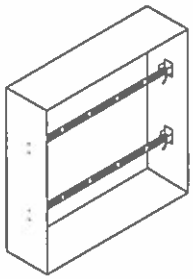
* Offset probes by 1-1/2 to 2 inches for proper installation.

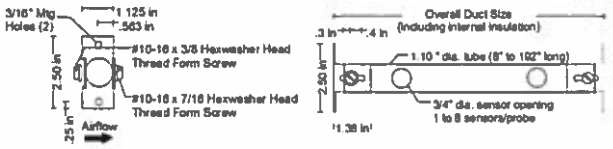
☐ **Insertion mounting:** Install through one side of duct or plenum. External insulation that interferes should be temporarily removed prior to installation. Probes less than 18" overall will not have the end stud pictured below and are fabricated 1/4" less than the overall duct size. Mounting requires a 1-1/4" hole on both sides of the duct (one side only if under 18 in.)





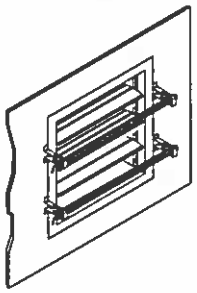
☐ **Internal mounting:** Install inside of the duct or plenum. Any internal insulation should be removed prior to installation. There is approximately ± 3/4" of adjustment from the nominal *Probe Length* ordered.

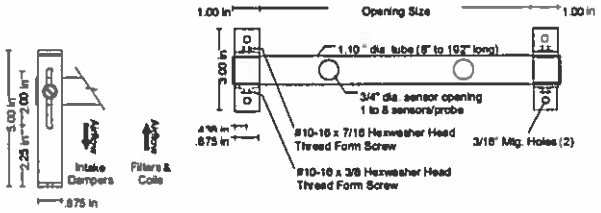




☐ **Standoff mounting:** Install directly in an outside air intake plenum. The sensor probe should be mounted 2" from the full open blade position. Unducted standoff mounting can add up to 3% to 5% of additional uncertainty to the system installed accuracy. This mounting can also be used on filters and coils inside of air handling units (no water carry over).

⚠ **Stand-off mounting probes are fabricated 2 inches longer than the *probe length* ordered.**





Transmitter Installation

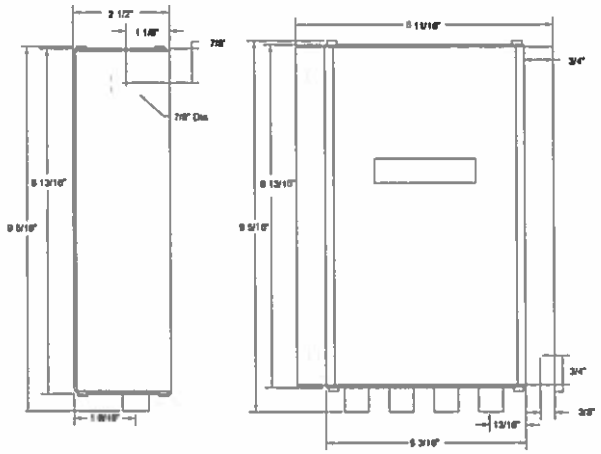
The **GTx116** transmitter aluminum chassis has been designed for use in a protected environment between -20° F and 120° F where it will not be exposed to rain or snow.

The transmitter should be mounted **upright** in a field accessible location. The chassis is designed to accept 3/4" conduit fittings for power and signal wiring at the top left and right of the enclosure. The transmitter should be located such that the connecting cables from all of the sensor probes reach the receptacles on the bottom of the transmitter enclosure.

⚠ **Do not expose the transmitter to rain or snow without providing a NEMA4 enclosure.**

⚠ **Leave at least 10 inches above, and 2 inches on each side and bottom, of unobstructed space around the transmitter to allow for heat dissipation and cover removal.**

Transmitter Dimensions



Electrical Connections

After mounting the sensor probe(s) and transmitter, connect one or more sensor probe cable plugs to the circular receptacles located at the bottom of the **GTx116** transmitter enclosure. **Probes are *"plug and play"* and do not have to be connected to a specific receptacle on the transmitter.** Transmitters designed for 1 or 2 probes (Type 'A') will have two receptacles while transmitters designed for 3 or 4 probes (Type 'B') will have four receptacles.

Do not drill into the transmitter chassis since metal shavings could damage the electronics.

Provide a "drip loop" at the transmitter if there will be the potential for water runoff or condensation along the sensor probe cable(s).

To wire the output signal and power, slide the cover plate up and out of the extruded chassis. Make sure that the power switch is in the "OFF" position. The **GTA116** wiring schematic is shown below. **Wiring and setup for network transmitters can be found in the *GTx116 Transmitter Installation & Configuration Guide* for RS-485, Ethernet and LonWorks options.** Signal wires for airflow and temperature should be connected to the small, three position output terminal labeled "OUTPUT" on the upper left hand side of the main circuit board.

When configured for a 4-20 mA output, the GTA116-PC is "4-wire" device. The host controls should not provide an excitation voltage to the output of the GTA116-P.

24 VAC power should be connected to the large, two position power input terminal labeled "POWER" on the upper right hand side of the main circuit board. Since the output signals are isolated from the power supply, it is not necessary to provide an isolated (secondary not grounded) power source.

Multiple GTx116 transmitters wired on a single transformer must be wired "in-phase".

Start-up

When installed in accordance with installation guidelines, no adjustment or calibration is necessary. To assure a successful startup, check that the airflow measuring station is installed in accordance with this document.

Check the physical installation, power connections, and signal wiring prior to turning the power switch to the "ON" position.

The **GTA116** transmitter is factory shipped with the analog output signals set to the 4-20mA default. If a 0-10 VDC output is desired, simply move the corresponding switch (SW1 for velocity, SW2 for temperature) to the 0-10 VDC position prior to power-up.

Move the power switch to the "ON" position. The transmitter executes a complete self-check each time the power is turned on. Check that scaling in the host control system returns an output that matches the output of the **GTx116**.

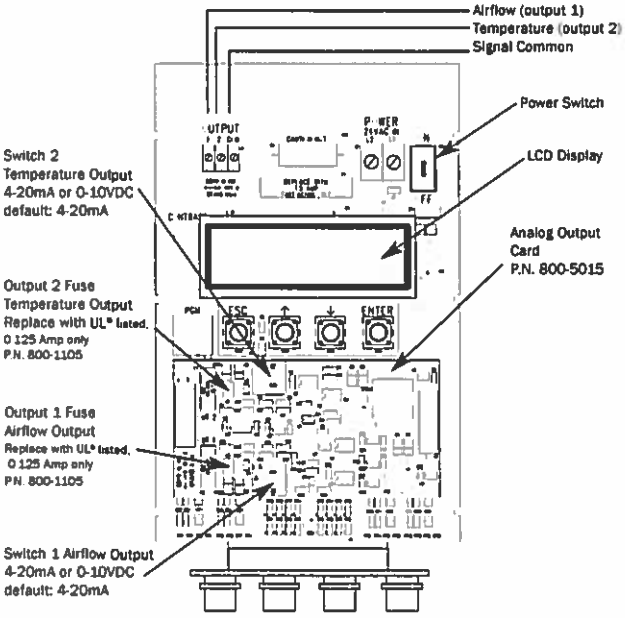
The **GTx116** is designed to operate on "power-up". No field configuration is required. If factory default settings require a change in the field, consult the ***GTx116 Transmitter Installation and Program Guide*** or contact ***EBTRON*** Customer Service, toll free, at 800-232-8766.

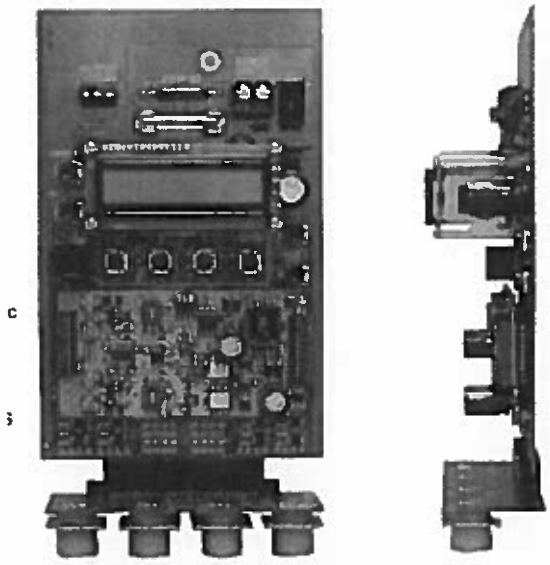
Maintenance

Periodic maintenance or recalibration is neither required nor recommended[1].

[1]In extremely dirty environments, periodic inspection of the sensor element is advised. Carefully remove any excessive buildup of material with compressed air or with a small brush. Recalibration is not required.

Transmitter Wiring and Circuit Board Functions (GTA116 Transmitter shown)





Standard Limited Parts Warranty

If the **GTx116-PC** fails within 36 months from shipment, ***EBTRON*** will repair/replace the device free of charge as described in the company's warranty contained in ***EBTRON's*** *Terms and Conditions of Sale*. Defective equipment shall be shipped back to ***EBTRON***, freight pre-paid, for analysis.

Guide Specification (use bold text for "short spec")

AIRFLOW MEASUREMENT DEVICES (Thermal Dispersion Technology)

PART 2 PRODUCTS

2.01 SECTION INCLUDES
- A. Products Included in this Section
- B. Acceptable Manufacturers
- C. Airflow Measurement Devices

2.02 Acceptable Manufacturers:
- **A. EBTRON, Inc. (basis of design)**
  1. Alternatives submitted as "equals" less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

2.03 PRODUCTS INCLUDED IN THIS SECTION
- A. Duct and plenum mounted airflow measurement devices

2.04 AIRFLOW/TEMPERATURE MEASUREMENT DEVICES
- **A. Provide airflow/temperature measurement devices where indicated on the plans. Fan inlet sensors shall not be substituted for duct or plenum sensor probes indicated on the plans.**
  1. Duct and plenum mounted sensors shall be fabricated of anodized aluminum alloy tube with 304 stainless steel mounting brackets.
- **B. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.**
- **C. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output. Devices, which average multiple non-linear sensing point signals, are not acceptable. Pitot tube arrays are not acceptable.**
- D. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.
- E. The operating airflow range shall be 0-5,000 FPM unless otherwise indicated on the plans.
- F. The operating temperature range for the measuring probes shall be -20° F to 160° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).
- G. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
- **H. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range and be wind tunnel calibrated or verified against standards that are traceable to NIST.**
  1. Devices whose accuracy is specified separately for the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
- I. Each independent temperature sensor shall have a laboratory accuracy of +/-0.15° F over the entire operating temperature range and be calibrated or verified against standards that are traceable to NIST.
- J. The number of sensors for each location shall be as follows:
  1. Ducts and plenums:

Area (sq.ft.)	Sensors
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

- K. The airflow/temperature measuring device shall be capable of displaying the airflow and temperature readings of each sensor on the transmitter's LCD display.
- L. The transmitter shall be capable of communicating with the host controls using the following interface options:
  1. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)
  2. RS-485: Field selectable ModBus-RTU and Johnson Controls N2 Bus
  3. 10 Base-T Ethernet: Field selectable ModBus TCP and TCP/IP
  4. LonWorks Free Topology
- M. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.
- N. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

Model GTx116-Pc

Technical Specifications

System Performance

GTx116-PC Installed Airflow Accuracy (typ. ± of reading): 2% to 3%

Repeatability (± of reading): 0.25%

Measurement Units: I.P. or S.I. (consult separate S.I. unit supplement for settings and factory defaults)

Sensor Probe Specifications

Sensor Assembly Model: GP1

Tube Construction: Gold anodized 6061 aluminum alloy [Option: 316 stainless steel tube]

Sensor Assembly: Two hermetically sealed "bead-in-glass" thermistors in a glass filled polypropylene housing [Option: Kynar housing. Requires 316 SS tube]

Mounting Brackets: 304 Stainless Steel

Mounting Options: Insertion, Internal or Stand-off

Standard Probe Size Range: 8" to 120"

Cable Assembly:

Type: Plenum Rated

Length: 10' std. (50' opt.)

Connection to Transmitter: 7/8" Positive lock w/gold plated contacts

Number of Air Velocity Calibration Points: 16

Number of Temperature Calibration Points: 3

Maximum Number of Sensors per Sensor Probe: 8

Sensor Distribution: Equal area or Log-Tchebycheff

Airflow Sensor Accuracy (± of reading): 2%

Calibrated Range: 0-5,000 FPM

Temperature Sensor Accuracy: ± 0.15° F

Sensor Temperature Range: -20° F to 160° F

Humidity range: 0 to 99% RH, non-condensing

Transmitter Specifications

Transmitter Model: GTx116

Maximum Number of GP1 Sensors per Location: 16

Microprocessor: Powered by Motorola® Digital DNA ™

A/D Converter: 12 bit

Sensor Independent Electronics: Yes

Power Requirement: 24 VAC (22.5 to 29 VAC), 20 VA max. (fused and protected on transmitter, isolation not required)

Chassis (enclosure): Aluminum (protect from water and condensation)

Output Signal Adjustments: Field adjustable digital airflow output offset/gain

Output Signal Filtering: Field adjustable digital airflow output filter

Display: 16 character LCD display with field selectable output

Airflow: FPM, CFM w/area input

Temperature: ° F

Display Digits (auto-ranging with units of measure):

Airflow: 0.00 to 999.99, 1000.0 to 9999.9, 10000 to 999999

Temperature: -99.9 to -0.1, 0.00 to 99.99, 100.0 to 999.9

Analog Output Configuration (GTA116 Transmitter)

Analog Output Protection: Fused and protected ISOLATED analog outputs

Analog Output Signals: Field selectable, linear analog output signals of 4-20mA and 0-10 VDC for airflow and temperature

Airflow Analog Output Scaling (0 to selected F.S.): Field selectable from 100 to 15,000 FPM, 100 FPM increments

Factory Default: 5,000 FPM

Temperature Analog Output Scaling (Min.S. to F.S.): Field selectable from -50° F to 160° F F.S. > M.S. + 10° F

Factory Default: -20° F to 160° F

Analog Output Resolution (full scale output): 0.025%

Network Output Configurations

GTN116 Transmitter: 9600 baud RS485 Serial, JCI N2-Bus, ModBus-RTU

GTE116 Transmitter: Ethernet 10 BaseT, TCP/IP, ModBus-TCP

GTL116 Transmitter: LonWorks Free Topology

Transmitter Temperature Range: -20° F to 120° F

Warranty

Standard Warranty: 36 Months from shipment

Underlined items indicate *Factory Default* settings.

LONWORKS®

EBTRON

Thermal Dispersion Airflow Measurement

Metasys and Metasys Compatible Product are Trademarks of Johnson Controls.

Applies to GTN116-P only.

1663 Hwy. 701 S., Loris, SC 29569 USA • Toll Free: 800-2EBTRON (232.8766) • Fax: 843.756.1838 • Internet: www.ebtron.com • e-mail: ebtron@ebtron.com

• F-1210 DUAL TURBINE • INSERTION FLOW METER ANALOG OUTPUT

ONICON INCORPORATED

Made in the USA

DESCRIPTION

ONICON insertion turbine flow meters are suitable for measuring electrically conductive water-based liquids. The F-1210 model provides non-isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

APPLICATIONS

- Chilled water, hot water, condenser water, and water/glycol/brine for HVAC
- Process water and water mixtures
- Domestic water

GENERAL SPECIFICATIONS

ACCURACY
± 0.5% OF READING at calibrated velocity
± 1% OF READING from 3 to 30 ft/s (10:1 range)
± 2% OF READING from 0.4 to 20 ft/s (50:1 range)

SENSING METHOD
Electronic impedance sensing
(non-magnetic and non-photoelectric)

PIPE SIZE RANGE
2½" through 72" nominal

SUPPLY VOLTAGE
24±4 V AC/DC at 50 mA

LIQUID TEMPERATURE RANGE
Standard: 180° F continuous, 200° F peak
High Temp: 280° F continuous, 300° F peak
Meters operating above 250° F require
316 stainless steel construction option

AMBIENT TEMPERATURE RANGE
-5 to 160° F (-20 to 70° C)

OPERATING PRESSURE
400 PSI maximum

PRESSURE DROP
Less than 1 PSI at 20 ft/s in 2½" pipe,
decreasing in larger pipes and lower velocities

OUTPUT SIGNALS PROVIDED:

ANALOG OUTPUTS (NON-ISOLATED)
Voltage output: 0-10 V (0-5 V available)
Current output: 4-20 mA

FREQUENCY OUTPUT
0-15 V peak pulse, typically less than 300 Hz

(continued on back)

CALIBRATION

Every ONICON flow meter is wet-calibrated in our flow laboratory against primary volumetric standards directly traceable to NIST. Certification of calibration is included with every meter.

FEATURES

Unmatched Price vs. Performance - Custom calibrated, highly accurate instrumentation at very competitive prices.

Excellent Long-term Reliability - Patented electronic sensing is resistant to scale and particulate matter. Low mass turbines with engineered jewel bearing systems provide a mechanical system that virtually does not wear.

Industry Leading Two-year "No-fault" Warranty - Reduces start-up costs with extended coverage to include accidental installation damage (miswiring, etc.). Certain exclusions apply; see our complete warranty statement for details.

Installation Flexibility - Patented dual turbine models deliver outstanding accuracy in short pipe runs.

Simplified Hot Tap Insertion Design - Standard on every insertion flow meter. Allows for insertion and removal by hand without system shutdown.

OPERATING RANGE FOR COMMON PIPE SIZES
0.17 TO 20 ft/s
± 2% accuracy begins at 0.4 ft/s

Pipe Size (Inches)	Flow Rate (GPM)
2½	2.5 - 230
3	4 - 460
4	8 - 800
6	15 - 1800
8	26 - 3100
10	42 - 4900
12	60 - 7050
14	72 - 8600
16	98 - 11,400
18	120 - 14,600
20	150 - 18,100
24	230 - 26,500
30	360 - 41,900
36	510 - 60,900

1500 North Belcher Road, Clearwater, Florida 33765 Tel (727) 447-6140 Fax (727) 442-5699
www.onicon.com E-mail: sales@onicon.com

F-1210 SPECIFICATIONS cont.

MATERIAL

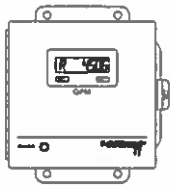
Wetted metal components
- Standard: Electroless nickel plated brass
- Optional: 316 stainless steel

ELECTRONICS ENCLOSURE
- Standard: Weathertight aluminum enclosure
- Optional: Submersible enclosure

ELECTRICAL CONNECTIONS

3-wire minimum for 4-20 mA or 0-10 V output
Second analog output and/or frequency output requires additional wires
- Standard: 10' of cable with ½" NPT conduit connection
- Optional: Indoor DIN connector with 10' of plenum rated cable

ALSO AVAILABLE



Display Modules

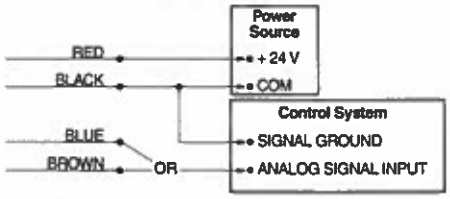
BTU Measurement Systems

F-1210 Wiring Information

WIRE COLOR CODE		NOTES
RED	(+) 24 V AC/DC supply voltage, 50 mA	Connect to power supply positive
BLACK	(–) Common ground (Common with pipe ground)	Connect to power supply negative & analog input ground
GREEN	(+) Frequency output signal: 0-15 V peak pulse	Required when meter is connected to local display or BTU meter
BLUE	(+) Analog signal: 4-20 mA (non-isolated)	Both signals may be used independently
BROWN	(+) Analog signal: 0-10 V (non-isolated)	
DIAGNOSTIC SIGNALS		
ORANGE	Bottom turbine frequency	These signals are for diagnostic purposes - connect to local display or BTU Meter
WHITE	Top turbine frequency	

F-1210 Wiring Diagram

Flow Meter into Control System (No Display or BTU Meter)

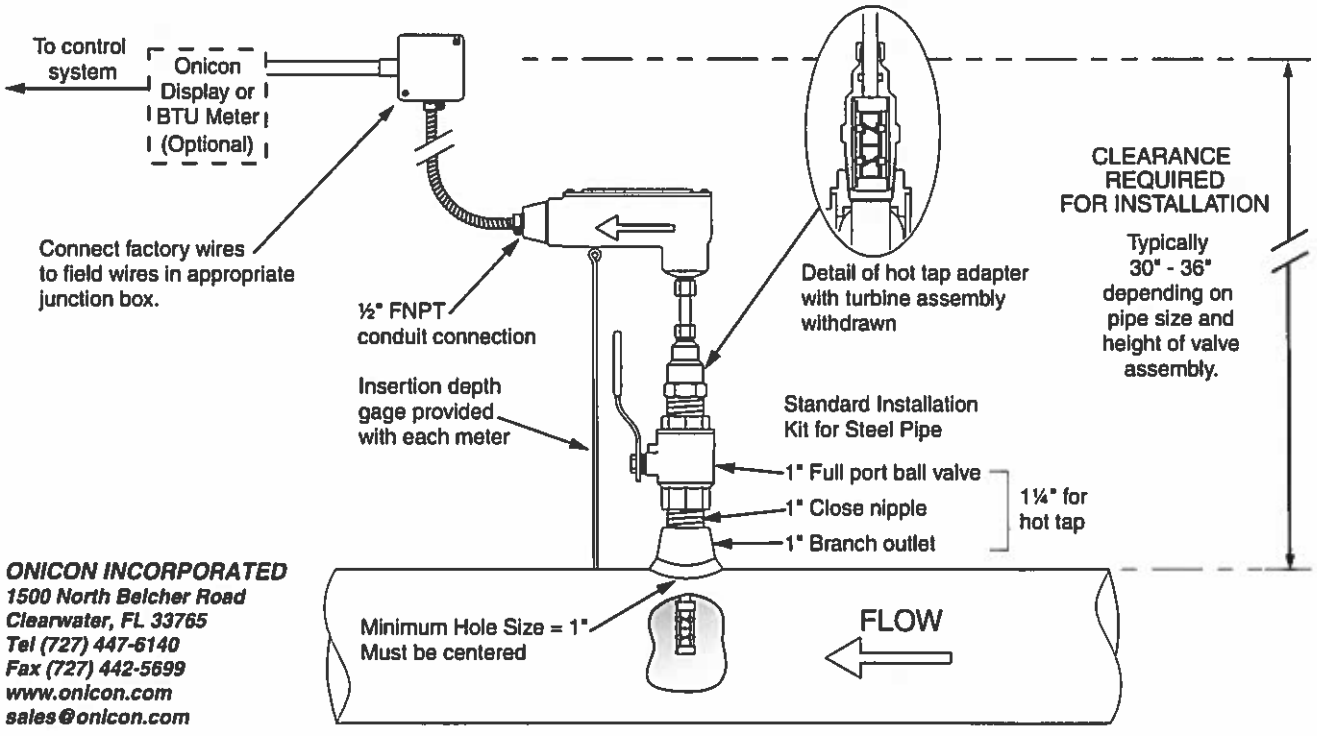


NOTE: 1. Black wire is common with the pipe ground (typically earth ground).
2. Frequency output required for ONICON display module or BTU meter, refer to wiring diagram for peripheral device.

Typical Meter Installation

(New construction or scheduled shutdown)

- Acceptable to install in vertical pipe
- Position meter anywhere in upper 180° for horizontal pipe



ONICON INCORPORATED
1500 North Belcher Road
Clearwater, FL 33765
Tel (727) 447-6140
Fax (727) 442-5699
www.onicon.com
sales@onicon.com

Note: Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use "Hot tap" 1¼ inch installation kit and drill hole using a 1 inch wet tap drill.

GAS & SPECIALTY SENSORS

CARBON DIOXIDE SENSORS
KCD SERIES

NEW!

Kele

DESCRIPTION

The Kele **KCD Series** was designed to offer an economical, reliable, non-dispersive infrared carbon dioxide sensor. It measures environmental carbon dioxide levels for use in demand-controlled ventilation, air-quality monitoring, and other HVAC applications in accordance with ASHRAE standards.

Fully isolated voltage analog outputs and convenient flying leads on the wall mount make installation both simple and trouble-free. The analog output is available in 0-10 VDC or 4-20 mA, over the industry standard 0-2000 ppm CO2 range.

Wall Mount

Duct Mount

MADE IN USA

8

GAS & SPECIALTY SENSORS

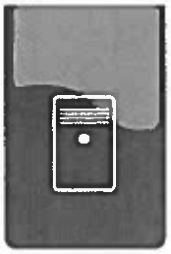
FEATURES

- ***24 VAC/VDC power***
- ***0-10 VDC or 4-20 mA output***
- ***0-2000 ppm CO2 range***
- ***Wall-mount and duct versions***
- ***Reverse polarity protected***
- ***Simple push-button calibration***
- ***Factory calibrated***

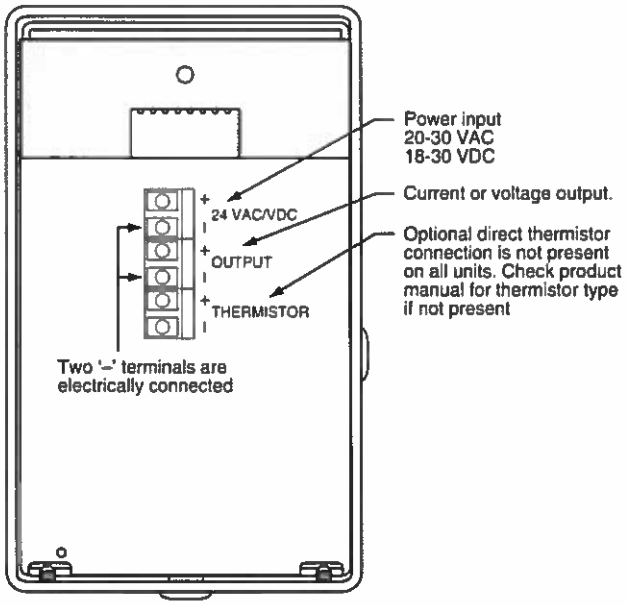
SPECIFICATIONS

Power supply	20-28 VAC, 50/60 Hz, or 18-30 VDC, 8 VA @ 24 VAC, reverse polarity protection	**Operating life expectancy**	10 years typical
Sensing technology	Non-dispersive IR (NDIR)	**Operating range**	
Detection range	0-2000 ppm CO2	**Humidity**	0% to 95% RH (noncondensing)
Accuracy	±3% of reading or ±40 ppm	**Temperature**	32° to 122°F (0° to 50°C)
Repeatability	±20 ppm	**Enclosure**	White finish, ABS, UL 94V-0
Output	0-10V or 4-20 mA (500Ω max) depending on model	**Dimensions**	4.63"H x 2.88"W x 1.0"D (11.8 x 7.3 x 2.54 cm); Duct probe: 6" L (15.2 cm), 1.7" (4.3 cm) diameter
Visual indication	LED flashes above 1000 ppm of CO2	**Weight**	
Calibration	Push button @ 2000 ppm	**Wall**	4 oz (0.11 kg)
Calibration interval	5 years	**Duct**	8 oz (0.23 kg)
Response time	<1 minute	**Warranty**	18 months
Warm-up time	3 minutes		

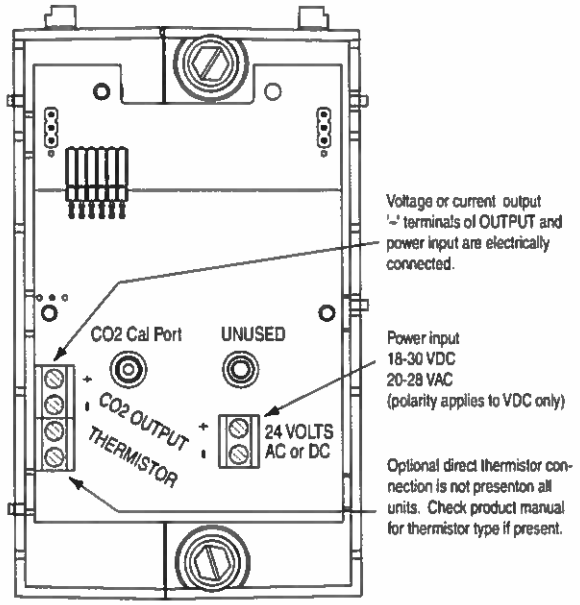
NEW!



WIRING



Wall Mount



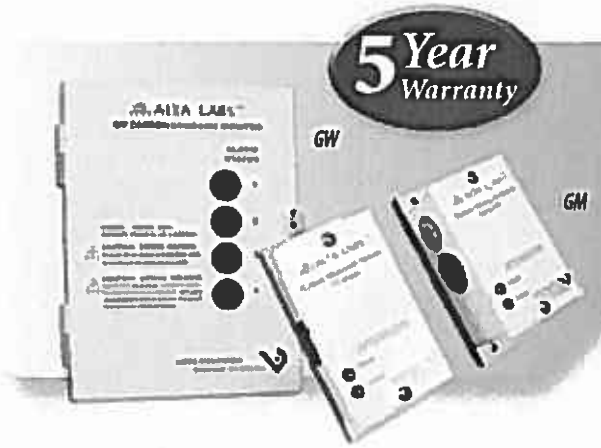
Duct Mount

ORDERING INFORMATION

MODEL	DESCRIPTION
KCD	CO_2 sensor
	MOUNTING
W	Wall mount
D	Duct mount
	ANALOG OUTPUT
V	0-10 VDC
A	4-20 mA

KCD – W – V

Example: **KCD-W-V** Wall-mount CO_2 sensor with 0-10 VDC output



G Series

Carbon Monoxide Sensors

G Series carbon monoxide sensors control ventilation systems in parking garages and other settings where air quality is a concern. Energy and maintenance costs are reduced by running the ventilation fan only as needed, rather than continuously. The relay output is normally-open to provide failsafe activation of the ventilation fan in conjunction with a normally-closed fan contactor. Both audible and visual alarms alert those in the vicinity of excess CO levels.

Relay Output: Relay contact closes when CO level is below 35ppm. Relay contact opens when CO level is above 35ppm. Removal of sensor, interruption of power, or cut wires cause relay circuit to open and start fan. Minimum relay cycle time is 3 minutes to prevent fan short-cycling.

Audible Alarm: 85dB alarm sounds if CO level rises above 100ppm for 30 minutes.

APPLICATIONS

Control ventilation for energy savings and OSHA compliance

- Parking garage ventilation control
- OSHA air quality compliance in commercial buildings and factories

GM Monitoring Station

The GM monitoring station accepts digital inputs from up to four sensors to provide alarm status indication for each channel, and a Form C (SPDT) fan actuation relay. If any of the sensors detects CO levels above 35ppm, or if a fault is detected, the corresponding alarm status indicator lights and the fan relay de-energizes (failsafe). A 24VDC internal power supply can operate four sensors, eliminating the need for external power supplies or transformers.

High accuracy and stability

- Microprocessor controlled...high accuracy, excellent stability
- No calibration required
- Metal oxide semiconductor (MOS) sensor

Low total installed cost

- Low-profile package mounts directly to conduit–no mounting hardware or concrete anchors required
- Long-life replaceable sensing element–tamper resistant

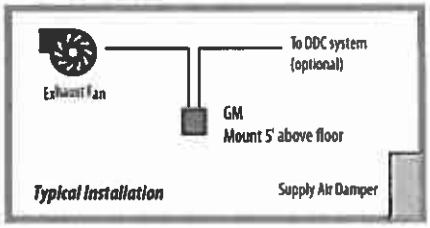
Versatile outputs for popular applications

- Interface to DDC system, GM panel, or direct fan control
- Onboard relay for direct ventilation fan control–failsafe
- Selectable output: 4-20mA, or 0-5V/0-10VDC
- Audible exposure limit alarm

Ventilation control in parking garages for energy savings

- 5-year, long-life replaceable sensor element
- Interface to control system via 4-20mA or 0-5/0-10VDC output
- Fail-safe alarm relay handles 5 amps for direct fan control
- Audible exposure alarm 100ppm, 30 minutes per UL 2034

Ventilation control for energy savings and OSHA compliance in parking garages and service bays



ORDERING INFORMATION

	(Enclosure)	(Output)	(Auxiliary Alarm Output)	(US or EU)
G	D = CO Duct W = CO Wall	V = Field-selectable 0-5/0-10VDC M = 4-20mA R = Relay only	A = Auxiliary Contact X = None	S = Standard

	(Sensors) – GWRXS
GM *Gas Monitoring Station*	0 = Station Only 1 = 1 Sensor 2 = 2 Sensors 3 = 3 Sensors 4 = 4 Sensors

ACCESSORIES

Verification Kits, replacement modules,...
See page 234

Examples:

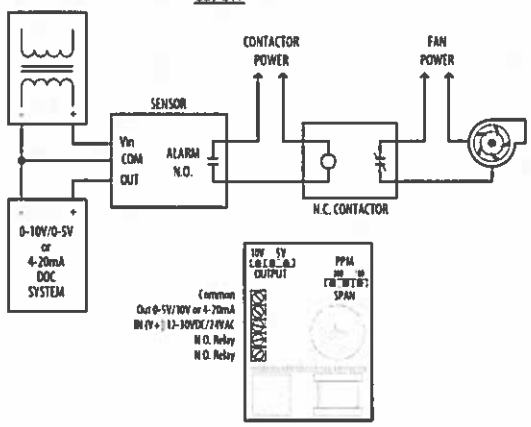
G W V X S

GM 4

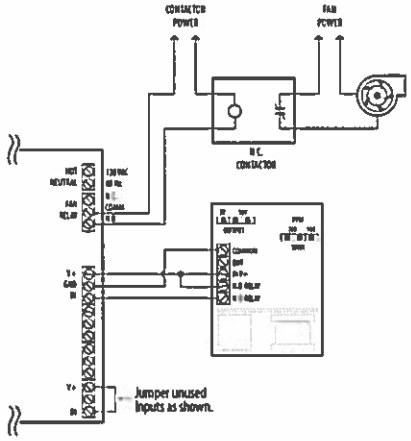
Discussed with Tower and was approved based on the time function available through the BAS.

WIRING DIAGRAMS

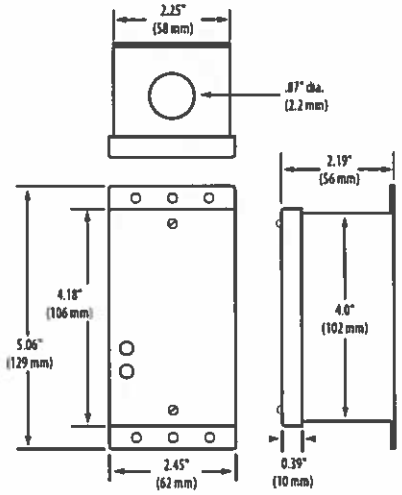
GD/GW

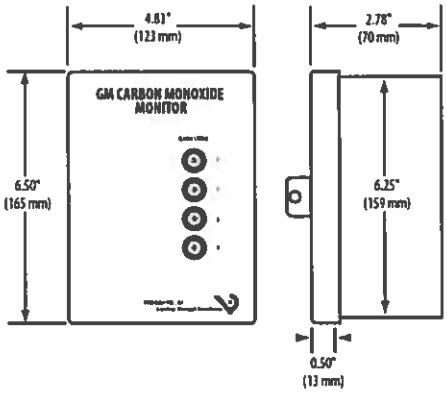


GM



DIMENSIONAL DRAWINGS





SPECIFICATIONS G Series

Sensor	Digitally-profiled Metal Oxide Semiconductor (MOS)
Sensor Life	5-10 years typical, replaceable
Supply Power	12-30VDC/24VAC, 0.2A@12VDC, 0.1A@24VDC
Detection Range	0 to 200ppm
Analog Output	3-wire sourcing 4-20mA, or user-selectable 0-5/0-10V (Specify mA or voltage)
Output Scaling	User-selectable 100ppm F.S. or 200ppm F.S.
Response Time	2 minutes 30 second sample interval cycle
Relay Setpoint	35ppm
Relay Output	N.O. Form A (SPST) 5A @120/240AC; (Use with N.C. contactor)
High Limit Setpoint	100ppm for 30 minutes
High Limit Alarm	Audible, 85dB, resets below 100ppm; (Solid-state contact for -A version)
LED Indicators	Normal=Green; Call for ventilation=Red; High-limit alarm=Flashing Red
Operating Environment	-20° to 50°C (-4° to 122°F); 0 to 90% RH non-condensing
Coverage	5000 sq. ft. typical
Physical	5.0" x 2.5" x 2.3" (125mm x 65 mm x 60 mm); 1 lb.; white powder coat over steel

SPECIFICATIONS GM Series

Supply Power	120VAC, 60 Hz, 1 amp max. Replaceable fuse
Inputs	Detect contact closure from sensor relay. Four channels. 24VDC loop
Output	Form C (SPDT) relay. 5A@125VAC
Sensor Power Output	24VDC, 1A max. Short circuit protected. UL recognized
Alarm Indicators	Four, 10mm Red LED; indicates alarm status
Power Indicator	Green LED; indicates power supply operation
Operating Environment	-20°C to 50°C (-4° to 122°F); 0 to 90% RH non-condensing
Physical	NEMA 1, metal enclosure, 6.3" x 4.5" x 2.0", white

Outside Air with LCD

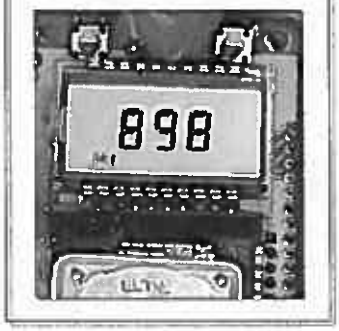
CO2 Transmitter/switch

0 -2000/0 -5000 ppm | 4-20mA; 0-5/10VDC
Integrated setpoint relay| Temp options

Outside air CO2 with LC display

- Ensure energy savings by conditioning minimum amount outside air.
- Integrated display and pushbutton menus for field selectable scale, calibration, and operational modes
- Dual 4-20mA and 0-5v/0-10v output (jumper selectable)
- Integrated high-reliability solid-state set-point relay is ideal for direct control applications; easy to set up thanks to LCD

Display simplifies install



High reliability reduces call backs

- Non-dispersive infrared sensing element (NDIR)
- Gold-plated optical chamber for high performance and endurance
- Field replaceable CO2 sensor
- Industry leading 7-year warranty on electronics; NDIR module 3 years
- Internal heater/thermostat extends operating range below freezing conditions

High accuracy for improved system performance

- Selectable auto-calibration mode returns sensor to baseline values
- +/-2% full scale to 1400 ppm. (5000 ppm f.s.)

p. 866-660-8864 • f. 503-296-2529

SPECIFICATIONS

Power Supply		12-30vdc/24vac[1], 200mA max.
Analog Outputs	Dual Analog	3-wire 4-20mA and 0-5v/0-10v [2] (jumper)
	Output scaling	0 - 2000 or 0 - 5000 ppm (selectable)
Digital Setpoint Output	Programmable	Solid-state, 1A @ 30VAC/DC, N.O.
Sensor Performance	Type	Non-dispersive Infrared (NDIR)
	Accuracy	+/-2% full scale to 1400 ppm. (5000 ppm f.s.)
	Response time	60 seconds to 90% reading
	Output update rate	3 seconds
LCD Menu Setup Parameters	SPH, Setpoint, Hi (On point)	500ppm to full-scale (700ppm default)
	SPL, Setpoint, Lo (Off point)	400ppm to full-scale-50 (600ppm default)
	SCL, Scaling	0-2000ppm or 0-5000ppm (2000ppm default)
	ADJ, Adjustment	Offset adjustment +/-250ppm (0 default)
	CAL, Calibration mode	Automatic mode ON or OFF (default=ON)
	RUN, Run mode	Displays CO2 in ppm
Operating Environment	Temperature	0 to 122F (0 to 50C) [3]
	Humidity	0-95% non-condensing
Enclosure	Material	Polycarbonate; aluminum tube
	Dimensions	3.7"h x 3.7"w x 2.24"d

(1) One side of transformer secondary is connected to signal common. Dedicated transformer is recommended.
(2) 15vdc power supply voltage required for 10 volt output.
(3) Internal heater/thermostat extends operating range below freezing conditions

ORDERING

CO2O- ☐

Temperature

A = None
C = 100Pt (385)
D = 1000Pt (385)
E = 10k type 2
F= 10k type 3
G = 10k type 3 w/11k shunt
H = 3k
I = 2k2
J = 1k8
K = 20k
L = 100k

Replacement Sensor Elements

CO2-5 Replacement NDIR element

Field replaceable gold-plated CO2 NDIR

Hawkeye® 735 Series

Solid-Core Adjustable Setpoint Digital Output

CURRENT SENSING THE ULTIMATE PROOF OF FLOW

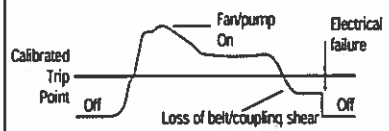
Maximize Reliability, Minimize Installed Cost

The **Hawkeye 735 Series** is the ideal solution for the automation installer. These units combine a current switch and relay into a single package, reducing the space required for total control of fans and pumps. The integral current switch and relay operate independently of one another. The H735-759 products facilitate the functions of start/stop and status with one device instead of two.

APPLICATIONS

- Starting/stopping and monitoring positive status of fan and pump motors
- Replaces pressure switches and other electromechanical devices

Detects belt loss/coupling shear!



Now you can easily detect when drive belts slip, break, or pump couplings shear. In fact, a typical HVAC motor that loses its load has a reduction of current draw of up to 50%. That's why our sensors are the industry standard for status.

Combines command relay & fan/pump status sensor in a single, easy to install unit

- Reduces number of components installed–fits better in small starter enclosures
- Command relay and status in a single unit
- Replace pressure switches and other electromechanical devices
- Detect belt loss and motor failure...ideal for fan and pump status
- H748 features SPDT command relay

Now one device does the job of two

- Reduced charges from electrician
- Relay and status LEDs for easy setup
- Polarity insensitive status output
- 1 to 135A adjustable setpoint for current sensor status
- 5-year limited warranty
- Made in USA

COMMAND & STATUS IN A SINGLE DEVICE!

US Patent No. 6,005,760

ORDERING INFORMATION

CE cULus LISTED 3T60 UL 508 E150462

H735 Form A (SPST) 5(3)@250VAC,30VDC, 1/6HP...24VAC/DC 10mA Output: 0.1A@30VAC/DC N.O. Solid-State

(Command Relay: Contact Coil)

H7 ☐

- **3** = Form A (SPST) 10(5)@250VAC,30VDC, 1/3HP...24VAC/DC 10mA
- **4** = Form C (SPDT), 8(3.5)@250VAC,30VDC, 1/4HP...24VAC/DC 10mA
- **5** = Form A (SPST) 10(5)@250VAC, 30VDC, 1/3HP...9-12VDC 20mA

(Status Output)

☐

- **8** = 1.0A@30VAC/DC N.O. Solid State
- **9** = 0.2A@120VAC/DC N.O. Solid State

Example:

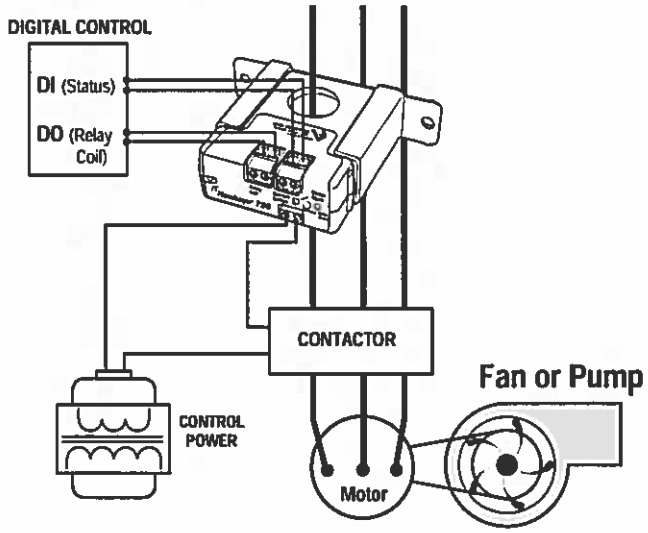
H7 [3] [8]

ACCESSORIES

MODEL	DESCRIPTION
H700/900-DIN	DIN Rail Mounting Clip Set

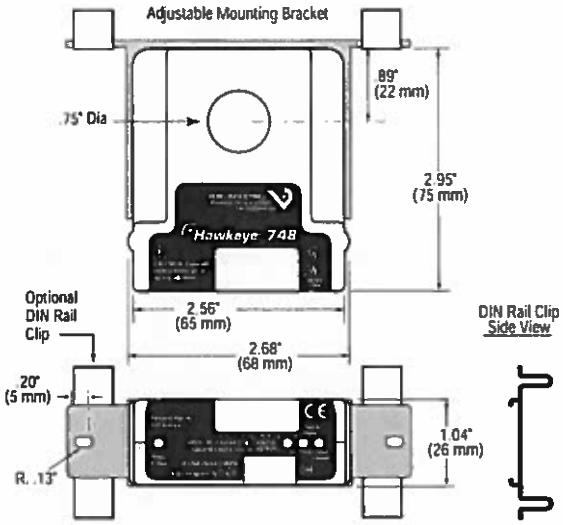
APPLICATIONS/WIRING EXAMPLE

Monitoring & Controlling Motor Loads...New Construction



- *A command relay and status sensor in a single unit; a clean, cost-effective solution for monitoring and controlling electrical loads*
- *All units feature status open and status closed LED's for a meter-free calibration*
- *All units feature a relay power LED for easy indication of relay status*

DIMENSIONAL DRAWINGS



SPECIFICATIONS

Amperage Range	1-135A
Sensor Power	Induced
Output	Digital Switch (see ordering table)
Insulation Class	600VAC rms
Frequency Range	50/60Hz.
Temperature Range	-15° to 60°C
Humidity Range	0-95% non-condensing
Setpoint	Adjustable 1-135A
Hysteresis	10% Typical
Dimensions...(L x W x H)	2.95" x 2.68" x 1.04"
Sensor Opening Size	.75" Dia.

Hawkeye® 600/800

Mini Solid & Split-Core Fixed Setpoint Digital Output

CURRENT SENSING
THE ULTIMATE PROOF OF FLOW

Maximize Reliability, Minimize Installed Cost

The Hawkeye 600/800 Series go/no current switches provide a cost-effective solution for monitoring status on unit vents, exhaust fans, recirculation pumps and other fixed loads where belt loss is not a concern.

APPLICATIONS

- Monitoring on/off status of electrical loads
- Monitoring direct drive units, exhaust fans and other fixed loads
- Verifying lighting run times

On/off status for direct-drive fans, pumps, and process motors

- More reliable for status than relays across auxiliary contacts
- Ideal for direct-drive units, unit vents, fan coil units, exhaust fans and other fixed loads
- Great for lighting status–less expensive than 277V relays
- Low 0.5A turn-on (H800), 0.75A (H600)...ideal for small exhaust fans (Not intended to detect belt loss)
- Mounting bracket provides installation flexibility

Monitor status of fans, pumps, motors & other electrical loads

- Split-core 600 for fast retrofit installation
- Mini solid-core 800 fits in tight enclosures
- 100% solid-state, no moving parts to fail
- Polarity insensitive output
- 5 year limited warranty
- Made in USA

ORDERING INFORMATION

See page 124 (H500) for Start/Stop & Status of fractional HP loads

CE

c UL us LISTED 3T60 UL 508 E150462

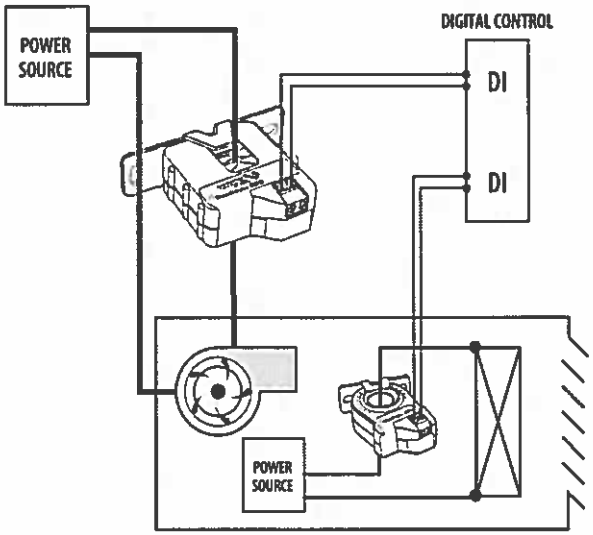
MODEL	AMPERAGE RANGE	OUTPUT TYPE	OUTPUT RATING (MAX.)
Solid-Core			
H800	0.5 - 200A	N.O., Solid-state	1.0A@30VAC/DC
H800HV	0.75 - 200A	N.O., Solid-state	.5A@250VAC/DC
H800NC	0.5 - 200A	N.C., Solid-state	.1A@30VDC
Split-Core			
H600	0.75 - 200A*	N.O., Solid-state	1.0A@30VAC/DC

**See temperature specifications on next page*

ACCESSORIES

MODEL	DESCRIPTION
H700/900-DIN	DIN Rail Clip Set compatible with all split-core models

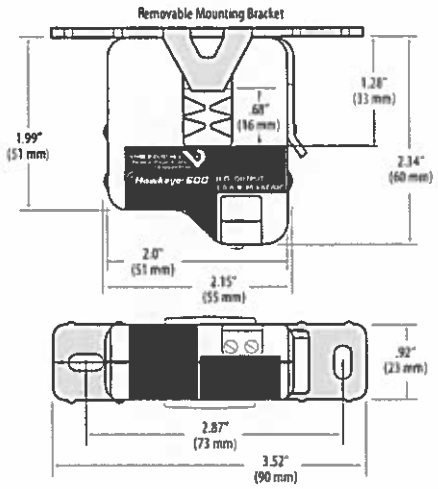
APPLICATIONS/WIRING EXAMPLE



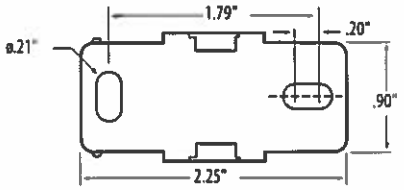
Unit Vent Heater

DIMENSIONAL DRAWINGS

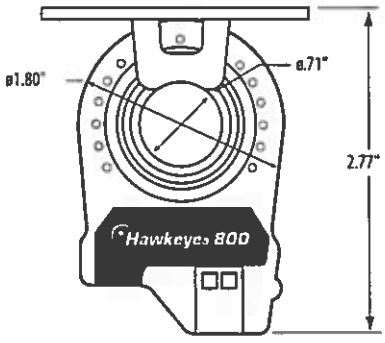
H600

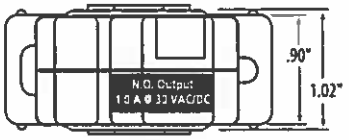


H800



Removable/Adjustable Mounting Bracket





SPECIFICATIONS

Amperage Range	Fixed 0.5 to 200A (H800), 0.75 to 200A* (H600)
Sensor Power	Induced
Output	Digital switch (see ordering table)
Insulation Class	600VAC rms
Frequency Range	50/60Hz.
Temperature Range	(H800) -15° to 60°C. Use min. 75°C insulated conductor
	(H600) -15° to 40°C (151-200A); -15° to 60°C (0-150A)
Humidity Range	0 - 95% non-condensing
Trip Setpoint	Fixed 0.5A (H800), 0.75A (H600)
Hysteresis	10% typical
Dimensions (H600)...(L x W x H)	(2.34" x 2.0" x .92")
Sensor Hole Size (H600)...(L x W)	.52" x .68"
Dimensions (H800)...(L x W x H)	2.77" x 1.80" x 1.02"
Sensor Hole Size (H800)	0.71" diameter

* See Temperature Specifications

Hawkeye® 904 Solid- & Split-Core Adjustable Setpoint Digital Output VFD Current Switch

THE VFD STATUS SENSOR!

FIVE-YEAR 5 WARRANTY

U.S. Patent No. 5,705,989

The Hawkeye 904 microprocessor based current status switch provides a unique solution for monitoring status of motors controlled by variable frequency drives.

Provide accurate status on loads controlled by variable frequency drives. The H904 stores the sensed amperage values for normal operation at various frequency ranges in non-volatile memory. This information allows it to distinguish between a reduced amp draw due to normal changes in the frequency and abnormal amperage drop due to belt loss or other mechanical failures.

APPLICATIONS

- Monitoring positive status on motors controlled by variable frequency drives
- Replace pressure switches

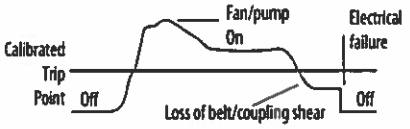
Microprocessor-based...real labor saver... No need to calibrate to detect belt loss on VFDs

- Self-adjusting trip setpoint...factory programmed to detect belt loss undercurrent conditions!
- Provides accurate status for VFD loads
- Automatically compensates for effects of frequency and amperage changes associated with VFDs
- LED indicates normal and alarm conditions
- Huge labor savings...no need to calibrate in live starter enclosures...Install and go

Accurately detects belt loss and coupling shear on VFD driven motors

- Monitors both frequency & amperage... distinguishes normal drops in amperage from
- Split-core design is ideal for retrofits...no need to remove conductor. Self-grips on wire-no drilling in "hot" enclosures

Detects belt loss/coupling shear!



Now you can easily detect when drive belts slip, break, or pump couplings shear. In fact, a typical HVAC motor that loses its load has a reduction of current draw of up to 50%. That's why our sensors are the industry standard for status.

ORDERING INFORMATION

MODEL	AMPERAGE RANGE	OUTPUT TYPE	OUTPUT RATING (MAX.)	STATUS LED
H904	3.5-135A, 20-75Hz (on/off status only 20-34Hz, belt loss detection 35-75Hz.)	N.O. Solid-state	0.1A@30VAC/DC	●

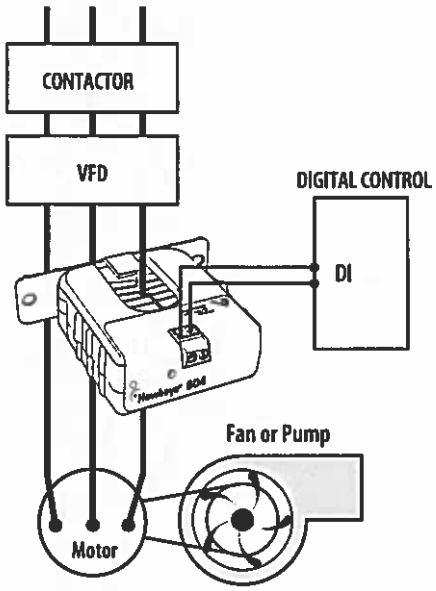
Do not use the LED indicators for evidence of applied voltage

ACCESSORIES

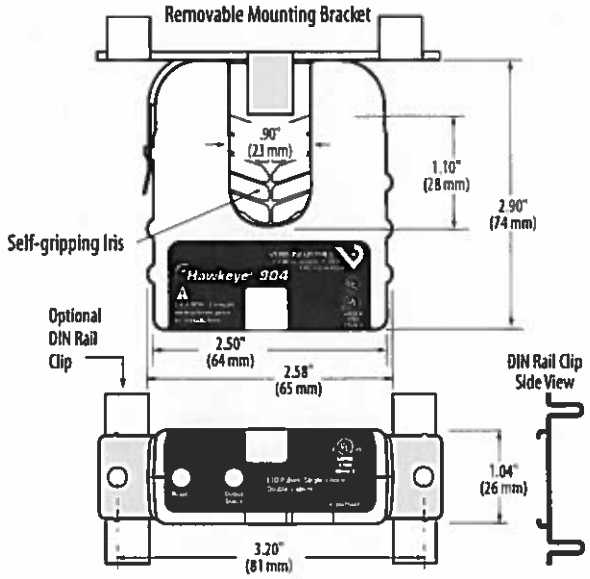
MODEL	DESCRIPTION
AH01	DIN Rail Clip Set

APPLICATIONS/WIRING EXAMPLE

Monitoring Fan /Pump Motors for Positive Proof of Flow



DIMENSIONAL DRAWINGS



SPECIFICATIONS

Amperage Range	3.5-135A (at all frequency levels)
Sensor Power	Induced
Output	Digital switch (see ordering table)
Insulation Class	600VAC rms
Frequency Range	34 to 75 Hz. (belt loss indication) 20 to 34 Hz. (on/off status)
Temperature Range	-15° to 60°C
Humidity Range	0-95% non-condensing
Trip Setpoint	Self-calibrating
Dimensions...(L x W x H)	2.90" x 2.58" x 1.04"
Sensor Opening Size	1.10" x .90"
Off Delay	0 sec to 2 min.

***NOTE:** The H904 is not intended for use in staged pump or variable inlet vane applications.*

t.a.c by Schneider Electric

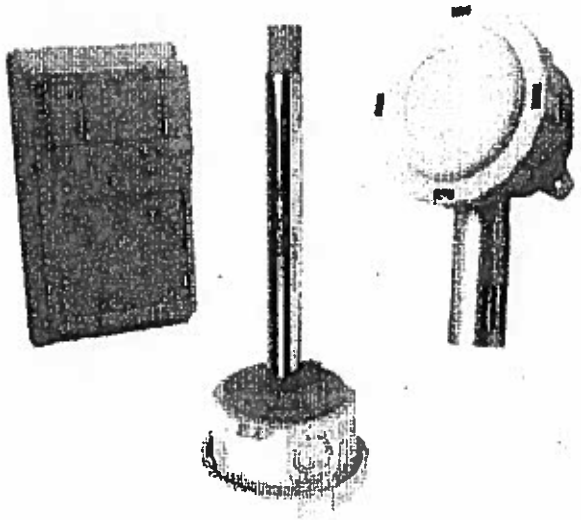
EH Series

Humidity Sensors

Data Sheet

DESCRIPTION

The EH Series Room, Duct and Outside hunidity sensors are a universal Relative Humidity transmitter that can be powered with either a +15 to 36 Vdc or 24 Vac supply voltage. The EH series sensors are designed with a field selectable 4-20 mA, 0-5 VDC, or 0-10 Vdc output signal that is equivalent to 0 to 100% RH. The EH Series is used in building automation systens, humidity chambers, and OEM applications and is compatible with Vista, Continuum, I/Net and I/A Systens.



EH Series

FEATURES

- Single point Field Calibration
- Field selectable output signals
- ±2% Accuracies
- Low Drift
- Highly Repeatable
- Integral Temperature Sensor

SPECIFICATIONS

Supply Voltage	250 Ohm Load: +15 to 36 Vdc / 21.6-26.4 Vac 0-5VDC: +15-36 Vdc / 21.6-26.4 Vac 500 Ohm Load: +18 to 36 Vdc / 21.6-26.4 Vac 0-10VDC: +18-36 Vdc / 21.6-26.4 Vac
Power Consumption	1VA maximum
RH Measurement Range	0 to 100%
RH Output	2-wire, 4 to 20mA (Factory Standard) 3-wire, 0-5, 0-10 Vdc or 4 to 20mA
Accuracy at 77° F (25° C)	+/- 2% from 20 to 95%
Long-term Stability	Less than 2% drift / 5 years
Hysteresis	Less than 0.4% RH
Repeatability	0.5% RH
Sensitivity	0.1 % RH
Response Time	110 seconds for 63% Step
Storage Temperature Range	41 to 95°F (5°C to 35°C) < 75% RH
Operating Temperature Range	-10 to 122°F (-23.3 to 50°C)
Operating Humidity Range	0 to 95 % RH non-condensing
Saturation Response Time	10 minutes for 63% Step
Temperature Sensor output at 77° F (25° C)	1.8K ohm (Vista), 10K ohm Type II (I/Net), 10K ohm Type III (Continuum), 10K ohm with 11K ohm shunt (I/A)

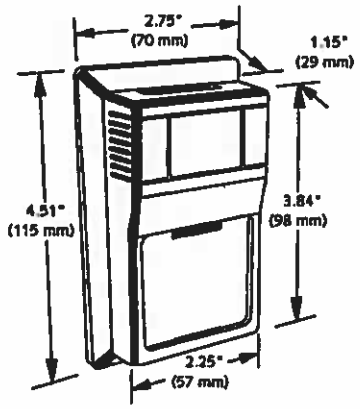
ORDERING INFORMATION

Description	Vista	I/Net	Continuum	I/A
Room-Humidity Only	EHR110			
Room-Humidity and Temperature	EHR110-100	EHR110-200	EHR110-500	EHR110-800
Duct-Humidity Only	EHD110			
Duct-Humidity and Temperature	EHD110-100	EHD110-200	EHD110-500	EHD110-800
Outdoor-Humidity Only	EHO110			
Outdoor-Humidity and Temperature	EHO110-100	EHO110-200	EHO110-500	EHO110-800

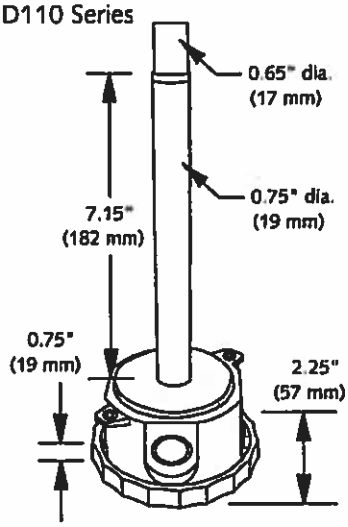
Miscellaneous Option	Code
LCD Display (Room Units Only. LCD displays humidity value.)	-LCD

DIMENSIONS

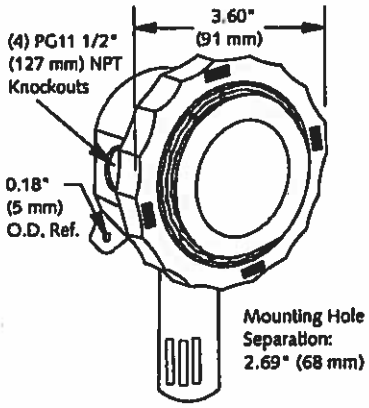
EHR110 Series



EHD110 Series



EHO110 Series



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www.tac.com

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PILOT LIGHTS
APW SERIES

IDEC

DESCRIPTION

APW Series Replaceable Incandescent and LED Pilot Lights can be mounted on control panels to provide immediate visual status of mechanical equipment such as fans, pumps, compressors, or control circuits.

SSG1-67

APW299D-G-24 mounted in E-1PBG

FEATURES

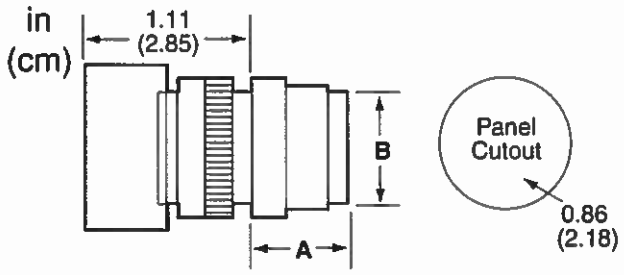
- ***Rugged, oil-tight construction***
- ***Bezel-threaded lock ring for easy panel installation***
- ***Incandescent or LED lamps***
- ***Small size***
- ***Excellent visibility***
- ***Multiple voltage input ranges***

APW199D-R-24

APW299D-G-24

RoHS

DIMENSIONS



PILOT LIGHTS	A	B
Dome	0.98 (2.49)	Ø 0.94 (2.36)
Flush	0.62 (1.57)	Ø 0.94 (2.36)

SPECIFICATIONS

Construction	
Lens	Acrylic
Base	Nylon
Bezel	Chrome-plated die-cast zinc
Terminals	#6-40 (M3.5) screws
Mounting	0.86" (2.2 cm) hole
Panel thickness	Panel thickness adjustment ring 0.04" to 0.24" (0.10 to 0.61 cm)
Lamps	T3-1/4 miniature bayonet base
LED	6 VDC, 52 mA; 12 VAC/VDC, 26 mA; 24 VAC/VDC,13 mA; 120 VAC, 8 mA; 1,000,000 hrs average life
Incandescent	6.3V, 1W; 12V, 1W; 24V, 1W; 3000 hrs average life
Protection rating	NEMA 1, 2, 3, 3R, 4, 4X, 12, 13
Agency approvals	UL listed, File #E70646; CSA certified, File #LR48366
Warranty	1 year

ORDERING INFORMATION

PILOT LIGHTS			
INCANDESCENT		**LED**	
MODEL	**STYLE**	**MODEL**	**STYLE**
APW299 - † - ††	Dome	APW299D - † - ††	Dome
APW199 - † - ††	Round flush	APW199D - † - ††	Round flush
† Lens Color Code: R-Red, G-Green, A-Amber, S-Blue, W-White †† Lamp Voltage Code: 6-6 VAC/VDC, 12-12 VAC/VDC, 24-24 VAC/VDC		† Lens Color Code: R-Red, G-Green, A-Amber, S-Blue, W-White, Y-Yellow †† Lamp Voltage Code: 6-6 VDC, 12-12 VAC/VDC, 24-24 VAC/VDC, 120-120 VAC	

REPLACEMENT LAMPS				
INCANDESCENT		**LED**		
MODEL	**VOLTAGE**	**MODEL**	**VOLTAGE**	**COLOR**
IS-6 IS-12 IS-24	6.3V 12V 24V	LSTD-6† LSTD-1† LSTD-2† LSTD-H2†	6 VDC 12 VAC/VDC 24 VAC/VDC 120 VAC	G - Green R - Red A - Amber W - White, Y - Yellow, S - Blue

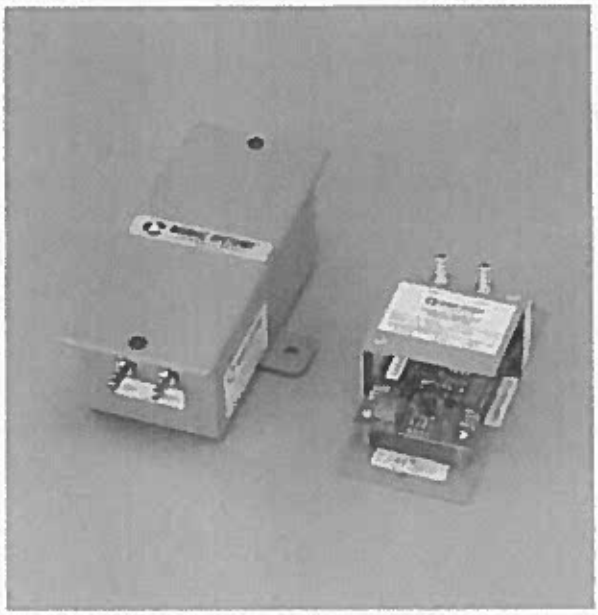
RELATED PRODUCTS

E-1PBG	One-hole NEMA 12/13 push-button enclosure	**E-3PBG***	Three-hole NEMA 12/13 push-button enclosure
E-2PBG*	Two-hole NEMA 12/13 push-button enclosure	**E-4PBG***	Four-hole NEMA 12/13 push-button enclosure
		SSG1-67	Wall plate box mount 7/8" hole

* Holes are 22.5 mm in a vertical arrangement.

Low Pressure Transducer

Model PR-274/275



- **100% solid state, micro-machined, glass-on-silicon, ultra-stable capacitance sensor**
- **As low as ± 0.05"wc (± 12.5 pa)**
- **Can resolve less than 0.00001"wc (0.00025 pa)**
- **Up to 10 PSID overpressure without zero shift**
- **Up to 6 field selectable ranges in one unit**
- **Wide 12-40 VDC/12-35 VAC unregulated supply voltage**
- **Two temperature compensated output versions, 4-20 mA 2-wire or field selectable 0-5 VDC/0-10 VDC**
- **Non-interacting zero and span trimmers**
- **NIST traceable calibration**
- **Two rugged steel enclosure types NEMA 4 (IP-65) or panel mount for ease of installation**
- **Short circuit and reverse polarity protected**
- **Conforms to EMC standards EN50082-1/ EN55014/EN60730-1**

The PR-274/275 incorporates a new micro-machined glass-on-silicon (Gl-Si) capacitance sensor. This technology revolutionizes very low pressure measurement. Temperature related zero drift, calibration shift due to overpressure, non-repeatability, non-linearity, and extremely low pressure sensitivity have been some of the problems which have plagued the controls industry. The PR-274/275 with the new Gl-Si technology not only addresses all of the above shortcomings, but for the first time offers a reliable, accurate means to measure and control building/room pressure, air flow, duct pressure, filter pressure drop, or any other extremely low pressure application. Up to six field selectable direct or compound ranges, two enclosure types, field selectable outputs, fully temperature compensated NIST traceable accuracy, non-interacting zero and span adjustments, short circuit and reverse polarity protected output, and a liberal two year warranty are some of the features which make the PR-274/275 the industry's highest performance, ultra-stable, low pressure transducer.

MAMAC SYSTEMS®
MONITOR • DECISION • CONTROL

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65-3927273 • Fax 65-3927276

PR-274/275

The PR-274/275 incorporates sophisticated integrated circuits to not only provide a high level, fully conditioned and temperature compensated output, but also to offer field selectable flexibility which was unheard of in the industry. The PR-274/275 offers up to six field selectable pressure ranges in one unit. In this way, a customer does not need to know the exact pressure range prior to selection. By merely knowing the application, a unit may be selected and then later field configured for the desired pressure range. With fixed range units, in case of engineering error or incorrect selection, the only solution is expensive field recalibration or time consuming product exchange or replacement. Similarly, numerous units have to be kept in stock as spares to cover all ranges in case of field failure. The PR-274/275 with the field selectable pressure ranges in a particular application thereby eliminating the need to stock numerous fixed range units. (For a complete listing of all the ranges available, please see the ordering information section on page three.)

On VDC output units, two additional field selectable options are available: dual outputs 0-5 or 0-10 VDC, and dual unregulated supply voltages 12-35 VAC or 12-40 VDC. By merely moving a shorting plug, one can select the desired output for the specific application. As far as supply voltage is concerned, the unit automatically configures for AC or DC and no field selection is necessary. Another feature is that the output is fully protected from short circuit to ground, or if the supply voltage is applied by mistake to the output. Past experience demonstrates that field related wiring problems do occur. Instead of denying this fact, the protection circuit is designed in to ensure trouble-free start-up. The VDC output unit is also designed to handle low impedance circuits. In fact, the unit can drive up to 1k ohms minimum. In this way, multiple controllers, indicators, or other devices can be paralleled to the output without performance degradation.

The mA output units can function over a wide unregulated supply voltage range: 12-40 VDC without any effect on calibration or performance. The unit has reverse polarity protection built in. As a result, it is next to impossible to damage the unit by mis-wiring. By using sophisticated low drop-out voltage regulators and CMOS integrated circuits, the mA output unit can drive very high output impedance. In fact, with only 12 VDC supply, the unit can drive 200 ohms. At 40 VDC, the unit is capable of handling up to 1600 ohms load. In this way, the output loop can be tied in series to multiple controllers, indicators, and other devices without degrading the performance.

Automated NIST traceable pressure controllers and precision Barocel® pressure sensors are utilized to calibrate and certify the PR-274/275 transducers. Calibration data on each unit is archived digitally for SPC and QC purposes. All automated calibration systems are networked and data is available on-line to numerous individuals at the same time. In this way, extremely high standards of quality and calibration integrity are maintained. Each unit is individually temperature compensated in an environmental chamber. The temperature compensation data is also digitized and archived for future reference purposes. Compensating each unit individually ensures that published specifications are adhered to.

Due to low mass of the micro-machined capacitance GI-Si sensor, the mounting orientation error for ranges higher than 1.0"wc (250 pa) is negligible. For extremely low ranges, if the unit is installed as indicated on the label, there should be no orientation error. However, due to space limitation, if the unit cannot be installed in the indicted position, the error can be easily removed by merely adjusting the zero trimmer. Since the zero and span trimmers are non-interactive, adjustment to the zero should under no circumstance affect the calibration integrity of the unit including linearity and repeatability specifications across the range.

The PR-274/275 is available with two packaging options: a NEMA 4 (IP-65) fully gasketed, dust proof and splash proof enclosure, or a lightweight but rugged panel mount chassis for ease of installation with minimum space requirement in a control panel. The NEMA 4 (IP-65) enclosure has an external mounting bracket to facilitate field installation. A 1/2" (.875"/22.25mm dia.) knock-out for conduit connection is also provided. A liquid tight cable connector is also supplied if the unit is not being hard wired. Once installed, the enclosure maintains its environmental rating and protects the electronics and the sensing element from condensation, corrosive contaminants and other environmental pollutants. Both packaging options also have additional features for ease of installation, including unpluggable terminal blocks, rugged brass hose barbs, easily accessible zero and span trimmers, and conveniently located shorting plugs for field selection.

PR-274/275

Specifications:

Accuracy*: ± 1% FS

Overpressure: 10 PSID

Supply Voltage: 12-40 VDC
12-35 VAC (VDC output units only)

Supply Current: VDC Units - 10 mA max.
mA Units - 20 mA max.

Enclosure: 18 Ga C. R. Steel NEMA 4 (IP-65) or Panel Mount Chassis

Finish: Baked on enamel-PMS2GR88B

Compensated Temp Range: 25°F-150°F (-4°C-65°C)

T. C. Error: ±0.0125%/°F (.02%/°C)

Operating Temp Range: 0°F-175°F (-18°C-80°C)

Media Compatibility: Clean dry air or any inert gas

Environmental: 10-90%RH Non-Condensing

Termination: Unpluggable screw terminal block

Wire Size: 12 Ga max.

Load Impedance: 1.6K ohms max. at 40 VDC (mA output units) 1K ohms min. (VDC output units)

Weight: Enclosure 1.0 lbs. (.45 kg),

Panel Mount: 0.5lbs. (.25 kg)

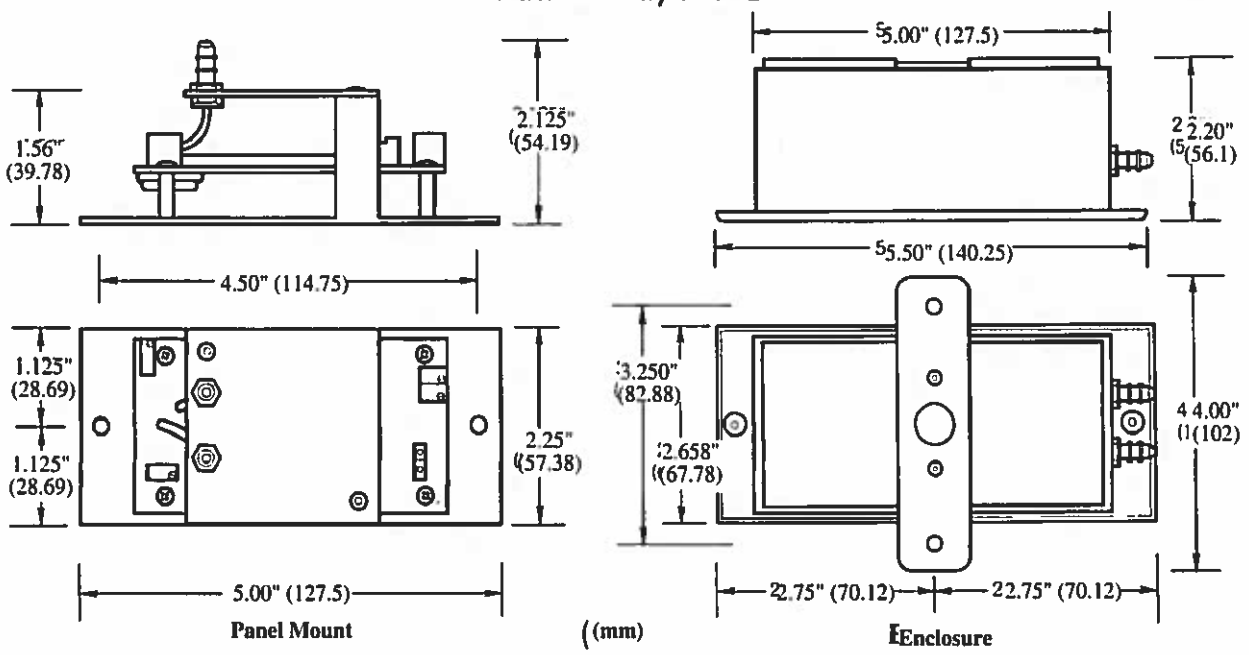
**Includes non-linearity, hysteresis and non-repeatability*

Ordering Information: PR-

PACKAGING	RANGE		OUTPUT	
274 (enclosure)	**Rl** ("wc)	0 T O 0. 10 / -0.05 TO + 0.05	**mA**	(4-20 mA 2 wire)
275 (panel mount)	**R2** ("wc)	0 TO 1.0 / 0 TO 0.5 / 0 TO0.25/ -0.5 TO + 0.5 / -0.25 TO + 0.25/ -0.125 TO + 0.125	**VDC**	(0-5 VDC or 0-10VDC field selectable)
	R3 ("wc)	0 TO 5.0 / 0 T O2.5 / 0 TO1.25/ -2.5 TO +2.5 / -1.25 TO + 1.25/ -0.625 TO + 0.625		
	R4 ("wc)	0 T O 30 / 0 TO 15 / 0 TO 7.5/ -15.0 TO + 15.0 / -7.5 TO +7.5/ -3.75 TO + 3.75		
	R5*(pa)	0 TO 25 / -12.5 TO + 12.5		
	R6*(pa)	0 TO 250 / 0 TO 125 / 0 TO 62.5/ -125 TO + 125 / -62.5 TO + 62.5/ -31.25 TO + 31.25		
	R7*(pa)	0 TO 1250 / 0 TO 625 / 0 TO 312.5/ -625 TO + 625 / -312.5 TO + 312.5/ -156.25 TO + 156.25		
	R8*(pa)	0 TO 7500 / 0 TO 3750 / 0 TO 1875/ -3750 TO + 3750 / -1875 TO + 1875/ -937.5 TO + 937.5		

Example: PR-274-R2-mA: Enclosure unit with R2 Range which has six (6) field selectable range options and 4-20 mA output.

PR-274/275



WARRANTY: MAMAC Systems, Inc. warrants its products to be free of defects in material and workmanship for a period of two (2) years from date of shipment. If a unit is malfunctioning, it must be returned to the factory for evaluation. A return authorization number (RMA) will be issued by the customer service department and this number must be written or prominently displayed on the shipping boxes and all related documents. The defective part should be shipped freight pre-paid to the factory. Upon examination by MAMAC Systems, Inc., if the unit is found to be defective, it will be repaired or replaced at no charge to the customer. However, this warranty is void if the unit shows evidence of being tampered with, damaged during installation, misapplied, misused, or used in any other operating condition outside of the unit's published specifications.

MAMAC Systems, Inc. makes no other warranties or representations of any kind whatsoever, expressed or implied, except that of title. All implied warranties including any warranty of merchantability and fitness for a particular purpose are hereby disclaimed. User is responsible to determine suitability for intended use.

LIMITATIONS OF LIABILITY: The remedies of buyer set forth herein are exclusive and the total liability of MAMAC Systems, Inc. with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the product upon which liability is based. **In no event shall MAMAC Systems, Inc. be liable for consequential, incidental or special damages.** MAMAC Systems, Inc. reserves the right to change any specifications without notice to improve performance, reliability, or function of our products.

Every precaution for accuracy has been taken in the preparation of this manual, however, MAMAC Systems, Inc. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the product in accordance with the information contained in the manual.

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EPW-EPW2 SERIES

EPW-EPW2 SERIES

Differential Pressure Transducer Wet Media

CE

NOTICE

- This product is not intended for life or safety applications.
- Do not install this product in hazardous or classified locations.
- Read and understand the instructions before installing this product.
- Turn off all power supplying equipment before working on it.
- The installer is responsible for conformance to all applicable codes.

PRODUCT IDENTIFICATION

EPW

Range	Local Display
103 = 0-50psig	Blank = No Display
104 = 0-100psig	LCD = LCD Display
105 = 0-250psig	

EPW2

Range	Local Display
103 = 0-50psig	Blank = No Display
104 = 0-100psig	LCD = LCD Display
105 = 0-250psig	

Select operational range according to the max. gauge pressure, NOT differential pressure. Example: For hi-gauge pressure = 90psig, select the 100psig model.

Note: The EPW Series is 3-wire. The EPW2 Series is 2-wire, loop-powered.

Installer's Specifications

Media Compatibility	17-4 PH stainless steel
Power Consumption	EPW2: 20mA max.
Input Power	EPW: 12 to 30VDC, 24VAC nom. EPW2: 12-24VDC
Output	EPW: 3-wire transmitter; user selectable 4-20mA/0-5V/0-10V* EPW2: 2-wire transmitter; 4-20mA; polarity insensitive (clipped and capped)*
Pressure Ranges (switch selectable)	103: 0-50psig (5/10/25/50psid) / 0-3.45 bar (0.34/0.69/1.72bar) 104: 0-100psig (10/20/50/100psid) / 0-6.89bar (0.69/1.38/3.45bar) 105: 0-250psig (25/50/125/250psid) / 0-17.24bar (1.72/3.45/8.62bar)
Status Indication	EPW: Dual color LED: solid green=normal, blinking green=low>high, solid red=over range, blinking red=over pressure
Proof Pressure	2x max.; F.S. range
Burst Pressure	5x max.; F.S. range
Accuracy @ 25°C	±1% F.S.** combined linearity, hysteresis, and repeatability; EPW: Range D accuracy = ±2% F.S.**
Surge Dampening	Electronic, selectable (1-second or 5-second averaging)
Temperature Compensated Range	0° to 50°C (32° to 122°F); TC Zero<±1.5% of product F.S. per sensor; TS Span<±1.5% of product F.S. per sensor
Sensor Operating Range	-20° to 85°C (-4° to 185°F)
Long Term Stability	±0.25% per year (all models)
Zero Adjust	Pushbutton autozero; digital input (2-position terminal block)
Operating Environment	-10° to 55°C (14° to 131°F); 10 to 90% RH non-condensing
Fittings	1/8" NPT female, stainless 17-4 PH
Physical	White powder-coated aluminum

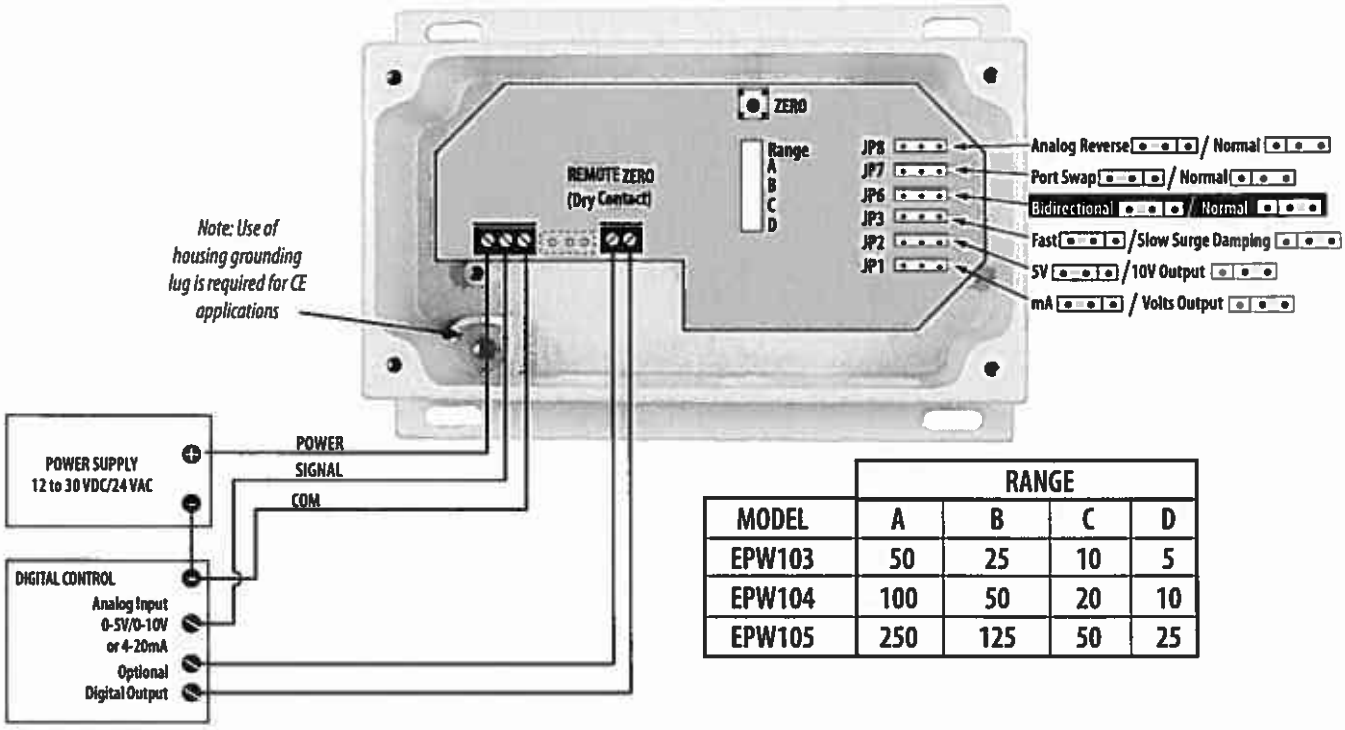
To conform to EMC standards, use shielded cabling.
** Minimum input voltage for 4-20mA operation: 250Ω loop (1-5V) = 12VDC; 500Ω loop (2-10V) = 15VDC.*
*** Full Scale is defined as the full span of the selected range in bidirectional mode.*

QUICK INSTALL

1. Affix the backplate to a mounting surface (wall, duct, sheet metal, etc.).
2. Plumb the ports to "HI" and "LO" sides of the pressure differential. Wrap the fitting with 2-3 turns of Teflon tape, hand tighten, then use a wrench to make two more turns.
3. Wire the sensor. See the Wiring section on page 2 for details.
4. Configure the jumpers as desired. See the Configuration section on page 3 for details.

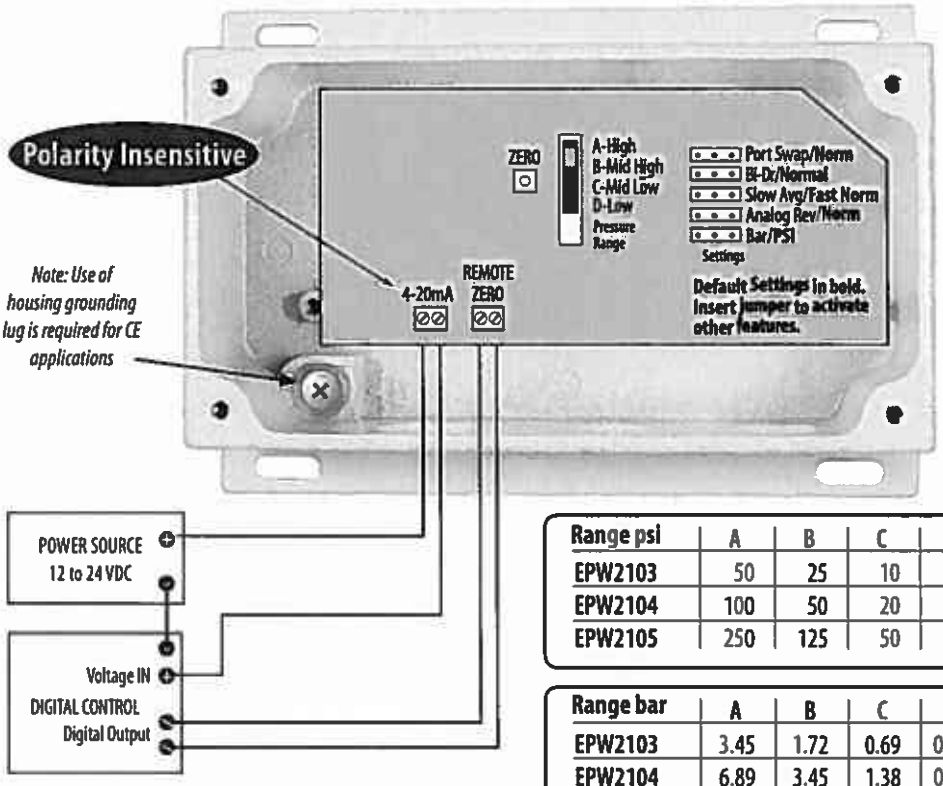
INSTALLATION/WIRING

EPW



MODEL	RANGE			
	A	B	C	D
EPW103	50	25	10	5
EPW104	100	50	20	10
EPW105	250	125	50	25

EPW2



Range psi	A	B	C	D
EPW2103	50	25	10	5
EPW2104	100	50	20	10
EPW2105	250	125	50	25

Range bar	A	B	C	D
EPW2103	3.45	1.72	0.69	0.34
EPW2104	6.89	3.45	1.38	0.69
EPW2105	17.24	8.62	3.45	1.72

CONFIGURATION

EPW

JP1: Voltage (V) or current (mA) mode.

JP2: 0-10V or 0-5V output span (Voltage mode only).

JP3: Slow or fast mode. Slow mode provides 5-second averaging for surge dampening; fast mode provides 1-second averaging.

JP6: Bidirectional or Normal. Normal mode range is from zero to full scale differential pressure. Bi-directional mode changes range from minus full scale to plus full scale differential pressure. Output will be at one half when the differential pressure is zero (see table below).

JP7: Port Swap or Normal. This setting is used to remedy situations when the "HI" & "LO" ports to the pressure transducer are incorrectly plumbed. Use jumper JP7 to reverse polarity of pressure ports. This jumper makes the "HI" port "LO" and the "LO" port "HI".

JP8: Analog Reverse or Normal. Normal mode output increases as pressure increases. Reverse mode output is maximum when pressure differential is zero and decreases as pressure increases.

RANGE: Use range switch to select full-scale differential pressure.

EPW2

Fast or Slow: Slow mode provides 5-second averaging for surge dampening; fast mode provides 1-second averaging.

Bidirectional or Normal: Normal mode range is from zero to full scale differential pressure. Bi-directional mode changes range from minus full scale to plus full scale differential pressure. Output will be at one half when the differential pressure is zero (see table below).

Port Swap: This setting is used to remedy situations when the "HI" & "LO" ports to the pressure transducer are incorrectly plumbed. Use jumper "Port Swap" to reverse polarity of pressure ports. This jumper makes the "HI" port "LO" and the "LO" port "HI".

Analog Reverse or Normal: Normal mode output increases as pressure increases. Reverse mode output is maximum when pressure differential is zero and decreases as pressure increases.

Range: Use range switch to select full-scale differential pressure. Select psi or bar by positioning jumper.

Bi-directional Operation

Input Conditions (psi)		Result	Outputs Read
Hi Port	Lo Port	DP	4-20mA
100	0	+100	20
100	50	+50	16
50	50	0	12
50	100	-50	8
0	100	-100	4

OPERATION

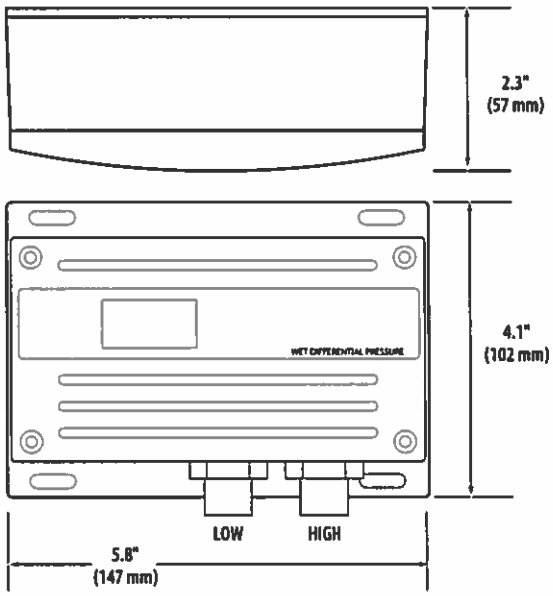
LED INDICATOR (EPW Only)

GREEN ON (solid):	Normal
GREEN (blinking):	Low > High - Use port swap jumper or bidirectional mode.
RED ON (solid):	Differential Pressure is too high. Select a higher range on device.
RED (blinking):	Gauge pressure has exceeded sensor; F.S. Reduce line pressure or replace with a higher range device.

ZERO

Press and hold the "ZERO" push-button for 2 seconds or provide contact closure on auxiliary "REMOTE ZERO" terminal to automatically reset output to ZERO pressure. To protect the unit from accidental ZERO, this feature is enabled only when detected pressure is within 5% of factory calibration.

DIMENSIONS



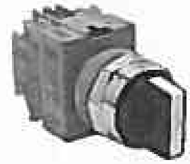
PANEL & INSTALLATION MATERIALS

GENERAL-PURPOSE SELECTOR SWITCHES
ASW SERIES

SSG1-67

ASW320 mounted in E-1PBG

ACSNO-354-YB-C3016



Knob Style Selector Switch

DESCRIPTION

ASW Series General-purpose Selector Switches are for pilot duty control of electrical equipment such as fans, pumps, compressors, or control circuits.

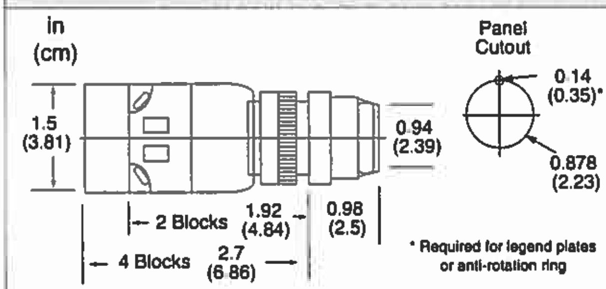
FEATURES

- ***Rugged, oil-tight construction***
- ***Snap-fit blocks with N.O. and N.C. contacts***
- ***Self-cleaning silver contacts***
- ***Durable nylon operator base***
- ***Optional key or lever styles available***

SPECIFICATIONS

Contact rating	10A, 600 VAC/VDC 5 mA, 3 VAC/VDC min
Contact resistance	50 mΩ max (initial value)
Rated insulation voltage	600V
Mechanical life	500,000 min operations
Electrical life	500,000 min operations
Terminals	#6-40 (M3.5) screws
Contact material	Silver
Mounting	0.878" (2.23 cm) hole
Panel thickness	Panel thickness adjustment ring, 0.04" to 0.24" (0.10 to 0.61 cm)
Protection rating	NEMA 1, 2, 3, 3R, 4, 4X, 12, 13
Agency approvals	UL listed, File #E70646; CSA certified, File #LR48366

DIMENSIONS



Knob Style

ORDERING INFORMATION

SELECTOR SWITCHES

TWO-POSITION MAINTAINED					THREE-POSITION MAINTAINED					
Model	Contact Configuration	Contact #	Operator Position L	Operator Position R	Model	Contact Configuration	Contact #	Operator Position L	Operator Position C	Operator Position R
ASW210 ASW2K10 (Key)	1 N.O.	1	O	X	ASW320 ASW3K20 (Key)	2 N.O.	1 2	X O	O O	O X
ASW201-116	1 N.C.	1	X	O	ASW321-255	2 N.O. 1 N.C.	1 2 3	X O O	O X O	O O X
ASW211 ASW2K11 (Key)	1 N.O. 1 N.C.	1 2	X O	O X	ASW322 ASW3K22 (Key)	2 N.O. 2 N.C.	1 2 3 4	X O O X—	O O -X- —X-	O X -X- O
NWAL-212	Legend Plate-Off-On				NWAL-317	Legend Plate-Hand-Off-Auto				

ADDITIONAL CONTACT BLOCKS

HW-C10	Normally open contact
HW-C01	Normally close contact
TW-D	Dummy block (needed when only one HW-C10 or HW-C01 is used)

Note: Key is removeable in any position.

X = Contacts closed O = Contacts open
-X—X- = Contacts remain closed when switch is moved between these two positions

CAM SWITCHES

ACSNO-244-YB-C2008	Four-position, contact made each position only, 45 degrees (1.2", 3.05 cm mounting hole)
ACSNO-354-YB-C3016	Five-position, contact made each position only, 45 degrees (1.2", 3.05 cm mounting hole)

Call Kele for selector switches with key or lever operators, other contact arrangements, and other legend plates.

RELATED PRODUCTS

E-1PBG	One-hole NEMA 12/13 push-button enclosure
E-2PBG*	Two-hole NEMA 12/13 push-button enclosure
E-3PBG*	Three-hole NEMA 12/13 push-button enclosure
E-4PBG*	Four-hole NEMA 12/13 push-button enclosure
SSG1-67	Wall plate box mount 7/8" hole

*Holes are 22.5 mm in a vertical arrangement.

STAINLESS STEEL FLOAT LEVEL SWITCH
MODEL F8-SSL

NEW!

MADE IN USA

DESCRIPTION

The **Model F8-SSL Stainless Steel Float Level Switch** is designed for high pressure or high temperature level monitoring applications. Magnets within the float actuate the hermetically sealed reed switch on rising or falling levels. The unit is mounted vertically and shipped in the normally open position. For normally closed operation, simply invert the float.

c UL us

FEATURES

- ***High pressure and high temperature performance***
- ***50 VA SPST switch operation (120-240 VAC)***
- ***Hermetically sealed***
- ***Easy installation***
- ***Vertical mounting***

ORDERING INFORMATION

MODEL	DESCRIPTION
F8-SSL	Vertical float switch

SPECIFICATIONS

Material (stem/float)	316 Stainless steel/316 stainless steel
Minimum specific gravity	0.75
Temperature limits	-40° to 300°F (-40° to 149°C)
Dimensions	2.06"L X Ø1.0"
Operating pressure	750 psig (51.7 bar)
Installation	Vertical
Mounting connection	1/4" NPT (M(M)
Weight	3.2 oz (91g)

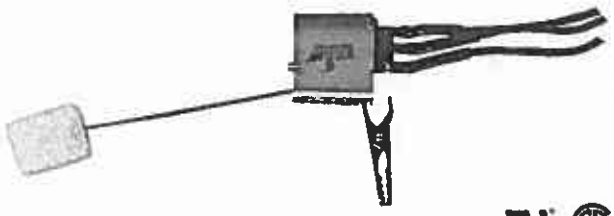
11

LEVEL

FLOAT SWITCH
JMP SERIES

DESCRIPTION

The **JMP Series Float Switches** provide a cost effective solution for applications such as condensate drip pan monitoring. The **JMP-100-4CC** features a spring clip and the **JMP-100-4CC11** an L bracket for mounting.



UL CSA

FEATURES

- ***Simple installation***
- ***Low cost***
- ***UL recognized, CSA certified***
- ***SPDT contacts***

ORDERING INFORMATION

MODEL	DESCRIPTION
JMP-100-4CC	Float switch with spring clip mount
JMP-100-4CC11	Float switch with L bracket mount

SPECIFICATIONS

Temp limits	150°F (70°C)
Electrical rating	5A @ 125 VAC 3A @ 250 VAC
Installation	Horizontal
Dimensions	3.5" (8.9 cm) clip to float
Wiring	6" leads 18 AWG
Approvals	UL-recognized component, CSA certified

NEW!

t.a.c by Schneider Electric

ET Series

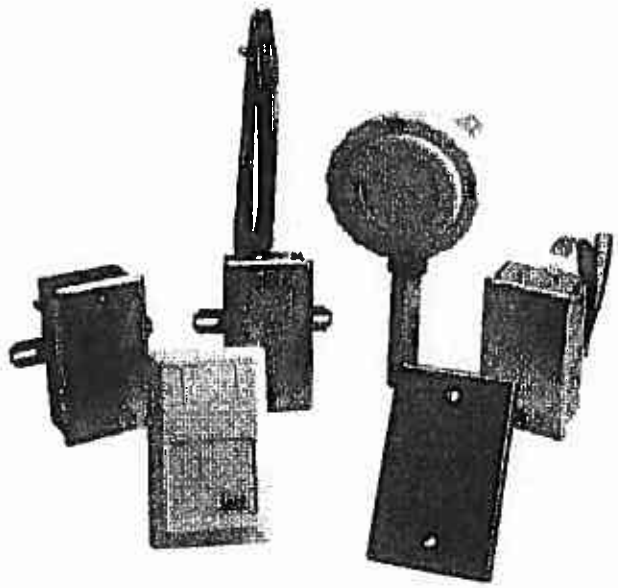
Temperature Sensors

General Instructions

APPLICATION

Thermistors offer high accuracy and interchangeability over a wide temperature range. The ET series can be used in the following applications:

- Space
- Duct
- Immersion
- Averaging
- Strap-On
- Bead/Bullet
- Outdoor Air



ET Series Photo

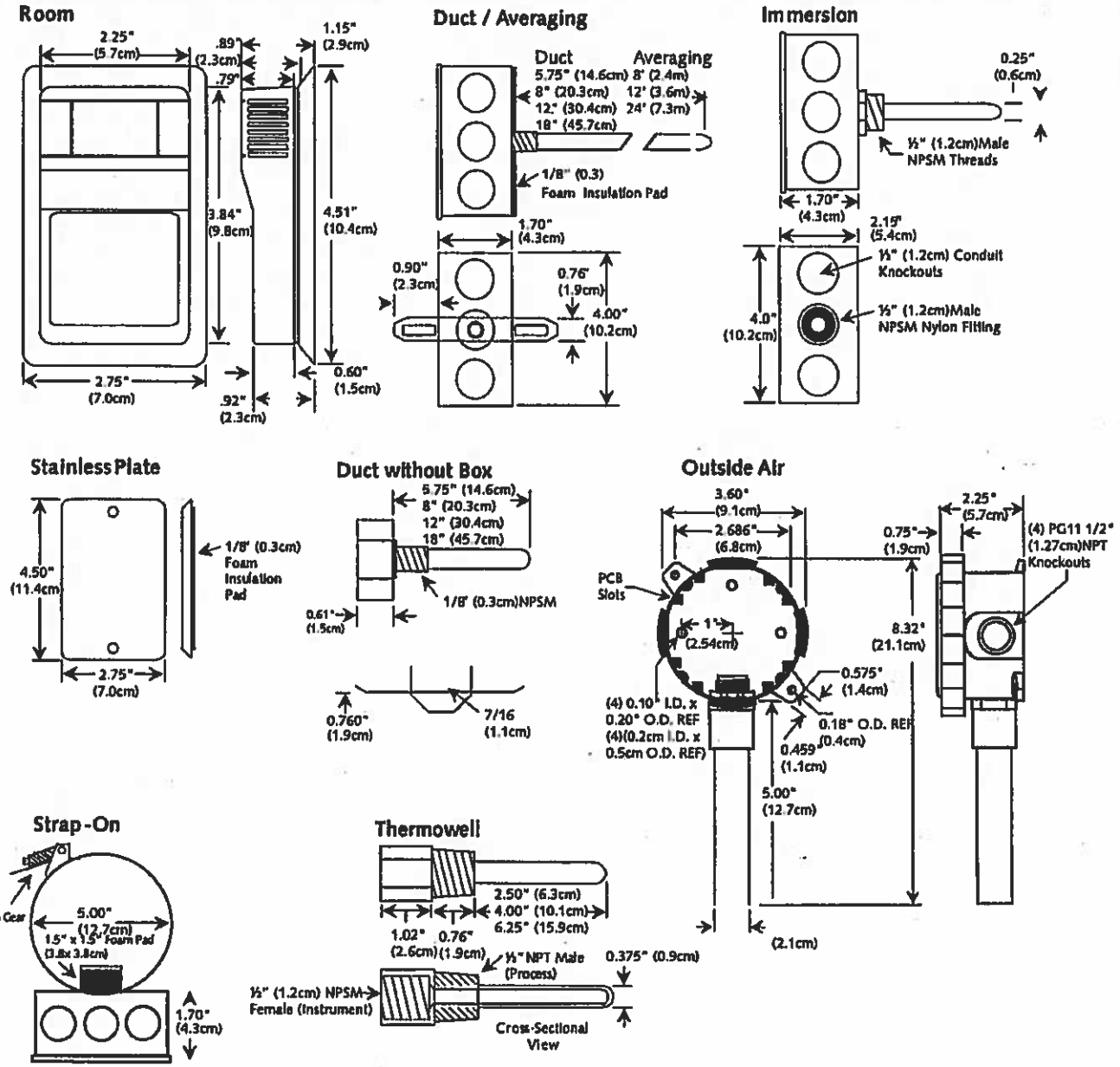
FEATURES

- Offer high accuracy and interchangeability over a wide temperature range.
- Non-polarity sensitive

SPECIFICATIONS

	For TAC Vista, I/NET, Continuum, and I/A	1000 Ohm Platinum	1000 Ohm BALCO
Output	1.8K Ohms @ 77° F (25° C) Vista 10K Ohms @ 77° F (25° C) I/Net 10K Ohms @ 77° F (25° C) Continuum 10K Ohms @ 77° F (25° C) with 11K Ohms shunt resistor I/A	1K Ohms @ 32°F (0°C)	1000 Ohms @ 70°F (21°C)
Temperature Range	-40° to 302° F (-40° to 150° C)	-58° to 392°F (-50 to 200°C) -50° to 275°F (-45.5° to 134.8°C)	-40° to 240°F (-40° to 116°C)
Interchangeability	+/- 0.2 C (0° to 70° C)		
Dissipation Constant Stability	3 mW / C		
Accuracy	+/- 0.2° C (0° to 70° C)	+/- 0.06% @ 32°F (0°C) Single Point +/- 1.0 Ohm @ 70°F (Averaging)	+/- 0.1%
Operating Humidity	0 to 90% RH non-condensing		

DIMENSIONS



INSTALLATION

ROOM TEMPERATURE SENSORS
This unit is suitable for either drywall mounting or junction box mounting. The room sensor is provided with screw terminal blocks for all connections. Remove the cover from the unit and mount the housing base to the wall using the (2) 6/32" x 1" machine screws. Replace the cover and tighten down, using the (2) 1/16" Allen Screws located on the bottom of the enclosure.

DUCT AND DUCT AVERAGING SENSORS
Duct temperature sensors - drill a 3/8" hole in the duct and insert the probe through the hole until the foam pad is tight to the duct. Now insert (2) screws through the mounting holes in flange and tighten them until the unit is held firmly to the duct. Duct Averaging sensors - Drill a 3/8" hole in the duct and insert the averaging element through the hole until the foam pad is tight to the duct. Now insert the (2) screws through the holes in the mounting flange and tighten until the unit is held firmly to the duct. The sensor should then be strung in a criss-cross pattern throughout the duct using the mounting clips provided, in a pattern that covers the greatest surface area of the duct, to insure that there is no stratification. When bending the copper tubing, be careful that you use a gradual bend and that you DO Not kink the copper tubing.

IMMERSION TEMPERATURE SENSORS
The TAC Fluid Immersion-type sensors are provided with a 2 ½", 4", or 6 ¼" insertion length, 304 series stainless steel thermowell. The thermowell has a 1/2" NPT external or process thread and a 1/2" NPT internal or instrument thread. Heat transfer compound may be used but it is not necessary.

STRAP-ON TEMPERATURE SENSORS
The TAC Strap-On sensors, are provided in a NEMA 1 rated junction box with an adjustable 2" to 5" pipe clamp. The unit should be mounted on the bottom side of the pipe to ensure proper heat transfer and a true temperature reading. Heat transfer compound and insulating the sensor will help the overall accuracy of the sensor. By ordering extra straps, and fastening them together, it is possible to make them fit larger pipes.

OUTSIDE AIR TEMPERATURE SENSORS
The TAC Outdoor Air temperature sensors are provided in a weatherproof enclosure. An optional weatherproof Aluminum Bell Box or NEMA 4X Polycarbonate enclosure is also available upon request for an additional charge. All of the mounting hardware is provided with the sensor. Be sure to mount the sensor out of direct sunlight, with the sensor probe pointing downward.

STAINLESS PLATE TEMPERATURE SENSORS
The TAC Stainless Plate temperature sensors are mounted on the back of a 1 Gang stainless steel plate. The foam pad will insulate the sensor from any drafts in the wall. (2) 6/32" x 1" machine screws are provided for junction box mounting. Be sure that the sensor is not mounted on an outside wall, due to the extreme temperature changes from either drafts or heat transfer.

WIRING DIAGRAMS

Diagram for ETR Sensors

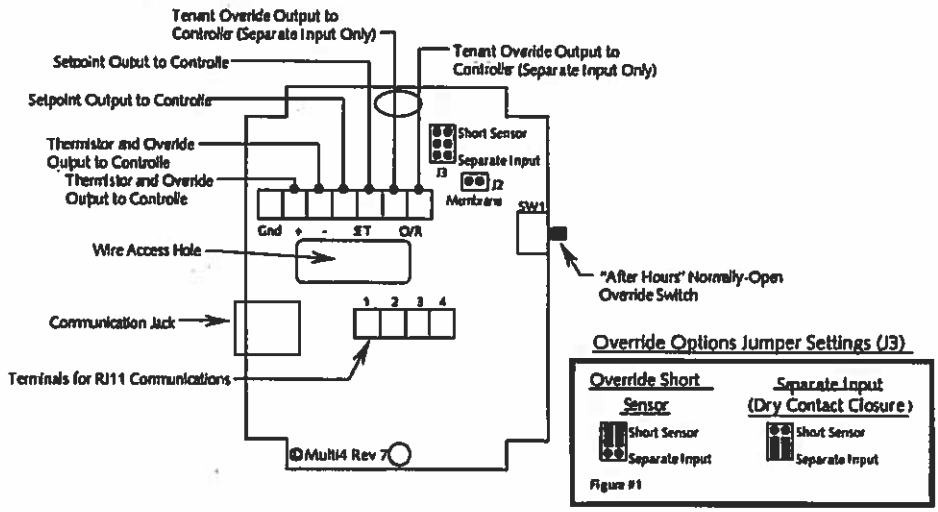
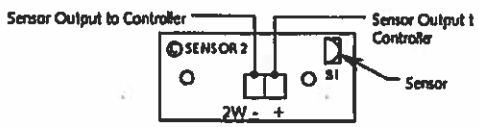


Figure #1

Diagram for ET Sensors Except ETR



ORDERING INFORMATION

Temperature Sensor Description	TAC Vista	I/NET	Continuum	I/A	1000 Ohm Platinum	1000 Ohm BALCO
Room	ETR100	ETR200	ETR500	ETR800	-	-
Room with Setpoint	ETR101	ETR201	ETR501	ETR801	-	-
Room with Override Pushbutton	ETR102	ETR202	ETR502	ETR802	-	-
Room with Setpoint and Override Pushbutton	ETR103	ETR203	ETR503	ETR803	-	-
Wallplate (Stainless Steel)	ETP100	ETP200	ETP500	ETP800		
4" Duct (Galvanized Steel Enclosure)	ETD100-4	ETD200-4	ETD500-4	ETD800-4	ETDPK0-4	ETDBK0-4
6" Duct Galvanized Steel Enclosure)	ETD100-6	ETD200-6	ETD500-6	ETD800-6	ETDPK0-6	ETDBK0-6
8" Duct (Galvanized Steel Enclosure)	ETD100-8	ETD200-8	ETD500-8	ETD800-8	ETDPK0-8	ETDBK0-8
12" Duct (Galvanized Steel Enclosure)	ETD100-12	ETD200-12	ETD500-12	ETD800-12	ETDPK0-12	ETDBK0-12
4" Duct without Enclosure	ETD100-NE-4	ETD200-NE-4	ETD500-NE-4	ETD800-NE-4	ETDPK0-NE-4	ETDBK0-NE-4
6" Duct without Enclosure	ETD100-NE-6	ETD200-NE-6	ETD500-NE-6	ETD800-NE-6	ETDPK0-NE-6	ETDBK0-NE-6
8" Duct without Enclosure	ETD100-NE-8	ETD200-NE-8	ETD500-NE-8	ETD800-NE-8	ETDPK0-NE-8	ETDBK0-NE-8
12" Duct without Enclosure	ETD100-NE-12	ETD200-NE-12	ETD500-NE-12	ETD800-NE-12	ETDPK0-NE-12	ETDBK0-NE-12
2" Immersion (Galvanized Steel Enclosure)	ETI100-2	ETI200-2	ETI500-2	ETI800-2	ETIPK0-2	ETIBK0-2
4" Immersion (Galvanized Steel Enclosure)	ETI100-4	ETI200-4	ETI500-4	ETI800-4	ETIPK0-4	ETIBK0-4
6" Immersion (Galvanized Steel Enclosure)	ETI100-6	ETI200-6	ETI500-6	ETI800-6	ETIPK0-6	ETIBK0-6
8' Averaging (Flexible Copper)	ETA100-8	ETA200-8	ETA500-8	ETA800-8	-	-
12' Averaging (Flexible Copper)	ETA100-12	ETA200-12	ETA500-12	ETA800-12	ETAPK0-12	ETABK0-12
24' Averaging (Flexible Copper)	ETA100-24	ETA200-24	ETA500-24	ETA800-24	ETAPK0-24	ETABK0-24
Outside Air	ETO100	ETO200	ETO500	ETO800	-	-
Strap On	ETS100	ETS200	ETS500	ETS800	-	-
Bead / Bullet	ETB100	ETB200	ETB500	ETB800	-	-

Miscellaneous Options	Code
LCD Display (for room units only)	-LCD
LED Indicator (for room units with override only)	-LED
Thermometer Indicator (for room units only)	-TI
RS232 Communication Jack (for use with I/NET systems only)	-RS232
Four-Pin RJ11 Communication Jack (for use with TAC Vista and Continuum systems only)	-RJ4

Well Type	Part Number
2" Stainless Steel Well	ETI-WELL-2S
4" Stainless Steel Well	ETI-WELL-4S
6" Stainless Steel Well	ETI-WELL-6S

TAC
1354 Clifford Ave
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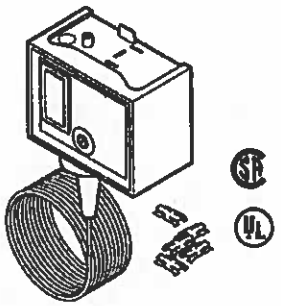
Loves Park, IL 61132-2940

www.tac.com

t.a.c by Schneider Electric

Low Temperature Thermostats

The TC-5231, TC-5232, and TC-5241 low temperature thermostats are used to control temperature in air conditioning or refrigeration systems.



Features:

- 20 ft. (6.1 m) element senses temperature over a large area. Control responds to coldest one-foot section of the sendor.
- Adjustable setpoint with 5 F degrees (3 C degrees) fixed differential.
- SPST, SPDT and DPST versions.
- Capillary mounting clips provided.

Model Chart

Model No.	Setpoint Range	Device Type	Electrical Switch	Voltage Vac	Full Load Amps	Locked Rotor Amps	Pilot Duty (VA)	Non-Inductive Amps
TC-5231	35 to 60°F (1.7 to 1.5°C)	Low temp auto reset	SPDT[a]	24[b]	—	—	100	16
				120	17	102	720	24
				208				
				240[c]				
				277	—	—	—	7.2
TC-5232			DPST[d]	24[b]	—	—	100	16
				120	24	144	125	24
				208				
				240[c]				
				277	—	—	—	7.2
TC-5241		Low temp manual reset[e]	SPDT[a]	24[b]	—	—	100	16
				120	17	102	720	24
				208				
				240[c]				
				277	—	—	—	7.2
TC-5242	15 to 55°F (-9.4 to 12.8°C)		1-SPST Main N.C. 1-SPST Aux N.O.	120	16	96	125	—
				208	9.2	55.2		
				240[c]	8	48		
				277	—	—		7.2
				120	6	36		6
				208	3.4	20.4		
				240[c]	3	18		
				277	—	—		

[a] Do not exceed pilot duty rating on one side of switch.

[b] Less than 0.5 Amp is not recommended.

[c] Full load and locked rotor ratings are suitable for hermetic compressors only.

[d] Limit two separate circuit loads with common return to <5885 VA. Only one load may be a motor load.

[e] Reset cannot be accomplished until the sensed temperature is at least 5°F above setpoint.

DC Ratings for TX-5232 Only.

Volts	FLA[a]	LRA[a]	NIA[a]	PD VA[a]
120	4.6	46	3	57.5
240	2.3	23	0.5	57.5
600	—	—	—	57.5

[a] FLA — Full Load Amps.
LRA — Locked Rotor Amps.
NIA — Non-Inductive Amps.
PDVA — Pilot Duty VA.

Specifications

Setpoint dial range	Dual marked 35 to 60°F (1.7 to 15.5°C). TC-5242: 15 to 55°F (-9.4 to 12.8°C).
Sensing element	Vapor pressure type, copper construction.
Response	To lowest temperature sensed by any one-foot section of its element. Altitude causes the control to operate approximately 1°F colder per 1000 ft. of elevation.
Differential	5 F degrees (3 C degrees) fixed.
Electrical switch	Refer to Model Chart.
Ratings	Refer to Model Chart.
Connections	Coded screw terminals.
Mounting	In any position on any surface not subject to excessive vibration.
Housing	Molded gray PVC plastic cover with a zinc-plated steel main enclosure with a 1/2 in. conduit opening. TC-5242: painted steel housing.
Environment	
Ambient temperature limits	Shipping: -40 to 150°F (-40 to 66°C). Operating: Must be 5°F (3°C) above setpoint to a maximum of 150°F (66°C) at case. Thermal sensing element: 300°F (149°C).
Humidity	Enclosure: 5 to 95% RH, non-condensing. Thermal sensing element: 0 to 100% RH.
Locations	NEMA Type 1.
Dimensions	
Case	2-45/64 H x 3-1/2 max. W x 2 max. D in. (69 x 89 x 51 mm). TC-5242: 3-1/4 H x 4 L x 2 D in. (83 x 101 x 51 mm)
Element	3/32 in. O.D. x 20 ft. length (2.4 mm x 6.1 m). TC-5242 1/8 in. O.D. x 20 ft. length. (3.2 mm x 6.1 m).
Agency Listings	
UL 873	Underwriters Laboratories Inc. listed (File # E9429 Category Temperature-indicating and Regulating Equipment).
CSA	Certified for use in Canada by Underwriters Laboratories. Canadian standards C22.2 No. 24-93.
General Instructions	Refer to F-25911.

Typical Applications

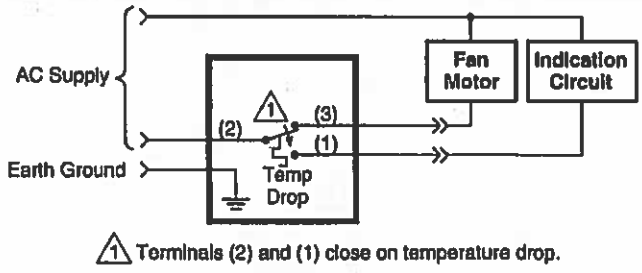


Figure 1 TC-5231 or TC-5241 Switch Action and Terminal Identification.

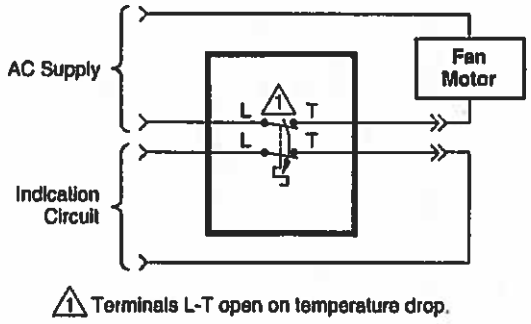


Figure 2 TC-5232 Switch Action and Terminal Identification.

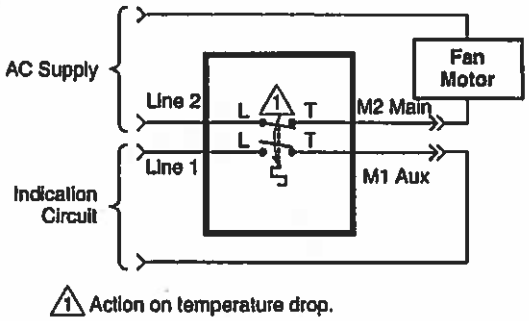


Figure 3 TC-5242 Switch Action and Terminal Identification Manual Reset.

Andover Controls

Infinity

Wall Mount Temperature Sensor

Andover Controls Wall Mount Temperature Sensor provides accurate, reliable measurement of interior room temperature for use in an Andover Controls building automation system. The active sensing element is a highly stable, precision thermistor, accurate to within ± 0.36°F. The sensor has an operating range of 40°F to 100°F (4.4°C to 37.8°C).

The thermistor is encapsulated with a low mass, high-conductivity thermal compound for good heat transfer characteristics. It is housed in an attractive, well-ventilated plastic enclosure. The unique two-piece enclosure design permits changeout of the thermistor material, which is located in the cover, without removal of the baseplate. The cover is securely snapped into the backplate.

The sensor may be mounted directly on dry wall, or on any electrical outlet box with no adapters required. The sensor is for interior use only, and is not suitable for use where condensation may occur.

FEATURES

- **Accurate, Reliable Type III Thermistor**
- **Attractive, Ventilated Two-Piece Housing**
- **Fast Response to Temperature Changes**
- **Easy Installation and Service**

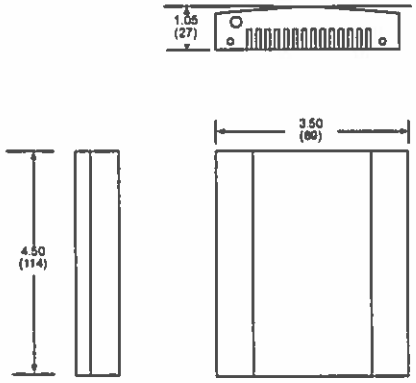
SPECIFICATIONS

Sensing Element:	Type III Thermistor, 10,000 ohms @ 77°F (25°C)
Range:	40°F to 100°F (4.4°C to 37.8°C)
Accuracy:	±0.36°F (±0.2°C)
Stability:	Thermistor will not deviate from accuracy spec for minimum of 5 years
Wiring Connections:	Wiring leads, 2 Yellow, Interchangeable
Wire Specifications:	18, 20, 22 or 24 gauge, 2 conductor, unshielded
Maximum Distance to Sensor:	24 gauge wire: 490 ft. with less than 0.1°F (-17.72°C) error 22 gauge wire: 850 ft. with less than 0.1°F (-17.72°C) error 20 gauge wire: 1,200 ft. with less than 0.1°F (-17.72°C) error 18 gauge wire: 2,000 ft. with less than 0.1°F (-17.72°C) error
Dimensions:	4.50"H x 3.50" W x 0.813"D (11.5 cm H x 8.9 cm W x 2.0 cm D)
Color:	Off-white

ORDERING INFORMATION

WallMount Room Sensor, ACC Logo:	TTS-S-1
WallMount Room Sensor, Blank Cover, No Logo:	TTS-S-B-1

DIMENSIONAL DRAWING



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#DS-WallMount-B

AndoverControls

Infinity

Smart Sensor LED/LCD Display Temperature Sensors

Andover Controls Smart Sensor combines an attractive display with a room temperature sensor to provide users with a cost effective way to view or modify VAV box operation. It is designed for use with the Andover Controls TCX 866 VAV controller and can also accomplish many local control and monitoring tasks.

The standard Smart Sensor provides a two character LED display and a 6 button programmable keypad that enables operators and occupants to change setpoints, monitor occupancy status and turn equipment on and off. An enhanced version of the Smart Sensor is also available with a 4-digit custom LCD that provides the following icons: PM, %, °, Setpoint, Cool, Heat, CFM, Fan, OA, and SP.

The function keys can be custom programmed to perform a wide variety of functions, including switching a specific zone to occupied mode, signaling an alarm condition, adjusting the amount of override time, arming or disarming a security system, and enforcing password security. Programming the display and function keys is done with Andover Controls' *Plain English*® programming language.

The Smart Sensor comes in a well-ventilated plastic enclosure. The active sensing element is a highly stable, precision thermistor, accurate to within ± 0.36°F. The sensor has an operating range of 32°F to 105°F (0°C to 40°C). Both versions of the Smart Sensor provide a connection for the Andover Controls *Infinity* Lap-Top Service Tool.

FEATURES

- **Accurate, Reliable Type III Thermistor**
- **Two 7-Segment LED Display or Four Digit Custom LCD Display**
- **6-Button Programmable Keypad**
- **Built-In Service Port for Andover Lap-Top Service Tool**
- **Powered Directly from Andover Controls' TCX 866 VAV Controller**

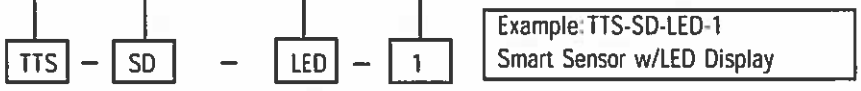
SPECIFICATIONS

Sensing Element:	Type III Thermistor, 10,000 ohms @ 77°F (25°C)
Range:	32°F to 105°F (0°C to 40°C)
Accuracy:	Thermistor ± 0.36°F (± 0.2°C)
Stability:	Thermistor will not deviate from accuracy spec for minimum of 5 years
Wire Specifications:	18, 20, 22 or 24 gauge, 3 conductor, unshielded wire An additional single pair twisted shielded is required for Lap-Top Service Tool connection
Maximum Distance to Sensor:	18 gauge wire: 1,200 ft. with less than 0.18°F (-17.67°C) error 20 gauge wire: 790 ft. with less than 0.18°F (-17.67°C) error 22 gauge wire: 500 ft. with less than 0.18°F (-17.67°C) error 24 gauge wire: 300 ft. with less than 0.18°F (-17.67°C) error
Dimensions:	4.50"H x 3.50" W x 0.813"D (11.5 cm H x 8.9 cm W x 2.0 cm D)
Color:	Off-white
Power:	One Smart Sensor is powered directly from Andover Controls' TCX 866

ORDERING INFORMATION

SMART SENSOR

MODEL	DESCRIPTION
TTS	Space Temperature Sensor, Type III Thermistor, 10,000 ohms @ 77°F
	SENSOR MODEL
SD	Smart Sensor w/Display
	SENSOR DISPLAY TYPE
LED	Two, 7-Segment LED Display
LCD	Four Digit Custom LCD Display
	PACKAGING
1	Single Sensor



Example: TTS-SD-LED-1
Smart Sensor w/LED Display

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Fax: 07531 993710

Andover Controls Corporation
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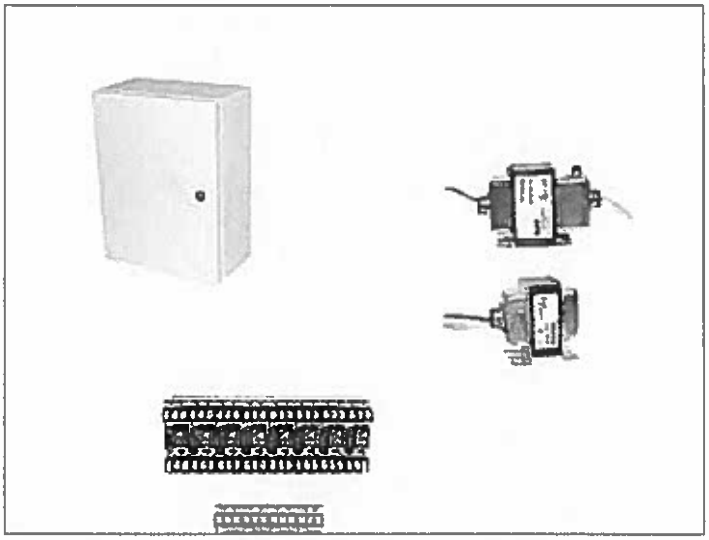
Kowloon, Hong Kong
Tel: 2739 5497
Fax: 2739 7350

Andover Controls S.A.
93 avenue de Fontainebleau
94270 Le Kremlin-Bicetre
Tel: 1 49 606363
Fax: 1 49 606271



Section 3: Panels, Panel Components and Miscellaneous

Enclosures

KELE RET SERIES NEMA 1 ENCLOSURE

Relays & Contactors

KELE PAM-1 AND PAM-4 MULTI-VOLTAGE RELAY

KELE RIB-T PILOT SERIES RELAY

KELE RIB-T POWER SERIES RELAY

Transformers

LECTRO LE11900 75 VA TRANSFORMER

LECTRO LE16550 50 VA TRANSFORMER

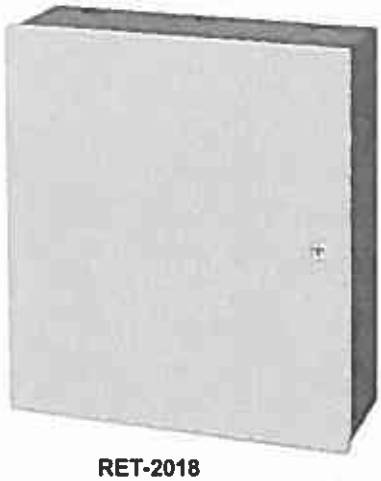
ENCLOSURES

NEMA 1 ENCLOSURES
RET SERIES

DESCRIPTION

The **RET Series** includes attractive, economical NEMA 1 enclosures designed to house controls and instruments in areas that do not require oil- and dust-tight ratings. The standard **RET Series** enclosures are furnished with a perforated metal subpanel for easy mounting of components. No drilling or layout is needed. Simply set the control components on the panel and attach with #7 or #8 self-tapping screws in the prepunched holes. The **RET Series** is also available in a UL listed version without the perforated subpanel.

Technologies
A Kele Company



RET-2018

FEATURES

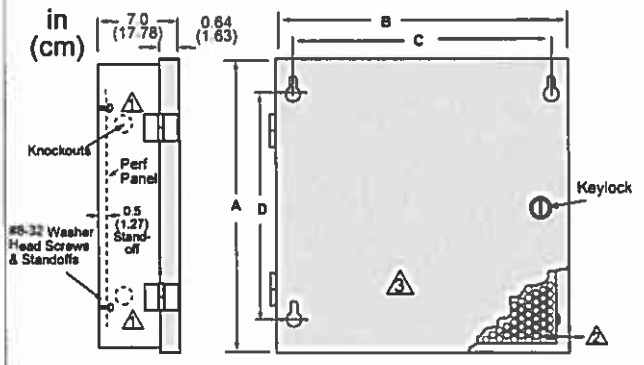
- ***Low cost NEMA 1 enclosure***
- ***Mounted with door hinged on left or right side***
- ***Removable door***
- ***Attractive powder-coated finish, standard brown enclosure with tan door***
- ***Optional colors available***
- ***Key lock, two keys, and attractive powder-coated perf panel furnished****
- ***Mounting of control components simplified with perf panel***
- ***Optional UL listed enclosures available****
- ***UL listed, File #E130598, for RET UL listed panels***

RET OPTIONAL COLOR CHART

Dark Blue | Powder Blue | Orange | Green | Gray

Optional colors are shown in approximate hue.

DIMENSIONS



1. Knockouts are for 3/4" conduit, 2 Knockouts on both sides, 3 Knockouts top and bottom, 4 Knockouts top and bottom on RET3826, RET3826UL, & RET4230
2. Perf Panel is 16-ga powder-coated steel.
3. Standard Color is brown enclosure with tan door

ORDERING INFORMATION

ENCLOSURE MODEL	DIMENSIONS in (cm) A	B	C	D	ENCLOSURE MATERIAL	PANEL	WEIGHT lb (kg)	PERF PANEL "H x "W (cm)
RET1812†	18 (46)	12 (31)	11 (28)	14 (36)	16-ga steel	Incl	16 (7.3)	15.5 x 9.0 (39 x 23)
RET2018†	20 (51)	18 (46)	16.5 (42)	14 (36)	16-ga steel	Incl	27 (12.3)	17.5 x 15.5 (44 x 39)
RET2620†	26 (66)	20 (51)	18.5 (47)	20 (51)	16-ga steel	Incl	36 (16.4)	23.5 x 17.5 (60 x 44)
RET3826†	38 (97)	26 (66)	24.5 (62)	32 (81)	16-ga steel	Incl	61 (27.8)	35.5 x 23.5 (90 x 60)
RET4230†	42 (107)	30 (76)	26.0 (66)	38 (97)	14-ga steel	Incl	83 (37.8)	39.5 x 27.5 (100 x 70)
RET1812UL*†	18 (46)	12 (31)	11 (28)	14 (36)	16-ga steel	RP1812	15 (6.8)	None*
RET2018UL*†	20 (51)	18 (46)	16.5 (42)	14 (36)	16-ga steel	RP2018	24 (10.9)	None*
RET2620UL*†	26 (66)	20 (51)	18.5 (47)	20 (51)	14-ga steel	RP2620	38 (17.3)	None*
RET3626UL*†	36 (91)	26 (66)	24.5 (62)	30 (76)	14-ga steel	RP3626	63 (28.7)	None*

† -DB: Dark Blue, -PB: Powder Blue, -OR: Orange, -G: Green, -GY: Grey

* Subpanels must be ordered separately for UL enclosures. Call Kele to order custom perf panels.

RELAYS & CONTACTORS

MULTI-VOLTAGE RELAY MODULES

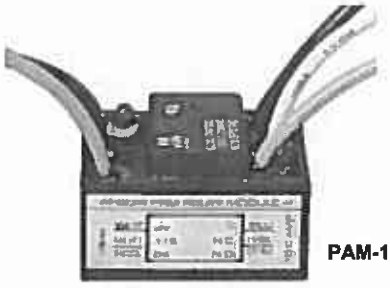
MODELS PAM-1, PAM-4

DESCRIPTION

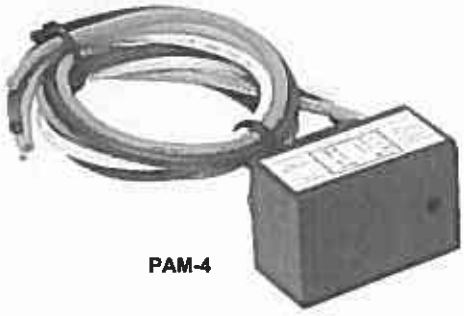
Model PAM relays are small, encapsulated multi-voltage modules that provide 10A Form C contacts.

These devices are ideal for applications where remote relays are required for control or status feedback. They are suitable for use with HVAC, temperature control, fire alarm, security, building automation, and lighting control systems.

The **Model PAM** relays may be mounted by using double-sided adhesive tape (provided) or, a self-drilling screw, or they may be loosely placed in a handibox.



PAM-1



PAM-4

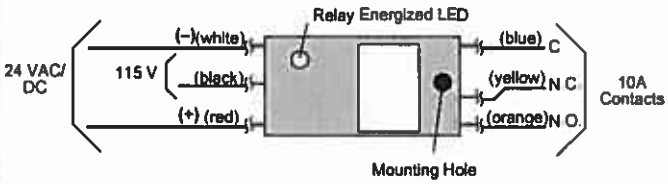
FEATURES

- ***Multi-voltage input***
- ***Small size***
- ***Multiple mounting options***
- ***Wirenuts, mounting screw, and tape included***
- ***LED indication (PAM-1 only)***

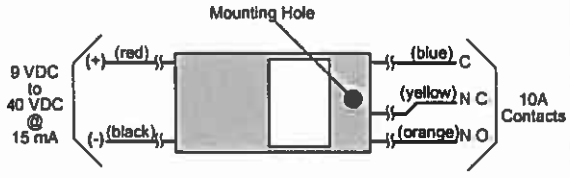
SPECIFICATIONS

Power requirements	
PAM-1	24 VAC, 24 VDC, 115 VAC @ 15 mA
PAM-4	9-40 VDC @ 15 mA
Contact rating	SPDT, Form C, 10A @ 115 VAC, 7A @ 28 VDC, 250 µA @ 5 VDC
Wire leads	10" (25.4 cm), 18 AWG
Ambient temp	-58° to 185°F (-50° to 85°C)
Dimensions	1.5"H x 1"W x 0.88"D (3.81 x 2.54 x 2.2 cm)
Weight	0.15 lb (6.80g)
Approvals	UL listed

WIRING



PAM-1



PAM-4

ORDERING INFORMATION

MODEL	DESCRIPTION
PAM-1	Multi-Voltage Relay Module, 24 VAC/DC, 115 VAC
PAM-4	Multi-Voltage Relay Module, 9-40 VDC

RELAYS & CONTACTORS

RELAY IN A BOX

RIB, RIBT POWER SERIES

DESCRIPTION

The **Relay In A Box (RIB) Power Series** controls most BAS, HVAC, low-horsepower motor and lighting applications. The relays come mounted and prewired in a housing, which saves the installer the time, trouble, and expense of buying separate components (relay, socket, mounting rail, and enclosure) and assembling them on the job or at the shop.

The **RIB Power Series** has a protruding 1/2" NPT nipple from which all wires exit (except **T Series**). To install, remove a 1/2" conduit knockout in the equipment, insert the wires and nipple through the hole, tighten the locknut, and connect the wires.

RIB Power Series - 20 & 30A Relays
The **RIB Power Series** has relay contacts rated for 20 and 30A. They require modest coil drive current and are used for direct switching and control of heavy electrical circuits, such as large resistive, motor, and lighting loads.

RIBT Series - High/Low Voltage Separation
The **RIBT Series** is designed to provide physically separate entrances for connections to the relay input coil and output contacts. Relay contact wires exit the housing through a 1/2" NPT nipple. The cover of the **RIBT Series** is removable and, with star bushings or 1/2" conduit, the coil drive wires can enter the housing through one of two convenient openings. The coil drive wires are secured to screw terminals within a separate wiring compartment in the RIBT. Most of the **RIBs** in the **Power Series** are also available in the **T Series**.

RIB2401SB

RIB2401B

FEATURES

- ***Convenient and economical to use***
- ***LED serves as relay status indicator***
- ***Coil uses low current and accepts a wide range of AC and DC voltages***
- ***Closed/Open/Auto switch option available***
- ***Nipple or screw mountable***
- ***Compact, gray plastic enclosure***
- ***Color-coded wires for eliminating errors***
- ***UL listed for UL916 Energy Management and UL864 Fire***
- ***Made in the USA***

SPECIFICATIONS - GENERAL

Enclosure size	
A	2.3" x 3.2" x 1.8" with 3/4" NPT (5.84 x 8.13 x 4.57 cm)
B	4" x 4" x 1.8" with 1/2" NPT (10.16 x 10.16 x 4.57 cm)
G	2.3" x 3.2" x 1.8" with 1/2" NPT (5.84 x 8.13 x 4.57 cm)
Operating temp	-30° to 140°F (-34° to 60°C)
Humidity	5% to 95% noncondensing
Life rating (all relays)	10 million cycles min mechanical
Relay status	LED, ON - relay activated
Housing	Plenum rated, NEMA1
Frequency	All relays rated for 50/60 Hz

Coil pull-in/ drop-out (nominal values)

	Pull-In		Drop-Out	
Coil Drive	**DC**	**AC**	**DC**	**AC**
24 VAC/DC	22	18	3.8	3
120 VAC	–	85	–	35
208-277 VAC	–	160	–	60
480 VAC	–	340	–	140

Wire length	16" (40.6 cm)
Approvals	UL listed, UL 916 Energy Management, UL 864 Fire, UL listed Canada
Weight	Approx. 1.0 lb (0.45 kg)

RELAY IN A BOX

RIB, RIBT POWER SERIES

SPECIFICATIONS - POWER SERIES

Model	Type	Coil Drive	Size	OVR SW	Relay Contact Ratings	Relay Contact Wiring	Relay Coil Drive Data
RIB2401B*	1-SPDT	24 VAC/DC 120 VAC	G	–	20A resistive 277 VAC 1 hp 120 VAC 2 hp 277 VAC 20A ballast N.O. 120/277 VAC 10A ballast N.C. 120/277 VAC 10A tungsten N.O. 120 VAC 770 VA pilot duty 120 VAC 1110 VA pilot duty 277 VAC	(blue) N.C. (yellow) Common (orange) N.O.	**Wiring** Common - White/Yellow wire 24 VAC/DC - White/Blue wire 120 VAC - White/Black wire 208-277 VAC - White/Brown wire **Input Current** 45 mA @ 18 VAC 30 mA @ 22 VDC 75 mA @ 24 VAC 32 mA @ 24 VDC 42 mA @ 120 VAC 42 mA @ 30 VDC 62 ma @ 208/277 VAC
RIB2402B*	1-SPDT	24 VAC/DC 208 - 277 VAC	G	–			
RIB2401SB*	1-SPST-NO	24 VAC/DC 120 VAC	G	Yes	20A resistive 277 VAC 1 hp 120 VAC 2 hp 277 VAC 20A ballast N.O. 120/277 VAC 10A ballast N.C. 120/277 VAC 10A tungsten N.O. 120 VAC 770 VA pilot duty 120 VAC 1110 VA pilot duty 277 VAC	(orange) Closed (orange) Open Auto For normally closed, add -NC after model number when ordering.	
RIB2402SB*	1-SPST-NO	24 VAC/DC 208 - 277 VAC	G	Yes			
RIB01P	1-DPDT	120 VAC	B	–	20A resistive 300 VAC 20A resistive 28 VDC, 15 VDC 15A resistive 600 VAC 1 hp 120 VAC 2 hp 240-277 VAC 3 hp 480-600 VAC 20A ballast 277-480 VAC 770 VA pilot duty 120 VAC 1,158 VA pilot duty 240 VAC 1,110 VA pilot duty 277 VAC 1,640 VA pilot duty 480 VAC	(blue) N.C. (yellow) Common (orange) N.O. (gray) N.C. (purple) Common (brown) N.O.	**Wiring** 120 VAC - White/Black wires 208-277 VAC - White/Brown wires 480 VAC - White/Green wires **Input Current** 100 mA @ 120-480 VAC
RIB02P	1-DPDT	208-277 VAC	B	–			
RIB04P	1-DPDT	480 VAC	B	–			
RIB24P*	1-DPDT	24 VAC/DC	G	–			**Wiring** 24 VAC White/Yellow wires **Input Current** 100 mA @ 20 VAC 50 mA @ 24 VDC 125 mA @ 24 VAC 70 mA @ 30 VDC
RIB2401SBC*	1-SPDT	24 VAC/DC 120 VAC	G	Yes-2	20A resistive 277 VAC 1 hp 120 VAC 2 hp 277 VAC 20A ballast N.O. 120/277 VAC 10A ballast N.C. 120/277 VAC 10A tungsten N.O. 120 VAC 770 VA Pilot Duty 120 VAC 1110 VA Pilot Duty 277 VAC	Auto Manual N/C - Closed Open N/O - Closed (yellow) Common (blue) N/C (orange) N/O	**Wiring** Common - White/Yellow wire 24 VAC/DC - White/Blue wire 120 VAC - White/Black wire 208-277 VAC - White/Brown wire **Input Current** 45 mA @ 18 VAC 30 mA @ 22 VDC 75 mA @ 24 VAC 32 mA @ 24 VDC 42 mA @ 120 VAC 42 mA @ 30 VDC
RIB2402SBC*	1-SPDT	24 VAC/DC 208 - 277 VAC	G	Yes-2			
RIB24S2*	2-DPST-NO	24 VAC/DC	B	Yes Double Pole	20A resistive 300 VAC 20A resistive 28 VDC, 15 VDC 1 hp 120 VAC 2 hp 240-277 VAC 20A ballast 277-480 VAC 770 VA Pilot Duty 120 VAC 1,110 VA Pilot Duty 277 VAC	Double Pole Switch Relay Pole #1 Relay Pole #2 (orange) Closed (brown) (orange) Open (brown) Auto For normally closed, add -NC after model number when ordering.	**Wiring** 24 VAC/DC White/Yellow wires **Input Current** 100 mA @ 20 VAC 50 mA @ 20 VDC 125 mA @ 24 VAC 50 mA @ 24 VDC 70 mA @ 30 VDC
RIB243P*	1-3PST-NO	24 VAC/DC	B	–	20A resistive 300 VAC 20A resistive 28 VDC 15A resistive 600 VAC 1 hp 120 VAC, 1 PH 2 hp 240-277 VAC, 1 PH 3 hp 480-600 VAC 1 PH 5 hp 240 VAC, 3 PH 7.5 hp 480 VAC 3 PH 20A ballast 277-480 VAC	(blue) (blue) N.O. (yellow) (yellow) N.O. (orange) (orange) N.O. For normally closed, add -NC after model number when ordering.	**Wiring** 24 VAC/DC - White/Yellow wires 120 VAC - White/Black wires 208-277 VAC - White/Brown wires 480 VAC - White/Green wires **Input Current** 190 mA @ 24 VAC 140 mA @ 30 VDC 140 mA @ 120 VAC 170 mA @ 208-277 VAC 120 mA @ 480 VAC
RIB013P	1-3PST-NO	120 VAC	B	–			
RIB023P	1-3PST-NO	208-277 VAC	B	–			
RIB043P	1-3PST-NO	480 VAC	B	–			
RIB24P30	1-DPDT	24 VAC/DC	A	–	30A resistive 300 VAC 25A resistive 28 VDC 15A resistive 600 VAC 1 hp 120 VAC 2 hp 240-277 VAC 3 hp 480-600 VAC 20A ballast 277-480 VAC 770 VA pilot duty 120 VAC 1,158 VA pilot duty 240 VAC 1,110 VA pilot duty 277 VAC 1,640 VA pilot duty 480 VAC	(blue) N.C. (yellow) Common (orange) N.O. (gray) N.C. (purple) Common (brown) N.O.	**Wiring** 24 VAC/DC - White/Yellow wires **Input Current** 125 mA @ 24 VAC 50 mA @ 24 VDC

ORDERING INFORMATION

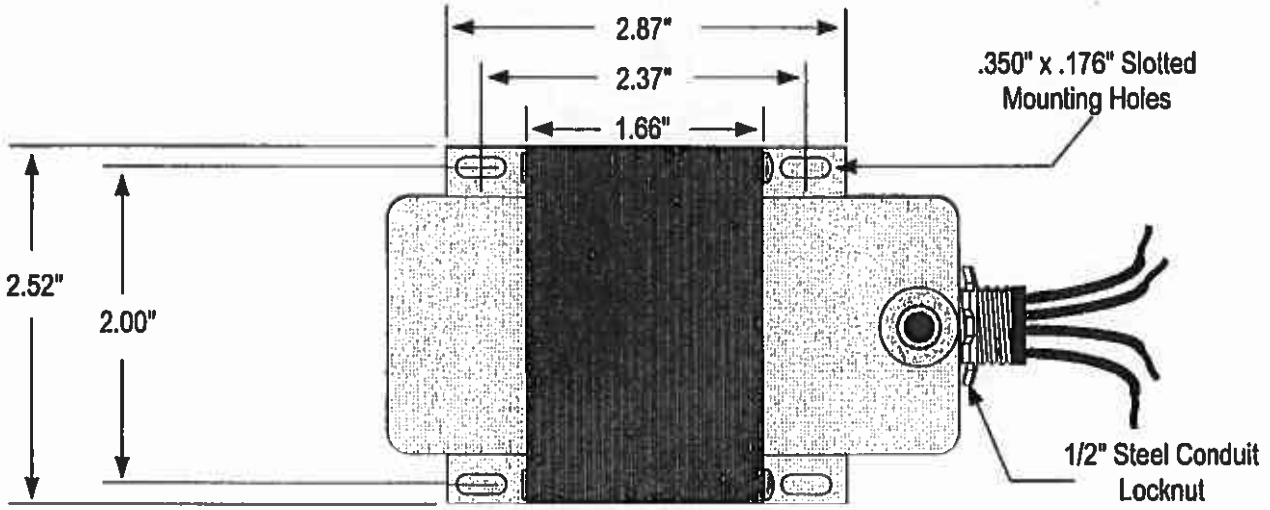
Order by Model Number

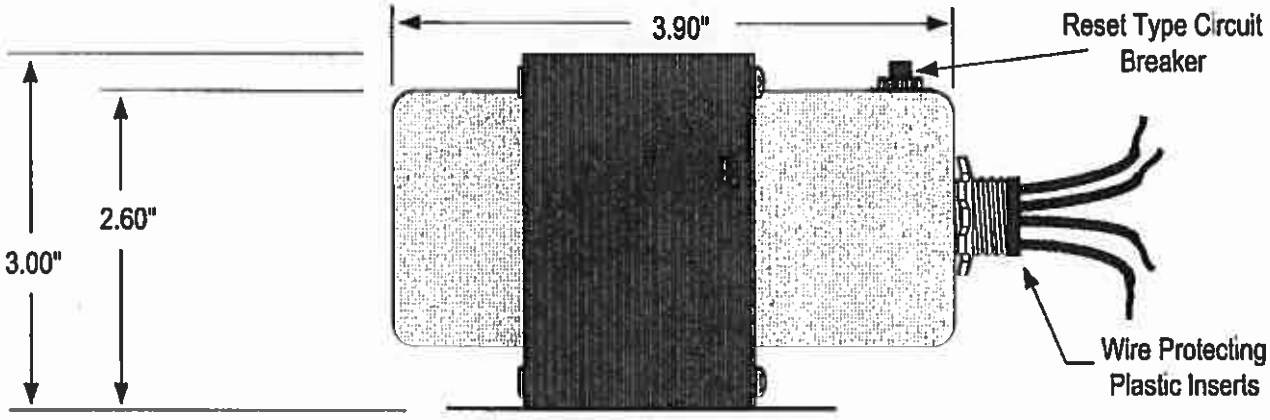
* Models may be ordered in **RIBT Series** with high/low voltage separation. Contact Kele.

CORE COMPONENTS
PRODUCT OF LECTRO COMPONENTS, INC.
Carol Stream, IL
www.corehvac.com
Phone 630 690 0520 or 1 800 323 2282 Fax 630 690 0583

LE11900

Part Number LE11900 - 120-024-075-TF-CB				
Rev.	Description	By	App.	Date
*	First Release	CDC	CDC	12/11/00
NOTE				
All Dimensions are Ref. Only				





Specifications

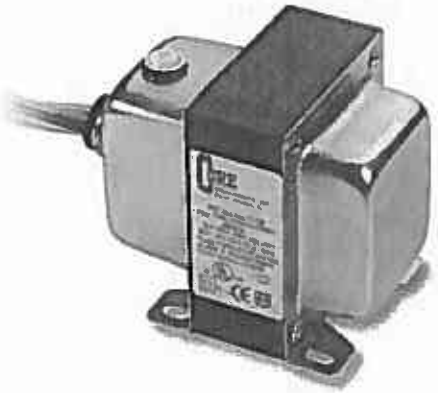
Input:	120V
Output:	24V
VA Rating:	75VA
Frequency Rating:	50/60 Hz
Circuit Breaker Type:	3.75 Amp Manual Reset
Configuration:	Steel End Bells
Mounting(s):	Slotted Foot Mounts and Threaded Flange Hub
Primary Wires:	9" Long with .375" ends Stripped and Tinned
Secondary Wires:	9" Long with .375" ends Stripped and Tinned
Approvals:	UL Recognized for US and Canada File E173056. Class II Transformer. CSA Certificate LR108412-3.

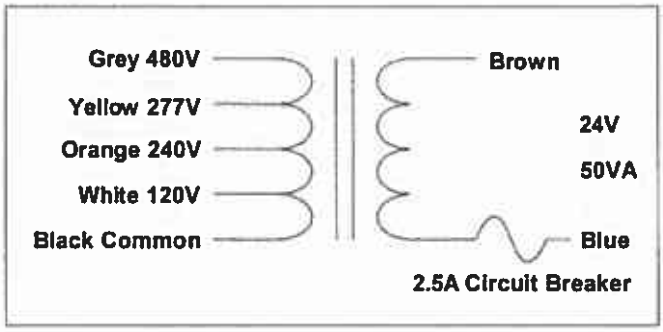
MUC-024-050-1TF-CB

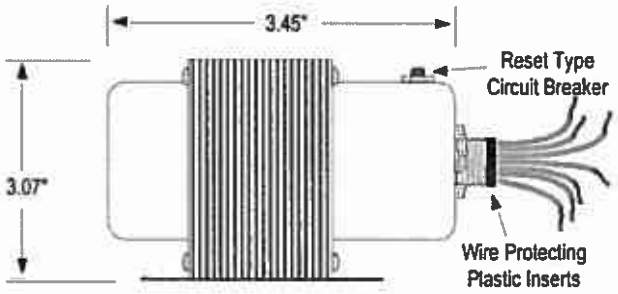
Catalog # LE16550

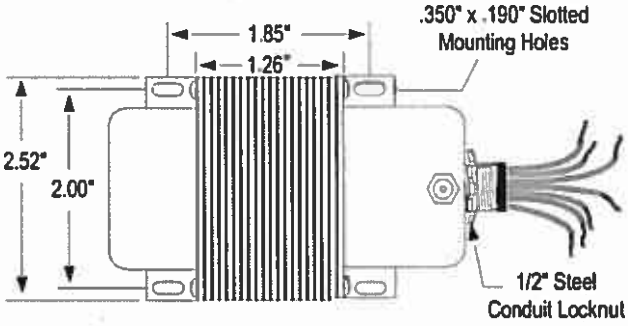
CORE COMPONENTS the source

Enclosed Control Transformer









SPECIFICATIONS

Input:	120/240/277/480 Vac
Output:	24 Vac
VA Rating:	50VA
Frequency:	50/60Hz
Circuit Protection:	Manual Reset Circuit Breaker
Configuration:	Enclosed Split Bobbin Design with Steel End Bells
Mounting(s):	Slotted Foot Mounts & Threaded Flange Hubs
Primary Connections:	UL 1015 Insulated 18AWG Lead Wires, 8" Long, .375" ends Stripped & Tinned
Secondary Connections:	UL 1015 Insulated 18AWG Lead Wires, 8" Long, .375" ends Stripped & Tinned
Insulation System:	UL 1446 Recognized Component Class B Insulation System PG125 (130°C, 266°F)
Agency Approvals:	UL 1585 / UL 5085-1 / UL 5085-3 Listed for USA & Canada. Class 2, Class 3 Transformer

RoHS

CORE COMPONENTS 154 Easy Street, Carol Stream, IL 60188 Phone (800) 216-CORE Fax (630) 690-0781
www.corecomponents.com

THERMOSTAT GUARDS
TG500, ATK, TG SERIES

SELECTED BY ARCHITECT

DESCRIPTION

The **TG, AT and BAPI-Guard Thermostat Guards** are used to enclose and protect wall thermostats and sensors against tampering, damage, and unauthorized adjustment of thermostat settings.

FEATURES

TG500 Series Vented Guards
- *Patented, double-wall construction*
- *Available in various sizes*
- *Clear plastic, or painted steel*
- *Includes ring base, cover, lock, and two keys*

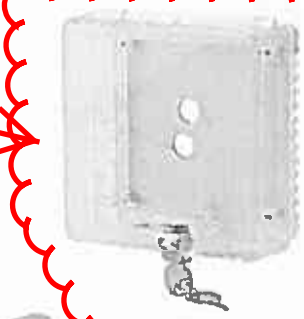
BAPI-Guard Series Vented Guards
- *Clear low-profile design*
- *All mounting hardware included*
- *Key lock for vertical or horizontal mounting*
- *Two sizes to fit most applications*
- *Hammer tough*

ATK Series
- *Available in wire and cast aluminum*
- *Vertical and horizontal mounting*

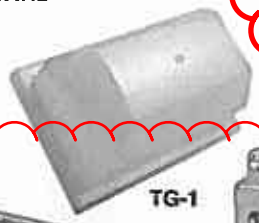
TG Series Vented Guards
- *One-piece, UV-stabilized, high-impact molded polycarbonate housing*
- *Ring base is 16-gauge steel with white finish and four mounting holes*
- *Stainless steel fasteners secure housing to base*
- *Ventilation holes allow air to circulate freely*

ARCHITECT SHALL DETERMINE TYPE.

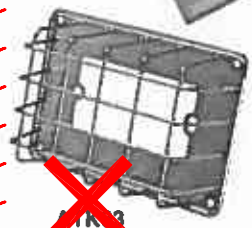
BAPI-GUARD

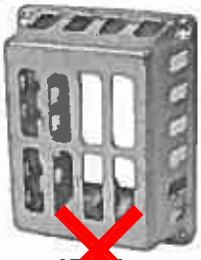


TG510A



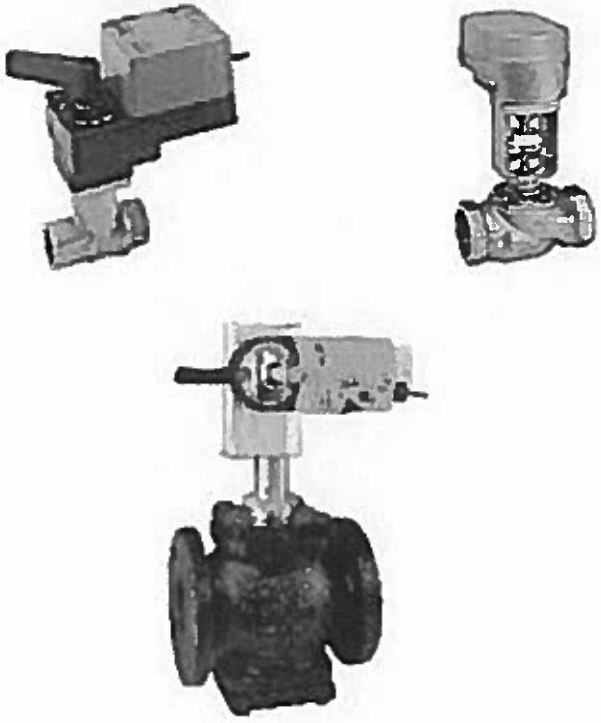
TG-1





ORDERING INFORMATION

MODEL	SIZE	COVER	RING BASE	SOLID WALL PLATE	INSIDE DIMENSIONS Height in (cm)	INSIDE DIMENSIONS Width in (cm)	INSIDE DIMENSIONS Depth in (cm)	OUTSIDE DIMENSIONS Height in (cm)	OUTSIDE DIMENSIONS Width in (cm)	OUTSIDE DIMENSIONS Depth in (cm)
TG509F1003	Small	Smoke	Clear	–	4.0 (10.2)	2.8 (7.1)	1.8 (4.6)	5.5 (14.0)	3.6 (9.1)	2.1 (5.3)
TG510A1001		Clear	Clear	Opaque	4.38 (11.13)	4.38 (11.13)	2.25 (5.72)	5.88 (14.94)	5.88 (14.94)	2.5 (6.35)
TG510D1005		Painted Steel (off-white)	Opaque	Opaque						
BA/BG2		Clear	Clear	–	4.8 (12.3)	2.9 (7.4)	1.43 (3.65)	6.75 (17)	4.75 (12)	2.1 (5.4)
ATK03		Wire	–	–	4.25 (10.80)	2.63 (6.66)	1.63 (4.12)	—	—	—
ATK04		Cast Aluminum	–	–	4.25 (10.80)	2.75 (6.98)	1.63 (4.12)	—	—	—
TG511A1000	Medium	Clear	Clear	Opaque	5.06 (12.85)	6.06 (15.39)	2.63 (6.68)	6.5 (16.51)	7.5 (19.05)	2.94 (7.47)
TG511D1004		Painted Steel (off-white)	Opaque	Opaque						
TG-1	Large	Pearlescent	White	–	2.8 (7.1)	5.0 (12.7)	3.1 (7.9)	5.375 (13.7)	7.75 (19.7)	4.25 (10.8)
TG-2		Clear	White	–	2.8 (7.1)	5.0 (12.7)	3.1 (7.9)	5.375 (13.7)	7.75 (19.7)	4.25 (10.8)
TG-37		Prismatic	White	–	3.0 (7.6)	5.5 (14.0)	3.1 (7.9)	5.875 (14.9)	8.5 (21.6)	4.125 (10.5)
TG512A1009		Clear	Clear	Opaque	5.88 (14.94)	8.38 (21.29)	3.0 (7.62)	7.25 (18.42)	9.75 (24.77)	3.38 (8.59)
TG512D1003		Painted Steel (off-white)	Opaque	Opaque						
BA/BG		Clear	Clear	–	6.9 (17.5)	4.7 (11.8)	1.75 (4.43)	9.45 (24)	6.7 (16.8)	3.0 (7.6)
ATK63		Wire	–	–	6.50 (16.51)	6.38 (16.21)	3.0 (7.62)	—	—	—



Section 4: Control Valves, Dampers, Actuators

Valves & Valve Actuators

BELIMO VALVE B2 + TR24-3-T ACTUATOR
BELIMO VALVE B2 + AFRB24-SR ACTUATOR
BELIMO VALVE B3 + AFRB24-SR ACTUATOR
BELIMO VALVE B3 + TR24-SR-T ACTUATOR
BELIMO VALVE F7 + SY2-120MFT ACTUATOR

Dampers

VCD-23 LOW LEAKAGE CONTROL DAMPER

BELIMO

B2 Series, 2-Way, Characterized Control Valve
Stainless Steel Ball and Stem

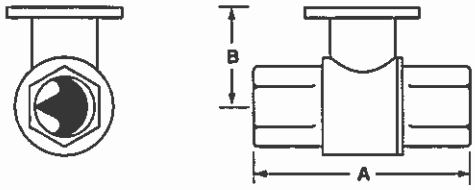
Application

This valve is typically used in air handling units on heating or cooling coils and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable flow.

Technical Data	
Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage
Controllable Flow Range	75°
Sizes	½", ¾", 1", 1¼", 1½", 2", 2½", 3"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body pressure rating	
600 psi	½" - 1¼" (B230)
400 psi	1¼" (B231) - 3"
Media temp. range	0°F to 250°F [-18°C to 120°C]
Close off pressure	
200 psi	½" - 2" (B250)
100 psi	2" (B251) - 3"
Maximum differential pressure (ΔP)	50 psi for typical applications
Leakage	0% for A to AB
External leakage	according to EN 12266-1:2003
C_V rating	A-port: see product chart for values

Tefzel® is a registered trademark of DuPont

Dimensions



2WayValve B207-B278

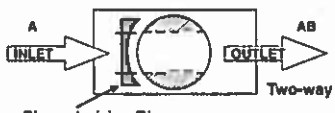
Valve Body	Valve Nominal Size Inches	DN [mm]	Dimensions (inches [mm]) A	B
B207-B211	½"	15	2.41" [61.1]	1.39" [35.2]
B212-B216	½"	15	2.38" [60.4]	1.78" [45.2]
B217-B221	¾"	20	2.73" [69.3]	1.87" [47.4]
B222-B225	1"	25	3.09" [78.4]	1.87" [47.4]
B229-B230	1¼"	32	3.72" [94.6]	1.87" [47.4]
B231-B232	1¼"	32	3.72" [94.6]	2.04" [51.9]
B238-B240	1½"	40	3.88" [98.5]	2.04" [51.9]
B248-B250	2"	50	4.21" [107.0]	2.27" [57.7]
B251-B254	2"	50	4.93" [125.2]	2.73" [69.5]
B261-B265	2½"	65	5.55" [140.9]	2.73" [69.5]
B277-B280	3"	80	5.82" [147.9]	2.73" [69.5]

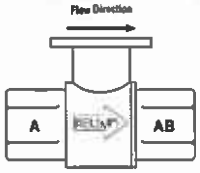
C_V	Valve Nominal Size Inches	DN [mm]	Type 2-Way NPT	Suitable Actuators Non-Spring	Spring
0.3	½	15	B207		
0.46	½	15	B208		
0.8	½	15	B209		
1.2	½	15	B210		
1.9	½	15	B211		
3	½	15	B212		
4.7	½	15	B213		
7.4	½	15	B214		
10	½	15	B215		
14	½	15	B216		
4.7	¾	20	B217		
7.4	¾	20	B218		
10	¾	20	B219		
14	¾	20	B220		
24	¾	20	B221*		
7.4	1	25	B222		
10	1	25	B223		
19	1	25	B224		
30	1	25	B225*		
10	1¼	32	B229		
19	1¼	32	B230*		
25	1¼	32	B231		
37	1¼	32	B232*		
19	1½	40	B238		
29	1½	40	B239		
37	1½	40	B240*		
29	2	50	B248		
46	2	50	B249		
57	2	50	B250*		
65	2	50	B251		
85	2	50	B252		
120	2	50	B253		
240	2	50	B254*		
60	2½	65	B261		
75	2½	65	B262		
110	2½	65	B263		
150	2½	65	B264		
210	2½	65	B265*		
70	3	80	B277		
130	3	80	B278		
170	3	80	B280*		

LR Series, NR...N4 Series, TF Series, LF Series, AR Series, AR...N4 Series, AF Series

*Models without characterizing disc

Flow Patterns

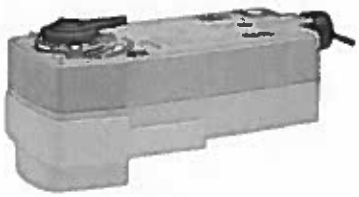




AFRB24-SR, AFRX24-SR

Proportional, Spring Return, 24 V, for 2 to 10 VDC or 4 to 20 mA Control Signal

BELIMO

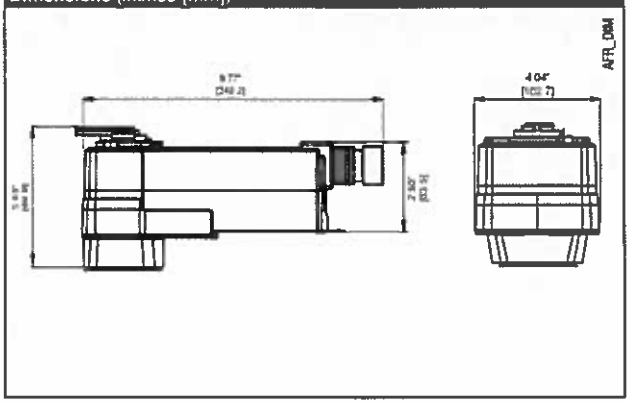


Technical Data

Power supply		24 VAC ±20%, 50/60 Hz 24 VDC +20% / -10%
Power consumption	running	5.5 W
	holding	3 W
Transformer sizing		8.5 VA (class 2 power source)
Electrical connection		
AFRB...		3 ft, 18 GA appliance cable, 1/2" conduit connector **-S models:** two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
AFX...		3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector **-S models:** Two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables, with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y		2 to 10 VDC, 4 to 20mA
Input impedance		100 kΩ for 2 to 10 VDC (0.1 mA) 500 Ω for 4 to 20 mA
Feedback output U		2 to 10 VDC (max. 0.5 mA)
Direction of rotation	spring	reversible with CW/CCW mounting
	motor	reversible with built-in switch
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	spring	< 20 seconds @ -4°F to 122°F [-20°C to 50°C], < 60 seconds @ -22°F [-30°C]
	motor	95 seconds
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		zinc coated metal and plastic casing
Agency listings†		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		≤40dB(A) motor @ 95 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.6 lbs (2.1 kg); 4.9 lbs (2.25 kg) with switches

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

Dimensions (inches [mm])



Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05" dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

NOTE: When using AFRB24-SR, AFRB24-SR-S, AFRX24-SR and AFRX24-SR-S actuators, only use accessories listed on this page.
For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

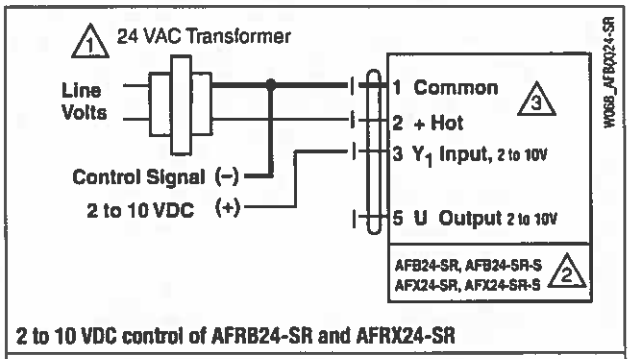
1. Provide overload protection and disconnect as required.
2. *CAUTION Equipment Damage!*
   Actuators may be connected in parallel.
   Power consumption and input impedance must be observed.
2. Up to 4 actuators may be connected in parallel if not mechanically mounted to the same shaft. With 4 actuators wired to one 500 Ω resistor.
   Power consumption must be observed.
3. Actuator may also be powered by 24 VDC.
4. For end position indication, interlock control, fan startup, etc., AFB24-SR-S and AFX24-SR-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.
5. Only connect common to neg. (–) leg of control circuits

APPLICATION NOTES

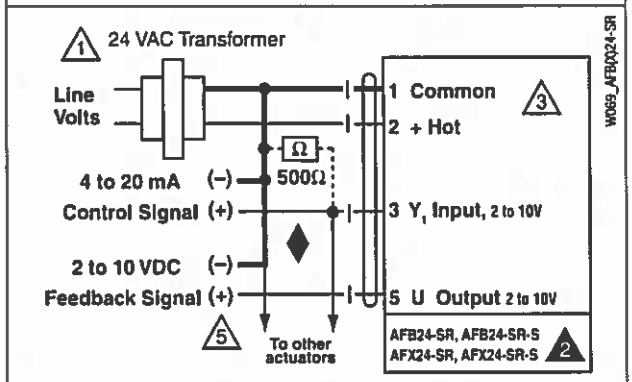
♦ The ZG-R01 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

ATTENTION: AFRB24-SR(-S) and AFRX24-SR(-S) cannot be tandem mounted on the same damper or valve shaft. Only On/Off and MFT AF models can be used for tandem mount applications.

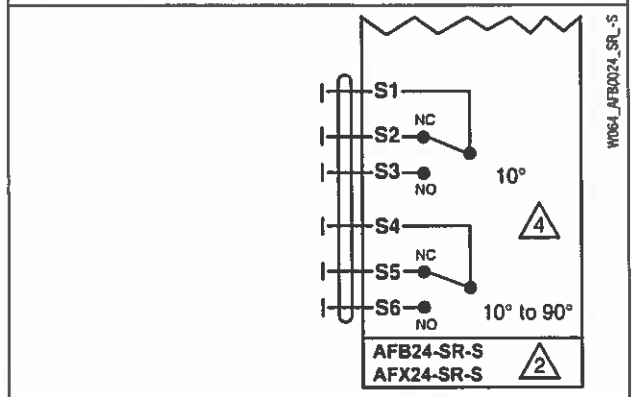
WARNING Live Electrical Components!
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC control of AFRB24-SR and AFRX24-SR



4 to 20 mA control of AFRB24-SR and AFRX24-SR with 2 to 10 VDC feedback output



Auxiliary switches for AFRB24-SR-S, AFX24-SR-S

B2 Series, 2-Way, Characterized Control Valve
Stainless Steel Ball and Stem

BELIMO

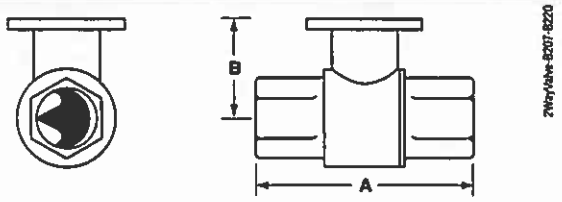
Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable flow.

Technical Data	
Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage
Action	90° rotation
Sizes	½", ¾", 1", 1¼", 1½", 2", 2½", 3"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body Pressure rating	
600 psi*	½" - 1¼" (B230)
400 psi*	1¼" (B231) - 3"
Media temp. range	0°F to 212°F [-18°C to 100°C]
Close off pressure	
200 psi	½" - 2" (B250)
100 psi	2" (B251) - 3"
Maximum differential pressure (ΔP)	30 psi for typical applications
Leakage	0% for A to AB
C_V rating	A-port: see product chart for values

Tefzel® is a registered trademark of DuPont
*Per EN 12266-1:2003

Dimensions

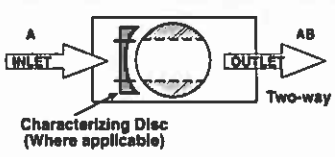


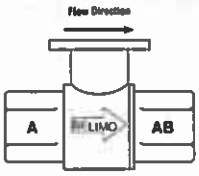
Valve Body	Valve Nominal Size Inches	DN [mm]	Dimensions (Inches [mm]) A	B
B207-B211	½"	15	2.41" [61.1]	1.39" [35.2]
B212-B215	½"	15	2.38" [60.4]	1.72" [43.7]
B217-B220	¾"	20	2.73" [69.3]	1.81" [45.9]
B222-B225	1"	25	3.09" [78.4]	1.81" [45.9]
B229-B230	1¼"	32	3.72" [94.6]	1.81" [45.9]
B231-B232	1¼"	32	3.72" [94.6]	1.98" [50.4]
B238-B240	1½	40	3.88" [98.5]	1.98" [50.4]
B248-B250	2"	50	4.21" [107.0]	2.21" [56.2]
B251-B254	2"	50	4.93" [125.2]	2.68" [68.0]
B261-B265	2½"	65	5.55" [140.9]	2.68" [68.0]
B277-B280	3"	80	5.82" [147.9]	2.68" [68.0]

C_V	Valve Nominal Size Inches	DN [mm]	Type 2-Way NPT	Suitable Actuators Non-Spring	Spring
0.3	½	15	B207	TR Series	LF Series
0.46	½	15	B208	LR Series	
0.8	½	15	B209	NR...N4 Series	
1.2	½	15	B210	TF Series	
1.9	½	15	B211		
3	½	15	B212		
4.7	½	15	B213		
7.4	½	15	B214		
10	½	15	B215*		
4.7	¾	20	B217		
7.4	¾	20	B218		
10	¾	20	B219		
24	¾	20	B220*		
7.4	1	25	B222		
10	1	25	B223		
19	1	25	B224		
30	1	25	B225*		
10	1¼	32	B229		
19	1¼	32	B230*		
25	1¼	32	B231	AR Series	AF Series
37	1¼	32	B232*	AR...N4 Series	
19	1½	40	B238		
29	1½	40	B239		
37	1½	40	B240*		
29	2	50	B248		
46	2	50	B249		
57	2	50	B250*		
65	2	50	B251		
85	2	50	B252		
120	2	50	B253		
240	2	50	B254*		
60	2½	65	B261		
75	2½	65	B262		
110	2½	65	B263		
150	2½	65	B264		
210	2½	65	B265*		
70	3	80	B277		
130	3	80	B278		
170	3	80	B280*		

*Models without characterizing disc

Flow Patterns





BELIMO

Models

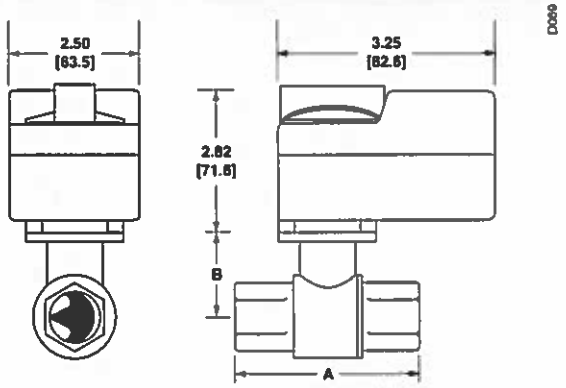
TR24-3-T US

TR24-3 US	TR24-3-T US with 3 ft plenum rated cable
TR24-3/300 US	TR24-3-T US with 10 ft plenum rated cable
TR24-3/500 US	TR24-3-T US with 16 ft plenum rated cable

Technical Data	
Control	On/Off, Floating Point
Nominal voltage	24 VAC 50/60 Hz
Nominal voltage range	19.2...28.8 VAC
Power consumption	1 W
Transformer sizing	1VA (class 2 power source)
Electrical connection	screw terminals accessible after removal of small cover (3 ft, 10 ft, 16 ft cables optional)
Input impedance	.36 kΩ
Angle of rotation	90°
Position indication	integrated into handle
Manual override	push down handle
Running time	90 seconds @ 60 hz, 108 seconds @ 50 hz
Humidity	5 to 95% non-condensing
Ambient temperature	-22°F to 122°F (-30°C to 50°C)
Storage temperature	-40°F to 176°F (-40°C to 80°C)
Housing	NEMA 1/IP40
Housing rating	UL94-5V(B)
Agency listing†	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE acc. to 89/336/EEC
Noise level	Max. 35 db (A)
Quality standard	ISO 9001

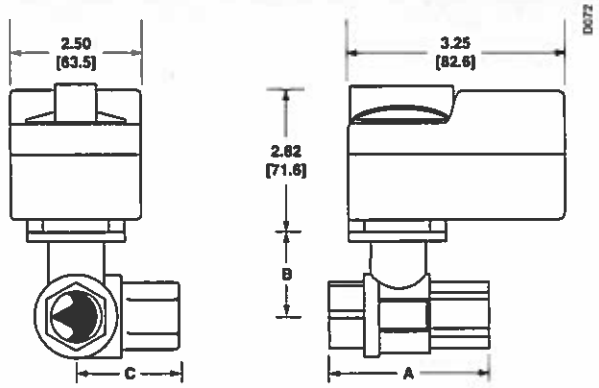
† Rated impulse voltage 330V, Control pollution degree 2, Type of action 1

Dimensions with 2-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])	
Valve Body	Inches	DN [mm]	A	B
B207(B)-B211(B)	½"	15	2.41" [61.1]	1.39" [35.2]
B212(B)-B215(B)	½"	15	2.38" [60.4]	1.72" [43.7]
B217(B)-B220(B)	¾"	20	2.73" [69.3]	1.81" [45.9]

Dimensions with 3-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307(B)-B311(B)	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312(B)-B315(B)	½"	15	2.38" [60.4]	1.72" [43.7]	1.26" [32.1]
B317(B)-B320(B)	¾"	20	2.73" [69.3]	1.81" [45.9]	1.45" [36.8]

Wiring Diagrams

INSTALLATION NOTES

2 The common connection from the actuator must be connected to the Hot connection of the controller.

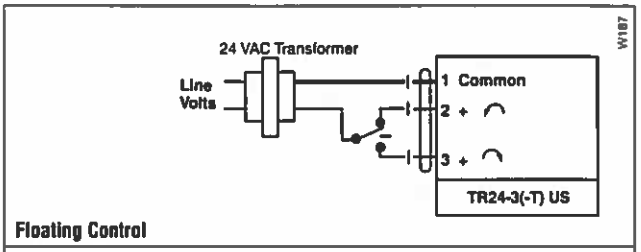
3 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.

4 The actuator Hot must be connected to the control board Hot.

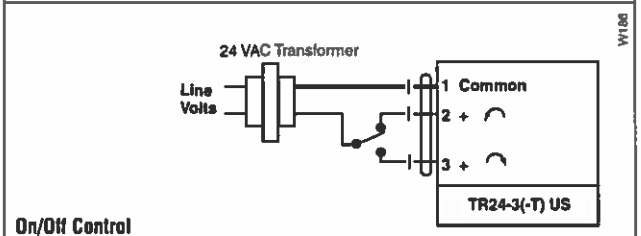
WARNING *Live Electrical Components!*

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

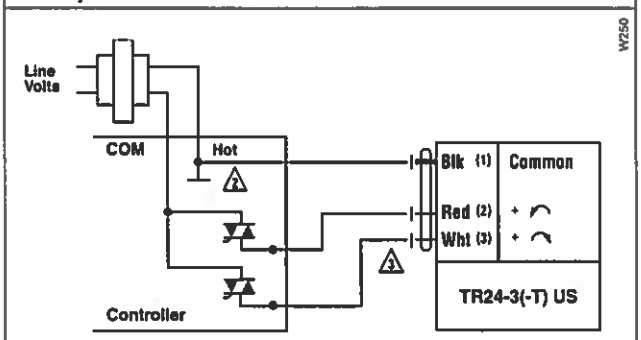
NOTE: TR24-3(-T) US cannot be wired in parallel with themselves or any other actuator.



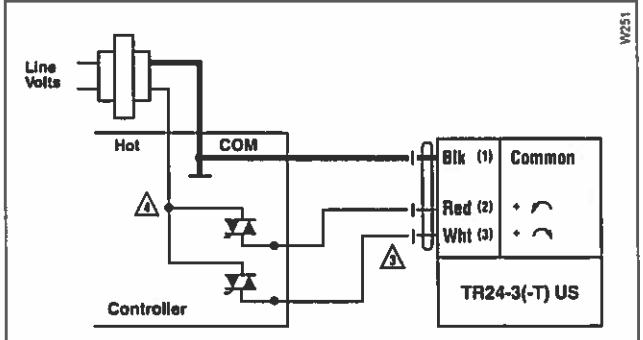
Floating Control



On/Off Control
You may not use one wire control.



Triac Sink



Triac Source

B2 Series, 2-Way, Characterized Control Valve
Stainless Steel Ball and Stem

BELIMO

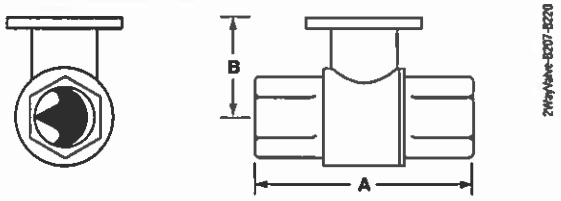
Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable flow.

Technical Data	
Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage
Action	90° rotation
Sizes	½", ¾", 1", 1¼", 1½", 2", 2½", 3"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body Pressure rating	
600 psi*	½" - 1¼" (B230)
400 psi*	1¼" (B231) - 3"
Media temp. range	0°F to 212°F [-18°C to 100°C]
Close off pressure	
200 psi	½" - 2" (B250)
100 psi	2" (B251) - 3"
Maximum differential pressure (ΔP)	30 psi for typical applications
Leakage	0% for A to AB
C_v rating	A-port: see product chart for values

Tefzel® is a registered trademark of DuPont
*Per EN 12266-1:2003

Dimensions



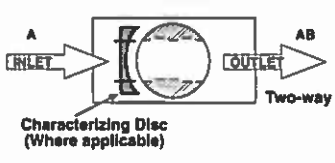
2WayValve-B207-B220

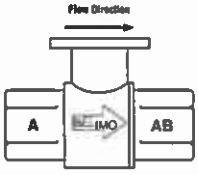
Valve Body	Valve Nominal Size Inches	DN [mm]	Dimensions (Inches [mm]) A	B
B207-B211	½"	15	2.41" [61.1]	1.39" [35.2]
B212-B215	½"	15	2.38" [60.4]	1.72" [43.7]
B217-B220	¾"	20	2.73" [69.3]	1.81" [45.9]
B222-B225	1"	25	3.09" [78.4]	1.81" [45.9]
B229-B230	1¼"	32	3.72" [94.6]	1.81" [45.9]
B231-B232	1¼"	32	3.72" [94.6]	1.98" [50.4]
B238-B240	1½	40	3.88" [98.5]	1.98" [50.4]
B248-B250	2"	50	4.21" [107.0]	2.21" [56.2]
B251-B254	2"	50	4.93" [125.2]	2.68" [68.0]
B261-B265	2½"	65	5.55" [140.9]	2.68" [68.0]
B277-B280	3"	80	5.82" [147.9]	2.68" [68.0]

C_v	Valve Nominal Size Inches	DN [mm]	Type 2-Way NPT	Suitable Actuators Non-Spring	Spring
0.3	½	15	B207	TR Series, LR Series, NR...N4 Series	TF Series, LF Series
0.46	½	15	B208		
0.8	½	15	B209		
1.2	½	15	B210		
1.9	½	15	B211		
3	½	15	B212		
4.7	½	15	B213		
7.4	½	15	B214		
10	½	15	B215*		
4.7	¾	20	B217		
7.4	¾	20	B218		
10	¾	20	B219		
24	¾	20	B220*		
7.4	1	25	B222		
10	1	25	B223		
19	1	25	B224		
30	1	25	B225*		
10	1¼	32	B229		
19	1¼	32	B230*		
25	1¼	32	B231	AR Series, AR...N4 Series	AF Series
37	1¼	32	B232*		
19	1½	40	B238		
29	1½	40	B239		
37	1½	40	B240*		
29	2	50	B248		
46	2	50	B249		
57	2	50	B250*		
65	2	50	B251		
85	2	50	B252		
120	2	50	B253		
240	2	50	B254*		
60	2½	65	B261		
75	2½	65	B262		
110	2½	65	B263		
150	2½	65	B264		
210	2½	65	B265*		
70	3	80	B277		
130	3	80	B278		
170	3	80	B280*		

*Models without characterizing disc

Flow Patterns





TR24-SR Actuators, Proportional

BELIMO

Models

TR24-SR-T US

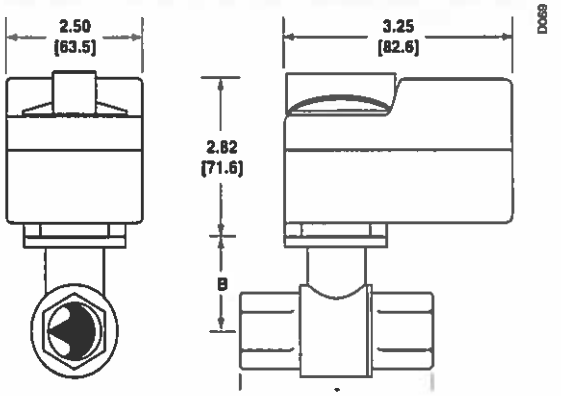
TR24-SR US	TR24-SR-T US with 3 ft plenum rated cable
TR24-SR/300 US	TR24-SR-T US with 10 ft plenum rated cable
TR24-SR/500 US	TR24-SR-T US with 16 ft plenum rated cable

Technical Data	
Control	Proportional
Nominal voltage	24 VAC 50/60 Hz, 24 VDC
Nominal voltage range	19.2...28.8 VAC, 21.6...28.8 VDC
Power consumption	0.5 W
Transformer sizing	1VA (class 2 power source)
Electrical connection	screw terminals accessible after removal of small cover (3 ft, 10 ft, 16 ft cables optional)
Input impedance	100 kΩ
Angle of rotation	90°
Direction of rotation	reversible with switch under cover
Position indication	integrated into handle
Manual override	push down handle
Running time	90 seconds
Humidity	5 to 95% non-condensing
Ambient temperature	-22°F to 122°F (-30°C to 50°C)
Storage temperature	-40°F to 176°F (-40°C to 80°C)
Housing	NEMA 1/IP40
Housing rating	UL94-5V(B)
Agency listing†	cULus according to UL 60730-1A/-2-14, CAN/CSA E60730-1:02, CE according to 2004/108/EC and 2006/95/EC for line voltage and/or –S versions
Noise level	max. 35 db (A)
Quality standard	ISO 9001

† Rated impulse voltage 500V, Control pollution degree 2, Type of action 1

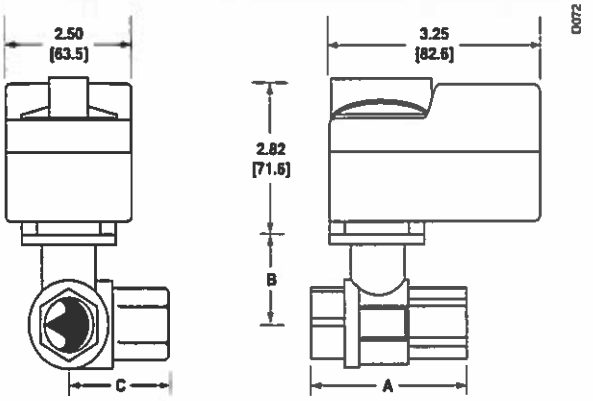
NOTE: Response sensitivity is 75mV

Dimensions with 2-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])	
Valve Body	Inches	DN [mm]	A	B
B207(B)-B211(B)	½"	15	2.41" [61.1]	1.39" [35.2]
B212(B)-B215(B)	½"	15	2.38" [60.4]	1.72" [43.7]
B217(B)-B220(B)	¾"	20	2.73" [69.3]	1.81" [45.9]

Dimensions with 3-Way Valve



	Valve Nominal Size		Dimensions (Inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307(B)-B311(B)	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312(B)-B315(B)	½"	15	2.38" [60.4]	1.72" [43.7]	1.26" [32.1]
B317(B)-B320(B)	¾"	20	2.73" [69.3]	1.81" [45.9]	1.45" [36.8]

Wiring Diagrams

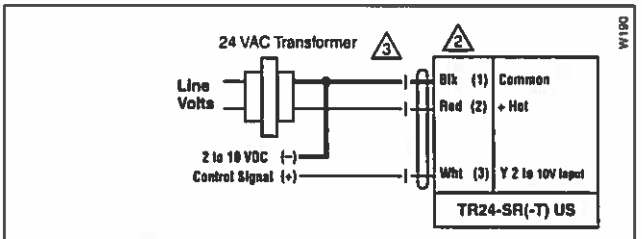
INSTALLATION NOTES

2 Actuators with color coded wires are optional.
Wire numbers are provided for reference.

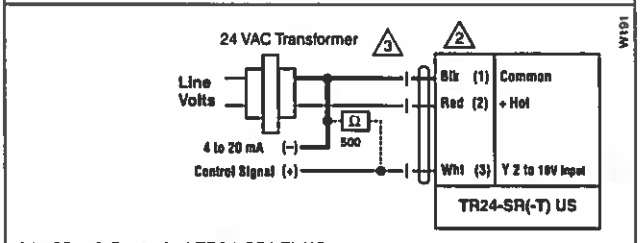
***CAUTION** Equipment damage!*
Actuators may be connected in parallel.
Power consumption and input impedance must be observed.

3 Actuators may also be powered by 24 VDC.

***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC Control of TR24-SR(-T) US



4 to 20 mA Control of TR24-SR(-T) US

Direct/Reverse acting switch is under wiring cover.
R = CW with decrease in signal
L = CCW with decrease in signal
No feedback

Application

This valve is typically used in air handling units on heating or cooling coils, and fan coil unit heating or cooling coils. Some other common applications include Unit Ventilators, VAV box re-heat coils and bypass loops. This valve is suitable for use in a hydronic system with variable or constant flow.

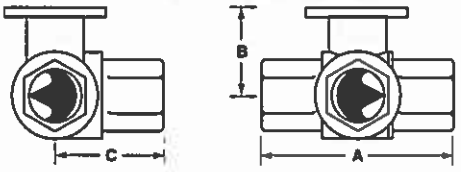
Technical Data	
Service	chilled or hot water, 60% glycol
Flow characteristic	A-port equal percentage B-port modified for constant common port flow
Action	90° rotation
Sizes	½", ¾", 1", 1¼", 1½", 2"
Type of end fitting	NPT female ends
Materials:	
Body	forged brass, nickel plated
Ball	stainless steel
Stem	stainless steel
Seats	PTFE
Characterizing disc	Tefzel®
Packing	2 EPDM O-rings, lubricated
Body Pressure rating	
600 psi	½" - 1"
400 psi	1¼" - 2"
Media temp. range	0°F to 212°F [-18°C to 100°C]
Close off pressure	
200 psi	½" - 2"
Maximum differential pressure (ΔP)	30 psi for typical applications
Leakage	0% for A to AB <2.0% for B to AB
C_v rating	A-port: see product chart for values B-port: 70% of A to AB C_v

Tefzel® is a registered trademark of DuPont

	Valve Nominal Size		Type	Suitable Return Actuators				
C_v	Inches	DN [mm]	3-Way NPT	Non-Spring			Spring	
0.3	½	15	B307	TR Series	LR Series	NR...N4 Series	TF Series	LF Series
0.46	½	15	B308					
0.8	½	15	B309					
1.2	½	15	B310					
1.9	½	15	B311					
3	½	15	B312					
4.7	½	15	B313					
10	½	15	B315*					
4.7	¾	20	B317					
24	¾	20	B320*					
7.4	1	25	B322					
10	1	25	B323					
30	1	25	B325*					
10	1¼	32	B329			AR Series	AR...N4 Series	AF Series
19	1¼	32	B330					
25	1¼	32	B331					
19	1½	40	B338					
29	1½	40	B339					
37	1½	40	B340					
46	1½	40	B341					
29	2	50	B347					
37	2	50	B348					
46	2	50	B349					
57	2	50	B350					
68	2	50	B351					
83	2	50	B352					

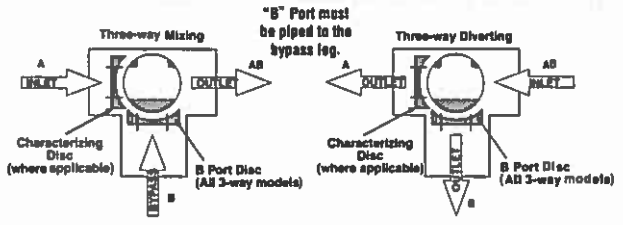
*Models without characterizing disc

Dimensions



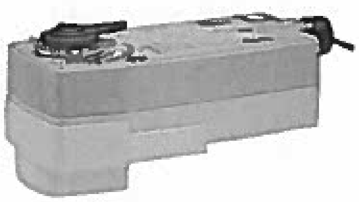
	Valve Nominal Size		Dimensions (inches [mm])		
Valve Body	Inches	DN [mm]	A	B	C
B307-B311	½"	15	2.41" [61.1]	1.39" [35.2]	1.20" [30.6]
B312-B315	½"	15	2.38" [60.4]	1.72" [43.7]	1.26" [32.1]
B317-B320	¾"	20	2.73" [69.3]	1.81" [45.9]	1.45" [36.8]
B322-B325	1"	25	3.09" [78.4]	1.81" [45.9]	1.56" [39.8]
B329-B331	1¼"	32	3.96" [100.6]	2.21" [56.2]	2.14" [54.3]
B338-B341	1½"	40	4.39" [111.6]	2.45" [62.2]	2.33" [59.1]
B347-B352	2"	50	4.90" [124.5]	2.68" [68.0]	2.60" [66.0]

Flow Patterns

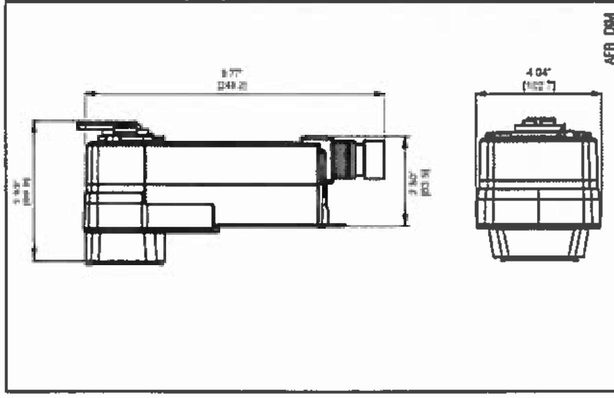


AFRB24-SR, AFRX24-SR

Proportional, Spring Return, 24 V, for 2 to 10 VDC or 4 to 20 mA Control Signal



Dimensions (Inches [mm])



Technical Data		
Power supply		24 VAC ±20%, 50/60 Hz 24 VDC +20% / -10%
Power consumption	running	5.5 W
	holding	3 W
Transformer sizing		8.5 VA (class 2 power source)
Electrical connection		
AFRB...		3 ft, 18 GA appliance cable, 1/2" conduit connector **-S models:** two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
AFX...		3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector **-S models:** Two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables, with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y		2 to 10 VDC, 4 to 20mA
Input impedance		100 kΩ for 2 to 10 VDC (0.1 mA) 500 Ω for 4 to 20 mA
Feedback output U		2 to 10 VDC (max. 0.5 mA)
Direction of rotation	spring	reversible with CW/CCW mounting
	motor	reversible with built-in switch
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	spring	< 20 seconds @ -4°F to 122°F [-20°C to 50°C]; < 60 seconds @ -22°F [-30°C]
	motor	95 seconds
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		zinc coated metal and plastic casing
Agency listings†		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		≤40dB(A) motor @ 95 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.6 lbs (2.1 kg); 4.9 lbs (2.25 kg) with switches

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05" dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4..., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

NOTE: When using AFRB24-SR, AFRB24-SR-S, AFRX24-SR and AFRX24-SR-S actuators, only use accessories listed on this page.
For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

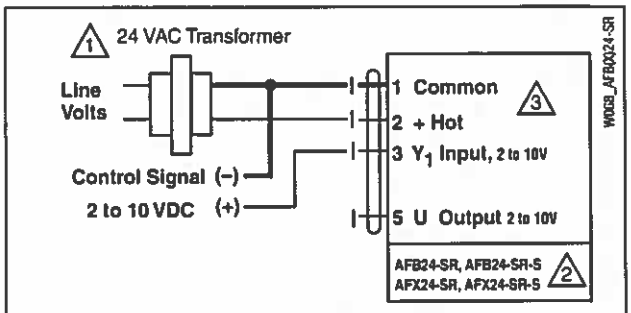
1. Provide overload protection and disconnect as required.
2. ***CAUTION** Equipment Damage!*
   Actuators may be connected in parallel.
   Power consumption and input impedance must be observed.
2. Up to 4 actuators may be connected in parallel if not mechanically mounted to the same shaft. With 4 actuators wired to one 500 Ω resistor.
   Power consumption must be observed.
3. Actuator may also be powered by 24 VDC.
4. For end position indication, interlock control, fan startup, etc., AFB24-SR-S and AFX24-SR-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.
5. Only connect common to neg. (–) leg of control circuits

APPLICATION NOTES

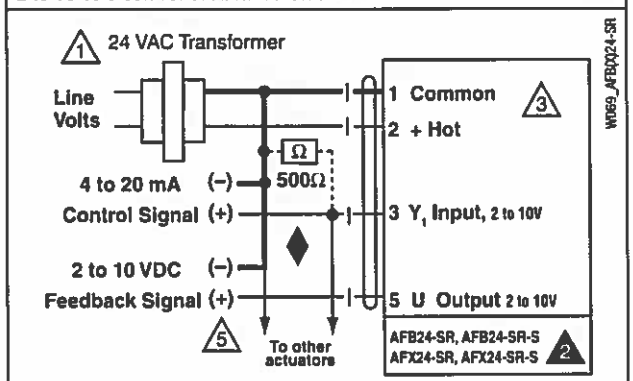
♦ The ZG-R01 500 Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

ATTENTION: AFRB24-SR(-S) and AFRX24-SR(-S) cannot be tandem mounted on the same damper or valve shaft. Only On/Off and MFT AF models can be used for tandem mount applications.

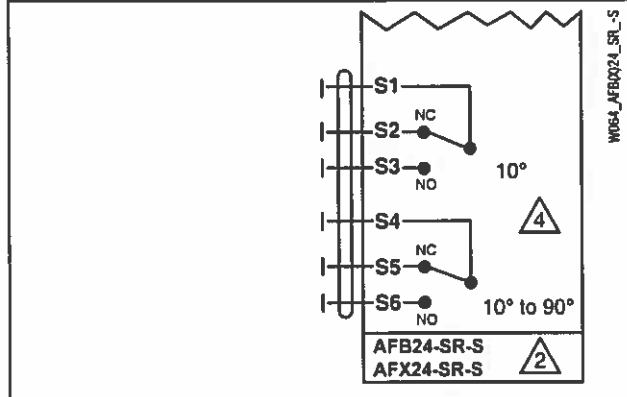
***WARNING** Live Electrical Components!*
During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



2 to 10 VDC control of AFRB24-SR and AFRX24-SR



4 to 20 mA control of AFRB24-SR and AFRX24-SR with 2 to 10 VDC feedback output



Auxiliary switches for AFRB24-SR-S, AFX24-SR-S

BELIMO

F7...HD Butterfly Valves 2"–24" Ductile Iron Lug Body Resilient Seat, 304 Stainless Disc

- 232 psi (2" to 12") and 150 psi (14"-30") bubble tight shut-off
- Long stem design allows for 2" insulation
- Valve face-to-face dimensions comply with API 609 & MSS-SP-67
- Completely assembled and tested, ready for installation
- Tees comply with ASME/ANSI B16.1 Class 125 flanges

Application

These valves are designed to meet the needs of HVAC and commercial applications requiring bubble tight shut off for liquids. Typical applications include chiller isolation, cooling tower isolation, change-over systems, large air handler coil control, bypass and process control applications. The large C_V values provide for an economical control valve solution for larger flow applications. Designed for use in Victaulic piping systems when mated to Victaulic 41 series flange nipples. Fail safe operation is possible with NSV-SY series battery backup systems.

Jobsite Note

Valves should be stored in a weather protected area prior to construction. Complete installation recommendations can be found in Belimo's Installation and Maintenance Instructions for F6/F7...HD/HDU Butterfly Valves.

Technical Data	
Service	chilled, hot water, 60% glycol
Flow characteristic	modified linear
Action	90° rotation
Sizes	2" to 24"
Type of end fitting	for use with ANSI 125/150 flanges
Materials:	
Body	ductile iron ASTM A536
Body finish	epoxy powder coated
Disc	304 stainless steel
Seat	EPDM standard
Shaft	416 stainless steel
O-ring	EPDM
Upper bushing	RPTFE
Middle bushings	RPTFE
Lower bushing	RPTFE
Media temperature range	-22°F to 250°F [-30°C to 120°C]
Operation ambient temperature range	-22°F to 122°F [-30°C to 50°C]
Body pressure rating	ASME/ANSI Class 125/150 (200 psi at -30°F to 275°F)
Close-off pressure	232 psi (2"-12"), 150 psi (14"-24")
Rangeability	10:1 (for 30° to 70° range)
Maximum Velocity	12 FPS

Valve Nominal Size				Type	Suitable Actuators			
C_V 90°	C_V 60°	IN	DN [mm]	2-way	Spring	Non-Spring		
115	44	2"	50	F750HD	AF Series	AM	GM Series	SY Series
196	75	2½"	65	F765HD				
302	116	3"	80	F780HD				
600	230	4"	100	F7100HD				
1022	392	5"	125	F7125HD				
1579	605	6"	150	F7150HD				
3136	1202	8"	200	F7200HD				
5340	2047	10"	250	F7250HD				
8250	3062	12"	300	F7300HD				
11917	4568	14"	350	F7350HD				
16388	6282	16"	400	F7400HD				
21705	8320	18"	450	F7450HD				
27908	10698	20"	500	F7500HD				
43116	16528	24"	600	F7600HD				

			MOD							ON/OFF
Valve	Size	C_V	10°	20°	30°	40°	50°	60°	70°	80°	90°
F750HD	2"	115	.06	3	7	15	27	44	70	105	115
F765HD	2½"	196	.10	6	12	25	45	75	119	178	196
F780HD	3"	302	.20	9	18	39	70	116	183	275	302
F7100HD	4"	600	.30	17	36	78	139	230	364	546	600
F7125HD	5"	1022	.50	29	61	133	237	392	620	930	1022
F7150HD	6"	1579	.80	45	95	205	366	605	958	1437	1579
F7200HD	8"	3136	2	89	188	408	727	1202	1903	2854	3136
F7250HD	10"	5340	3	151	320	694	1237	2047	3240	4859	5340
F7300HD	12"	8250	4	234	495	1072	1911	3062	5005	7507	8250
F7350HD	14"	11917	6	338	715	1549	2761	4568	7230	10844	11917
F7400HD	16"	16388	8	464	983	2130	3797	6282	9942	14913	16388
F7450HD	18"	21705	11	615	1302	2822	5028	8320	13168	19752	21705
F7500HD	20"	27908	14	791	1674	3628	6465	10698	16931	25396	27908
F7600HD	24"	43116	22	1222	2587	5605	9989	16528	26157	39236	43116

F7...HD Butterfly Valves 2"–24" Ductile Iron Lug Body Resilient Seat, 304 Stainless Disc

BELIMO

Maximum Dimensions (Inches)

Valve	Size	C_v 90°	A	B	C	D(Max)	BHC	No. of Holes	Lug Bolt	Actuator	Close-Off (PSI)	
F750HD	2"	115	4.50	6.15	6.15	20.25	4.75	4	5/8-11UNC	AF	200	Fail Safe
F765HD	2½"	196	5.00	6.76	6.76	20.75	5.50	4	5/8-11UNC	2*AF	200	Fail Safe
F750HD	2"	115	4.50	6.15	6.15	20.25	4.75	4	5/8-11UNC	SY2...	200	Non-Fail Safe
F765HD	2½"	196	5.00	6.76	6.76	20.75	5.50	4	5/8-11UNC		200	
F780HD	3"	302	5.50	7.28	7.28	21.00	6.00	4	5/8-11UNC		200	
F7100HD	4"	600	6.50	8.55	8.55	21.75	7.50	8	5/8-11UNC		200	
F7125HD	5"	1022	7.50	9.64	9.64	22.25	8.50	8	3/4-10UNC	SY2...	200	
F7150HD	6"	1579	8.00	10.19	10.19	22.75	9.50	8	3/4-10UNC		200	
F7200HD	8"	3136	9.00	11.37	11.37	29.00	11.75	8	3/4-10UNC	SY4...	200	
F7250HD	10"	5340	11.00	13.58	13.58	30.00	14.25	12	7/8-9UNC		200	
F7300HD	12"	8250	12.00	15.01	15.01	32.00	17.00	12	7/8-9UNC	SY5...	200	
F7350HD	14"	11917	14.00	17.02	17.02	33.00	18.75	12	1-8UNC	SY6...†	150	
F7400HD	16"	16388	15.00	18.39	18.39	38.50	21.25	16	1-8UNC	SY7...†	150	
F7450HD	18"	21705	16.50	20.63	20.63	39.50	22.75	16	1 1/8-7UNC	SY8...†	150	
F7500HD	20"	27908	18.00	23.00	23.00	41.50	25.00	20	1 1/8-7UNC		150	
F7600HD	24"	43116	22.00	27.9	27.9	53.25	29.50	20	1 1/4-7UNC	SY12...†	150	

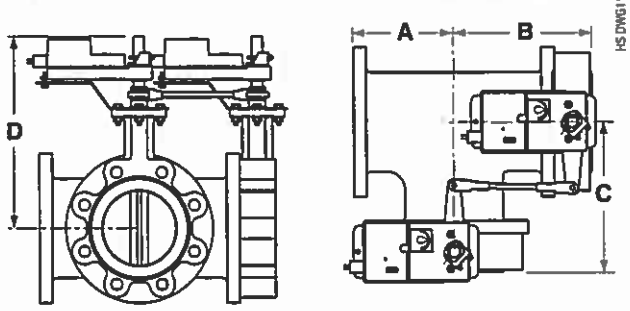
AF maximum actuator ambient temperature is 122°F.
SY... maximum actuator ambient temperature is 150°F.
†SY6 and larger available in 110/220 VAC versions only.

Application Notes

1. Valves are rated at 200 psi differential pressure in the closed position.
2. Valves are furnished with lugs tapped for use with ANSI Class 125/150 flanges. Installation flanges and hardware are not included.
3. 3-way assemblies are furnished assembled and tested, ready for installation. **All 3-way assemblies require the customer to specify the 3-way configuration prior to order entry to guarantee correct placement of valves and actuators on the assembly.**
4. Dimension "D" allows for actuator removal without the need to remove the valve from the pipe.
5. Belimo SY Series actuators are NEMA 4X rated.
5. Weather shields are available, dimensional data upon request.
6. Dual actuated valves have single actuators mounted on each valve shaft.
7. Bolts supplied are for shipping purposes only. Upon installation replace with an appropriate SAE grade 5 or better hardware.

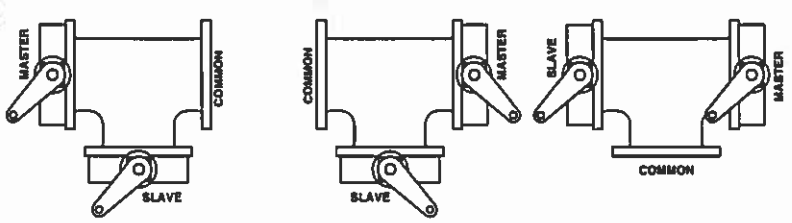
⚠ **Note:** For tee configuration, please refer to page 4.

Dimensions



HS DWG11

3-Way Configuration Codes



CONFIG CODE	ON/OFF OR MOD@2VDC MASTER VALVE IS	MASTER VALVE @ FAIL
X10	OPEN	NON-FAIL
X11	OPEN	OPEN
X12	OPEN	CLOSED
X13	CLOSED	NON-FAIL
X14	CLOSED	OPEN
X15	CLOSED	CLOSED

CONFIG CODE	ON/OFF OR MOD@2VDC MASTER VALVE IS	MASTER VALVE @ FAIL
X20	OPEN	NON-FAIL
X21	OPEN	OPEN
X22	OPEN	CLOSED
X23	CLOSED	NON-FAIL
X24	CLOSED	OPEN
X25	CLOSED	CLOSED

CONFIG CODE	ON/OFF OR MOD@2VDC MASTER VALVE IS	MASTER VALVE @ FAIL
X30	OPEN	NON-FAIL
X31	OPEN	OPEN
X32	OPEN	CLOSED
X33	CLOSED	NON-FAIL
X34	CLOSED	OPEN
X35	CLOSED	CLOSED

X Specifies Bi-Directional Flow Capability

NOTES

1. Slave Valve operates inversely of the Master Valve.
2. The Master Valve is always located on the run.
3. The Slave Valve may also have an actuator if required (Direct Coupled).
4. On/Off actuator normal position is a function of field logic.
5. Proportional actuator normal position is a function of the CCW/CW switch.
6. All 3-way assemblies are designed for 90 degree actuator rotation.

ORDERING INFORMATION

Please note that HD series BF valves over 18" and ALL sizes 3-way tee assemblies ordered with *Configuration Codes 30-35* are special order/custom built and are *NOT* returnable.

BELIMO

SY...120 Series Non-Spring Return Actuator

Technical Data - 120 VAC

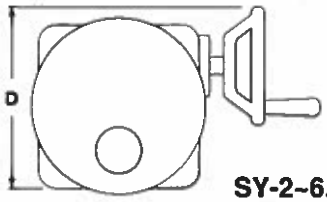
Application:

The SY actuators are NEMA 4X rated and designed to meet the needs of HVAC and Commercial applications. Offered on Belimo standard and high performance valve series, these actuators are available for on/off and modulating applications. Depending on the application, they are available in 24 VAC/ VDC, 120 VAC and 230 VAC.

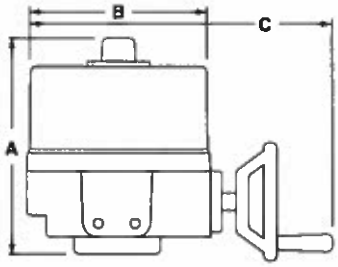
Technical Data	
Electrical connection	½" conduit connector, screw terminals
Overload protection	thermally protected 135°C cut-out
Motor protection	H Class insulation (SY-1), F Class (SY-2...12)
Gear train	high alloy steel gear sets, self locking
Operating range	(SY...-110) on/off, floating point (SY...120MFT) 2-10 VDC, 4-20mA, 0-10 VDC
Sensitivity	(SY...120MFT) 0.4mA/200mV
Reversal hysteresis	(SY...120MFT) 1.0mA/500mV
Feedback	(SY...120MFT) 2-10 VDC
Angle of rotation	90°
Direction of rotation	reversible
Position indication	top mounted domed indicator
Internal humidity control	resistive heating element
Auxiliary switches	(2) SPDT, 5A 250 VAC factory set for 5° and 85° change of state
Ambient temperature	-22°F to +150°F [-30°C to +65°C]
Humidity range	up to 95%
Housing type	IP67, NEMA 4X
Housing material	die cast aluminum alloy
Agency listings	ISO, CE, cCSAus

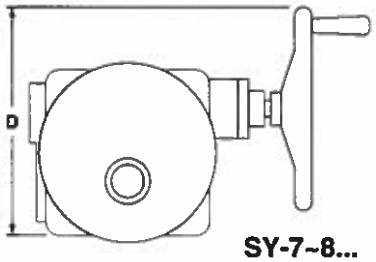
Power Supply 120 VAC 50/60Hz, single phase

Model	Torque	Speed 60Hz	Speed 50Hz	Power Consumption	Duty Cycle On/Off	Duty Cycle Proportional	Override	Weight
SY1-110(P)	35Nm/310 in-lbs	12s	13s	0.5A	30%	75%	8mm Wrench	2.0kg/4.9 lb.
SY2-120(MFT)	90Nm/801 in-lbs	15s	17s	1.0A	30%	75%	Hand Wheel	11kg/24.5 lb.
SY3-120(MFT)	150Nm/1335 in-lbs	22s	26s	1.0A	30%	75%	Hand Wheel	11kg/24.5 lb.
SY4-120(MFT)	400Nm/3560 in-lbs	16s	18s	1.3A	30%	75%	Hand Wheel	22kg/48.5 lb.
SY5-120(MFT)	500Nm/4450 in-lbs	22s	25s	1.5A	30%	75%	Hand Wheel	22kg/48.5 lb.
SY6-120(MFT)	650Nm/5785 in-lbs	28s	31s	1.8A	30%	75%	Hand Wheel	22kg/48.5 lb.
SY7-120(MFT)	1000Nm/8900 in-lbs	46s	55s	3.2A	30%	75%	Hand Wheel	36kg/79.5 lb.
SY8-120(MFT)	1500Nm/13350 in-lbs	46s	55s	4.0A	30%	75%	Hand Wheel	36kg/79.5 lb.
SY9-120(MFT)	2000Nm/17800 in-lbs	58s	70s	3.2A	30%	50%	Hand Wheel	56kg/123.5 lb.
SY10-120(MFT)	2500Nm/22250 in-lbs	58s	70s	4.0A	30%	50%	Hand Wheel	56kg/123.5 lb.
SY11-120(MFT)	3000Nm/26700 in-lbs	58s	70s	3.0A	30%	50%	Hand Wheel	56kg/123.5 lb.
SY12-120(MFT)	3500Nm/31150 in-lbs	58s	70s	4.0A	30%	50%	Hand Wheel	56kg/123.5 lb.

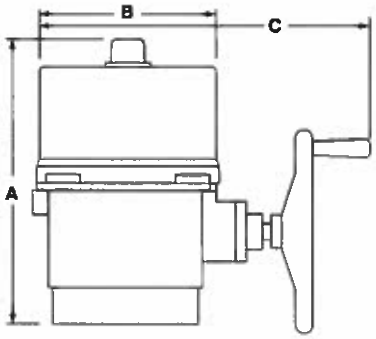


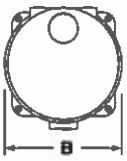
SY-2~6...



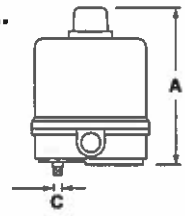


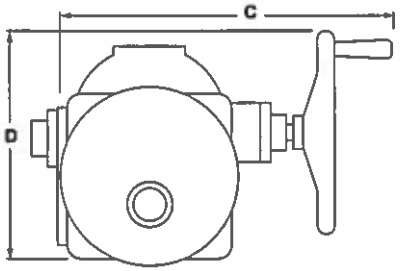
SY-7~8...

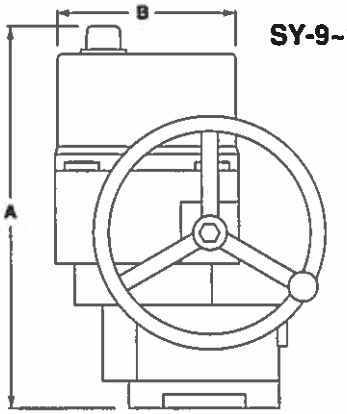




SY-1...



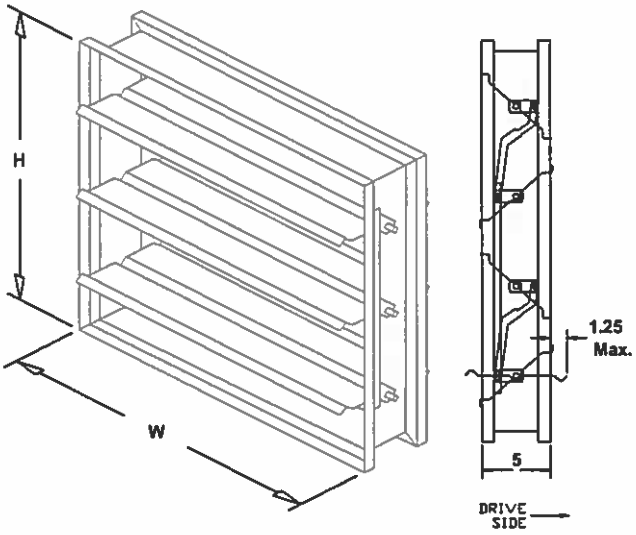




SY-9~12...

MODEL	DIM A (MAX)	Add to Dim A for cover removal	DIM B	DIM C (MAX)	DIM D
	Inches [mm]	Inches [mm]	Inches [mm]	Inches [mm]	Inches [mm]
SY1	6.10 [155]	3.94 [100]	4.25 [108]	8mm	-
SY2-3	10.04 [255]	7.48 [190]	7.87 [200]	12.99 [330]	7.87 [200]
SY4-6	12.40 [315]	8.86 [225]	9.21 [234]	14.96 [380]	11.81 [300]
SY7-8	16.54 [420]	8.86 [225]	9.21 [234]	17.72 [450]	13.39 [340]
SY9-12	23.23 [590]	8.86 [225]	10.24 [260]	18.50 [470]	13.78 [350]

Note: ~ indicates range of actuator i.e., SY2~3 = SY-2 and SY-3



VCD-23

Low Leakage Control Damper

Application & Design

The VCD-23 is a ruggedly built low leakage control damper intended for application in low to medium pressure and velocity systems. A wide range of electric and pneumatic actuators are available.

RATINGS
Pressure: 5 in. wg
Velocity: 3,000 fl/min
Leakage: Class 1A @ 1 in. wg, Class 1 @ up to 5 in. wg.

Installation instructions available at www.greenheck.com.

Notes: All dimensions shown are in units of inches.

W & H furnished approximately 0.25 in. undersized and only refer to damper dimensions (sleeve thickness is not included).

Electrical accessory wiring terminates at the accessory. Field wiring is required to individual components.

Maximum velocity is based upon damper width.

CONSTRUCTION FEATURES

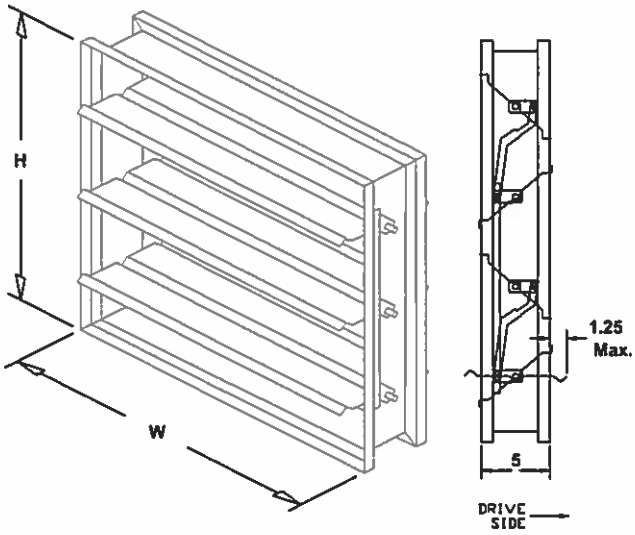
Blade Action:	Opposed	**Blade Seal:**	TPE
Frame Type:	Channel	**Jamb Seal Mat.:**	304 SS
Material:	Galvanized	**Sizing:**	Nominal
Axle Material:	Steel	**Frame Thickness (ga):**	16
Axle Bearings:	Synthetic	**Jackshafting:**	No Preference
Linkage Material:	Steel	**Temp. Rating (F):**	180

ID #	Tag	Qty	W (in.)	H (in.)	Drive Arr.
11-1	RV-2	1	48.000	114.000	Drive-CC-12-2CEL-0
Tags:	RV-2				
11-2	RV-3	1	72.000	102.000	Drive-CC-22-2CEL-2
Tags:	RV-3				
11-3	Stairwell...	2	88.000	60.000	Drive-CC-21-1CEL-1
Tags:	Stairwell Pressureization Fans				

AMCA

AMCA Licensed for Air Performance & Air Leakage

Greenheck Fan Corporation certifies that the model shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs.The AMCA Certified Ratings Seal applies to Air Leakage and Air Performance ratings.



VCD-23

Low Leakage Control Damper

Application & Design

The VCD-23 is a ruggedly built low leakage control damper intended for application in low to medium pressure and velocity systems. A wide range of electric and pneumatic actuators are available.

RATINGS
Pressure: 5 in. wg
Velocity: 3,000 fl/min
Leakage: Class 1A @ 1 in. wg, Class 1 @ up to 5 in. wg.

Installation instructions available at www.greenheck.com.

Notes: All dimensions shown are in units of inches.

W & H furnished approximately 0.25 in. undersized and only refer to damper dimensions (sleeve thickness is not included).

Electrical accessory wiring terminates at the accessory. Field wiring is required to individual components.

Maximum velocity is based upon damper width.

CONSTRUCTION FEATURES

Blade Action:	Opposed	**Blade Seal:**	TPE
Frame Type:	Channel	**Jamb Seal Mat.:**	304 SS
Material:	Galvanized	**Sizing:**	Nominal
Axle Material:	Steel	**Frame Thickness (ga):**	16
Axle Bearings:	Synthetic	**Jackshafting:**	No Preference
Linkage Material:	Steel	**Temp. Rating (F):**	180

ID #	Tag	Qty	W (in.)	H (in.)	Drive Arr.
17-1	EF-1	1	18.000	18.000	Drive-CC-11-1CEL-0
Tags:	EF-1				
17-2	EF-2	1	18.000	18.000	Drive-CC-11-1CEL-0
Tags:	EF-2				
17-3	EF-3	1	10.000	10.000	Drive-CC-11-1CEL-0
Tags:	EF-3				

AMCA

AMCA Licensed for Air Performance & Air Leakage

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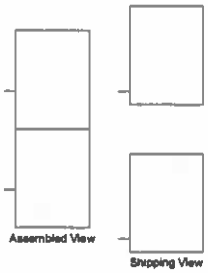
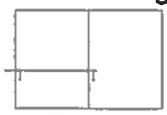
Damper Drive Arrangements Job Summary -Start-

Drive Arrangement: Drive-CC-11-1CEL-0

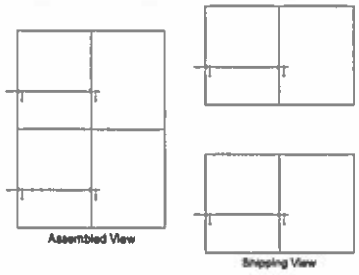
Drive Arrangement: Drive-CC-12-2CEL-0



Drive Arrangement: Drive-CC-21-1CEL-1



Drive Arrangement: Drive-CC-22-2CEL-2



Damper Drive Arrangements Job Summary -End-

GREENHECK

VCD-23

Low Leakage CONTROL DAMPER

Application and Design

The VCD-23 series is a ruggedly built low leakage control damper intended for application in low to medium pressure and velocity systems. A wide range of electric and pneumatic actuators are available.

Ratings (See page 4 for specific limitations)

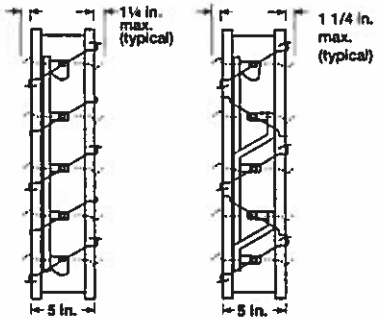
Pressure: Up to 5.0 in. wg (1.2 kPa) - pressure differential.
Velocity: Up to 3000 fpm (15.2 m/s)
Leakage: Class 1A @ 1 in. wg (.25 kPa)
Class 1 @ up to 5 in. wg (1.2 kPa)
Temperature: Up to 250°F (121°C). Consult Greenheck for higher temperatures.

Construction	Standard	Optional
Frame Material	Galvanized Steel	304SS
Frame Thickness	16 ga.	12 ga. (2.7mm)
Frame Type	5 in. x 1 in. Channel	-
Blade Material	Galvanized steel	304SS
Blade Thickness	16 ga.	-
Blade Type	3V	-
Blade Seals	TPE	Silicone
Axle	1/2 in. dia. Plated Steel	304SS
Axle Bearings	Synthetic	Bronze, 304SS
Linkage Material	Plated Steel	304SS
Jamb Seal	304SS	-
Paint Finishes	Mill Finish	Baked Enamel, Epoxy, HI Pro Polyester, Industrial Epoxy, Permatector™

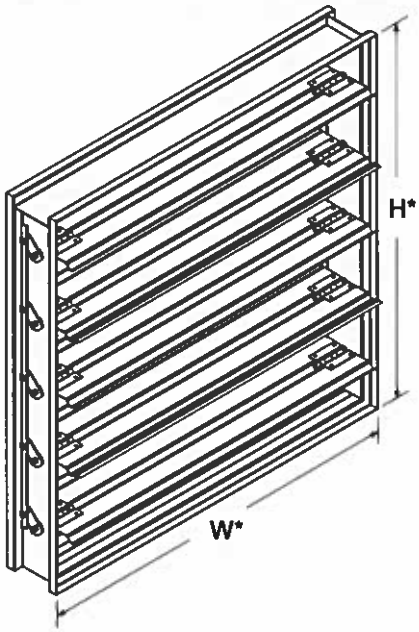
Size Limitations

W x H	Minimum Size	Maximum Size	
		Single Section	Multiple Section
Inches	6 x 6	48 x 74	Unlimited
mm	152 x 152	1219 x 1880	Unlimited

Blade Operation

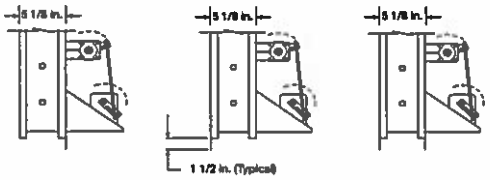


Parallel Blades Opposed Blades



* W&H dimension furnished approximately ¼ in. (6mm) undersize.

Flange Options



Single Flange | Single Reversed Flange | Double Flange

Features & Options

- Blade seals - pressure activated to produce tighter sealing.
- Linkage concealed in the frame
- Low profile head and sill are used on sizes less than 17 in. (432mm)
- Wide range of electric actuators, manual quadrant and pneumatic actuators available. Factory installation available.
- Sleeves available
- 5/8 in. - 2 in. (16mm - 51mm) flange available
- Retaining angles
- Transitions- R, C and O
- Open Close Indicator (OCI)
- Security bars

Installation instructions available at www. greenheck.com.

Pressure Drop Data VCD-23

This pressure drop testing was conducted in accordance with AMCA Standard 500-D using the three configurations shown. All data has been corrected to represent standard air at a density of .075 lb/ft^3(1.2 kg/m^3). Actual pressure drop found in any HVAC system is a combination of many factors. This pressure drop information along with an analysis of other system influences should be used to estimate actual pressure losses for a damper installed in a given HVAC system.

AMCA Test Figures

Figure 5.2 Illustrates a ducted damper exhausting air into an open area. This configuration has a lower pressure drop than Figure 5.5 because entrance losses are minimized by a straight duct run upstream of the damper.

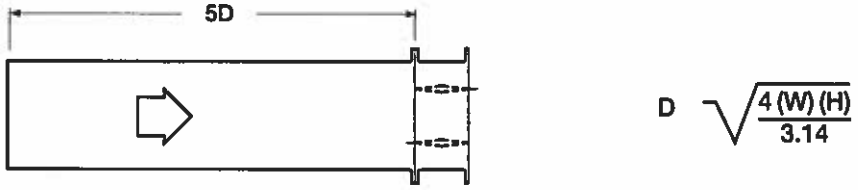


Figure 5.3 Illustrates a fully ducted damper. This configuration has the lowest pressure drop of the three test configurations because entrance and exit losses are minimized by straight duct runs upstream and downstream of the damper.

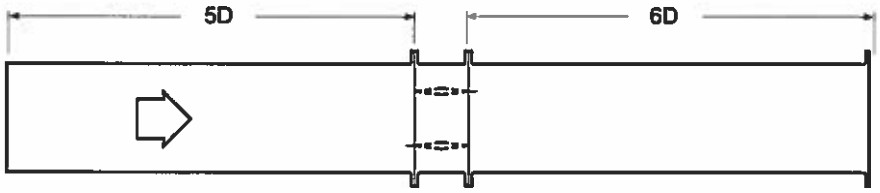
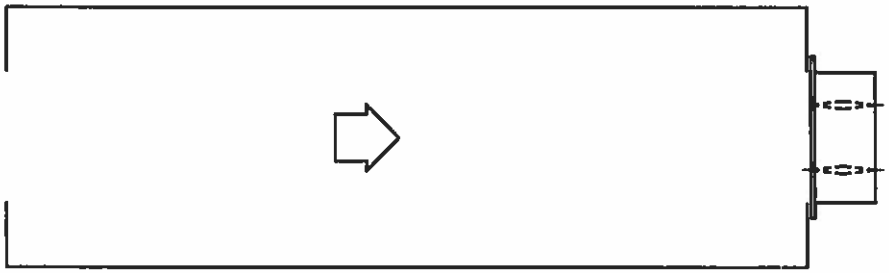


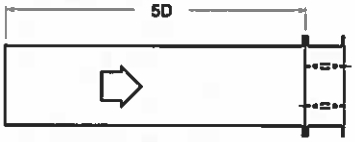
Figure 5.5 Illustrates a plenum mounted damper. This configuration has the highest pressure drop because of extremely high entrance and exit losses due to the sudden changes of area in the system.



AMCA Certified Pressure Drop Data VCD-23

Greenheck Fan Corporation certifies that the model VCD-23 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs.The AMCA Certified Ratings Seal applies to Air Leakage and Air Performance ratings.

AMCA 5.2



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.05
1500	0.11
2000	0.19
2500	0.29
3000	0.41
3500	0.55
4000	0.72

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.10
2500	0.16
3000	0.23
3500	0.30
4000	0.40

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.05
2000	0.09
2500	0.14
3000	0.19
3500	0.27
4000	0.35

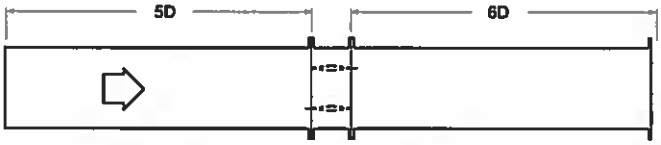
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.04
1500	0.08
2000	0.15
2500	0.22
3000	0.32
3500	0.43
4000	0.56

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.07
2000	0.12
2500	0.18
3000	0.26
3500	0.36
4000	0.47

AMCA 5.3



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.13
2500	0.20
3000	0.29
3500	0.40
4000	0.51

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.04
2000	0.07
2500	0.11
3000	0.16
3500	0.21
4000	0.28

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.03
2000	0.06
2500	0.09
3000	0.13
3500	0.19
4000	0.25

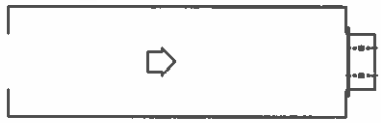
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.07
2000	0.12
2500	0.18
3000	0.26
3500	0.36
4000	0.46

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.10
2500	0.16
3000	0.22
3500	0.30
4000	0.39

AMCA 5.5



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.13
1500	0.30
2000	0.53
2500	0.82
3000	1.19
3500	1.62
4000	2.10

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.26
2000	0.47
2500	0.75
3000	1.04
3500	1.41
4000	1.90

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.02
1000	0.10
1500	0.22
2000	0.40
2500	0.62
3000	0.90
3500	1.23
4000	1.62

12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.27
2000	0.47
2500	0.75
3000	1.07
3500	1.45
4000	1.91

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.28
2000	0.49
2500	0.77
3000	1.12
3500	1.53
4000	2.01

AMCA Certified Leakage Data VCD-23

Air leakage is based on operation between 32°F (0°C) and 120°F (49°C).
Tested for leakage in accordance with ANSI/AMCA Standard 500-D, Figure 5.5.
Tested for air performance in accordance with ANSI/AMCA Standard 500-D, Figures 5.2, 5.3 and 5.5.

Torque
Data are based on a torque of 5.0 in.lb./ft² (0.56 N·m) applied to close and seat the damper during the test.

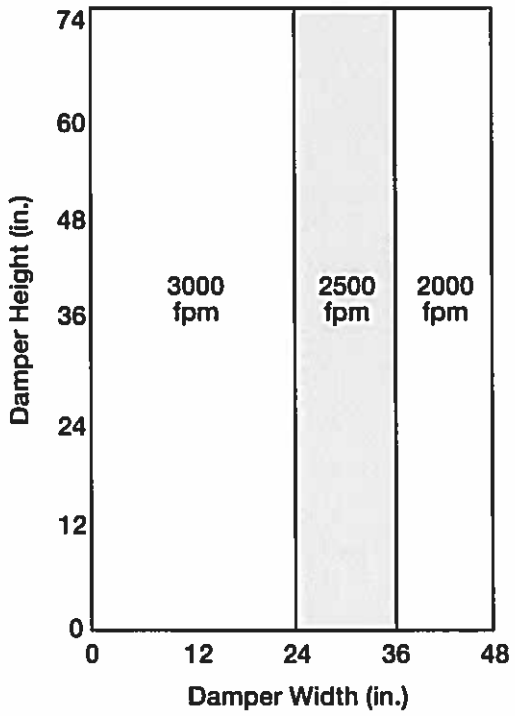
VCD-23	Leakage Class*		
Maximum Damper Width	1 in. wg (0.25 kPa)	4 in. wg (1 kPa)	5 in. wg (1.2 kPa)
48 in. (1219mm)	1A	1	1

Greenheck Fan Corporation certifies that the model VCD-23 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs.The AMCA Certified Ratings Seal applies to Air Leakage and Air Performance ratings.

***Leakage Class Definitions**
The *maximum* allowable leakage is defined by AMCA as the following:

- Leakage Class 1A - 3 cfm/ft^2 @ 1 in. wg (class 1A is only defined at 1 in. wg).
- Leakage Class 1
  - 4 cfm/ft^2 @ 1 in. wg
  - 8 cfm/ft^2 @ 4 in. wg
  - 11 cfm/ft^2 @ 8 in. wg
  - 12.6 cfm/ft^2 @ 10 in. wg

Velocity Limitations

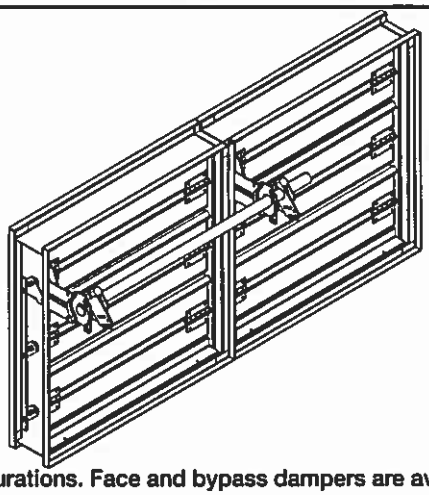


ASSEMBLY

Multi-Section Assembly

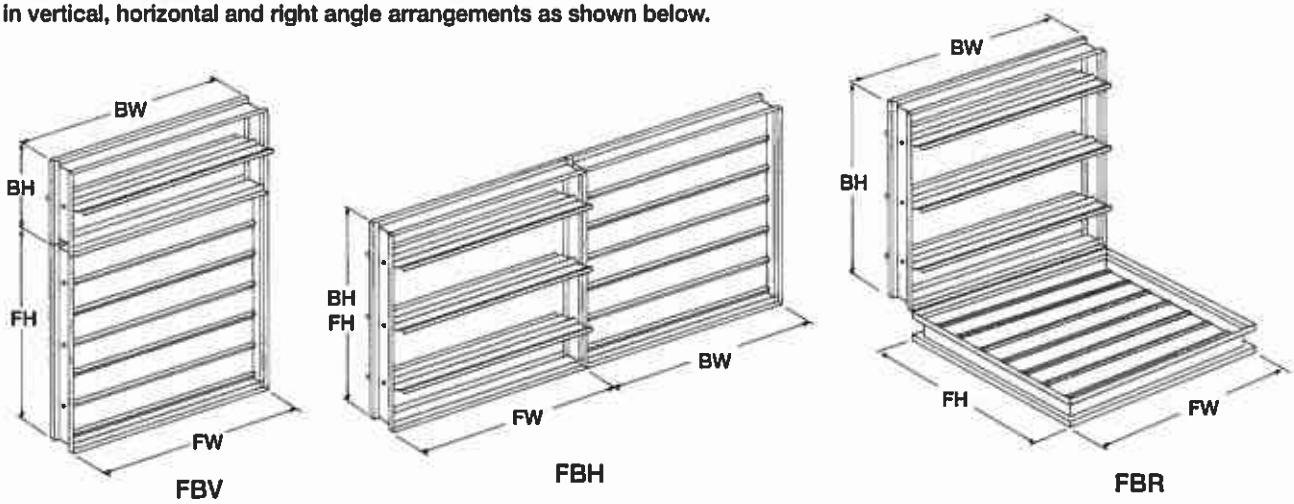
Dampers larger than the maximum single section size, will be made up of a multiple of equal size sections. Multiple section dampers can be jackshafted together so that all sections operate together as shown below.

NOTE: Dampers larger than 48 in. x 74 in. (1219mm x 1880mm) are not intended to be structurally self supporting. Additional horizontal bracing is recommended to support the weight of the damper and vertical bracing should be installed as required to hold against system pressure.



Face and Bypass Configurations

VCD-23 series control dampers can be assembled for face and bypass configurations. Face and bypass dampers are available in vertical, horizontal and right angle arrangements as shown below.



SPECIFICATIONS

Specifications

Control dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules.

Damper blades shall be 16 ga. (1.5mm) galvanized steel 3V type with three longitudinal grooves for reinforcement. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 1/2 in. [13mm] are unacceptable). Blade seals shall be TPE. Linkage shall be blade-to-blade concealed in jamb (out of the airstream) to protect linkage and reduce pressure drop and noise.

Damper frame shall be 16 ga. (1.5mm) galvanized steel formed into a structural hat channel shape with reinforced corners to meet 11 ga. (3.1mm) criteria. Bearings shall be corrosion resistant, permanently lubricated, synthetic (acetal) sleeve type rotating in extruded holes in the damper frame for maximum service. Axles shall be square and positively locked into the damper blade. Jamb seals shall be flexible stainless steel compression type to prevent leakage between blade end and damper frame.

The Damper Manufacturer's submittal data shall certify all air leakage and air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3 and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.

Basis of design is Greenheek's model VCD-23.

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Drive Arrangement Definition

On multi-blade dampers (except vertical blade and Face & Bypass), they are given a drive arrangement code that helps describe the construction of the damper. The following breaks down what each number and letter represents.

22-2FEL-2

① ② ③ ④ ⑤ ⑥ ⑦

① Number of sections wide

② Number of sections high

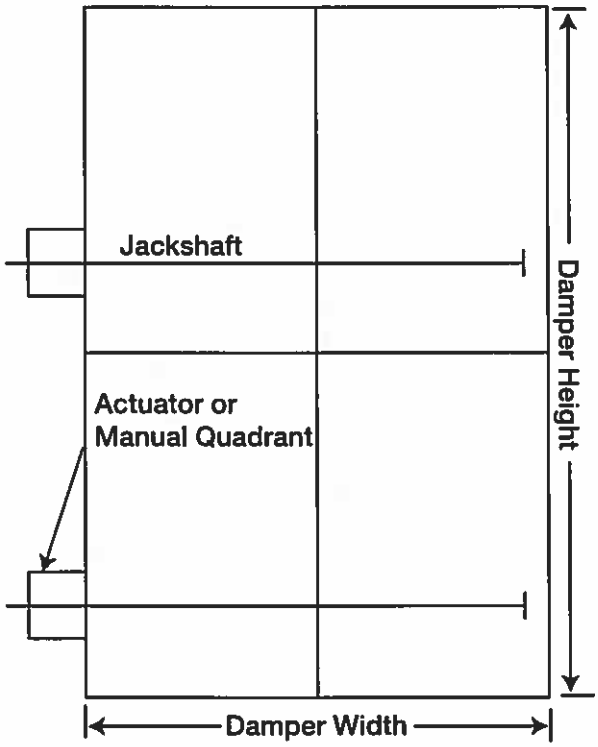
③ Number of actuators or manual quadrants

④ Who supplies the actuators or manual quadrants
- F - Factory
- C - Customer Supplied (field mounted)

⑤ Actuator or manual quadrant mounting
- E - External
- I - Internal
- B - Both internal and external

⑥ Actuator or manual quadrant location
- L - Left hand drive
- R - Right hand drive
- B - Both right and left

⑦ Number of jackshafts



On vertical blade and face & bypass dampers, they are given a configuration ID number that helps describe the construction of the damper. See the following examples:

Model	Drive Arrangement Prefix
AMD-23, 33, 42	AMD
AMD-42V	VB
DFD-210, 230; DFDAF-310; DFDTF-210; SEDFD-210	MLS
FBH & FBV	FB
FSD, OFSD, CFSD, SMD, SEFSD, SSFSD, SESMD, SSSMD series (except vertical blade models)	MLS
FSD-311V, SMD-301V	VB
GFSD series	GFSD
ICD series	CC
IMO series	MLS
MBD-15 & VCD series (except vertical blade models)	CC
VCD-xxV (vertical blade models)	VB

GREENHECK

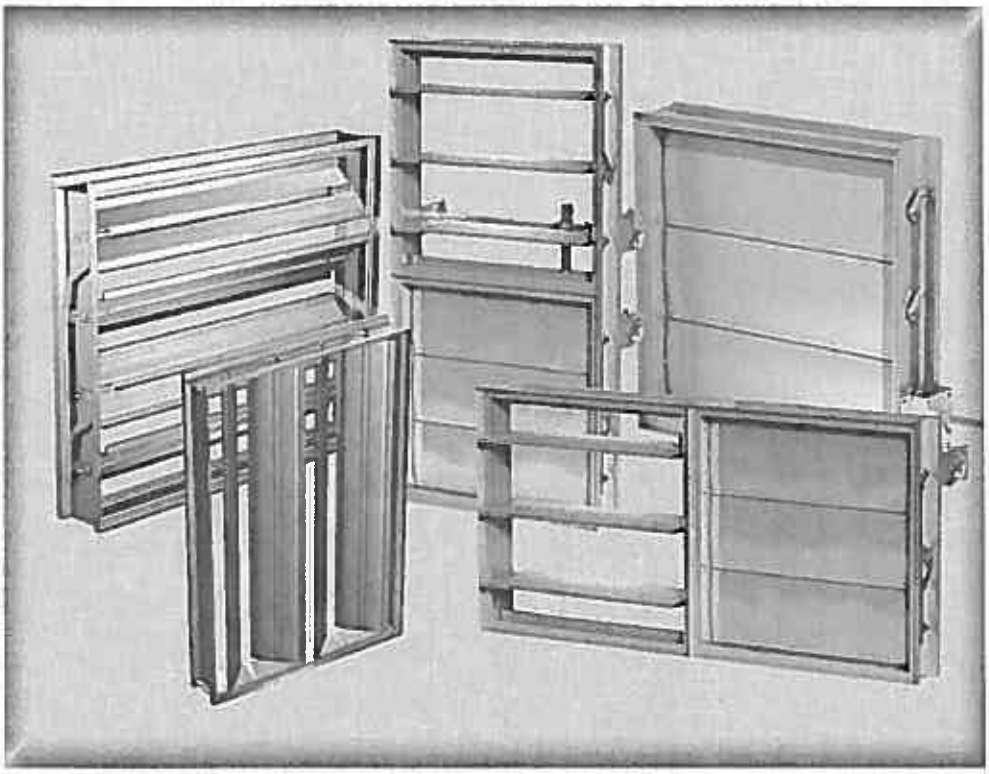
VCD, FBH & FBV MODELS

Vertical and Horizontal Mount

Part number 463384

Installation, Operation, and Maintenance Instructions

This manual is the property of the owner, and is required for future maintenance. Please leave it with the owner when the job is complete.



RECEIVING AND HANDLING

Upon receiving dampers, check for both obvious and hidden damage. If damage is found, record all necessary information on the bill of lading and file a claim with the final carrier. Check to be sure that all parts of the shipment, including accessories, are accounted for.

Dampers must be kept dry and clean. Indoor storage and protection from dirt, dust and the weather is highly recommended. Do not store at temperatures in excess of 100°F (37°C).

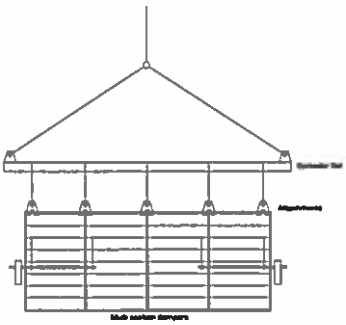
SAFETY WARNING:

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating, and maintenance instructions thoroughly before installing or servicing this equipment.

Due to continuing research, Greenheck reserves the right to change specifications without notice.

Pre-Installation Guidelines

The basic intent of a proper installation is to secure the volume control damper into the opening in such a manner as to prevent distortion and disruption of damper operation. The following items will aid in completing the damper installation in a timely and effective manner.



1) Check the schedules for proper damper locations within the building. Visually inspect the damper for damage.
2) Lift or handle damper using sleeve or frame. Do not lift damper using blades, linkage, actuators, or jackshafting. When handling multiple sections assemblies, use sufficient support to evenly lift at each section mullion (see drawing). Do not drag, step on, apply excessive bending, twisting, or racking.
3) Do not install screws in damper frame that will interfere with unexposed blade linkage and prevent damper blades from opening and/or closing.
4) Damper must be installed into duct or opening square and free of twist or other misalignment. Damper must not be squeezed or stretched into duct or opening. Out of square, racked, twisted or misaligned installations can cause excessive leakage and/or torque requirements to exceed damper/actuator design.
5) Damper and actuator must be kept clean, dry and protected from dirt, dust and other foreign materials prior to and after installation. Examples of such foreign materials include but are not limited to:
    a) Mortar dust
    b) Drywall dust
    c) Firesafing materials
    d) Wall texture
    e) Paint overspray
6) Damper should be sufficiently covered as to prevent overspray if wall texturing or spray painting will be performed within 5 feet (1.50m) of the damper. Excessive dirt or foreign material deposits on damper can cause excessive leakage and/or torque requirements to exceed damper/actuator design.
7) ACCESS: Suitable access (actuators maintenance, etc.) must be provided for damper inspection and servicing. Where it is not possible to achieve sufficient size access, it will be necessary to install a removable section of duct.

Electrical Guidelines

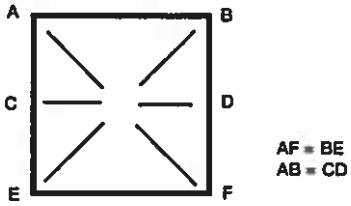
Electrical and/or pneumatic connections to damper actuators should be made in accordance with wiring and piping diagrams developed in compliance with applicable codes, ordinances and regulations.

SAFETY CAUTION !
Verify power requirements before wiring actuator. Greenheck is not responsible for any damage to, or failure of the unit caused by incorrect field wiring.

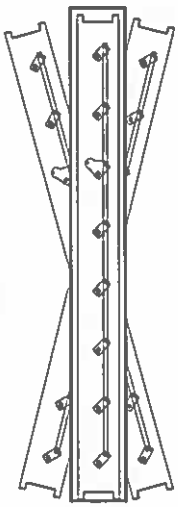
SAFETY DANGER !
Electrical input may be needed for this equipment. This work should be performed by a qualified electrician.

Installation - Failure to follow instructions will void all warranties

1. Duct opening or opening square should measure ¼ inch (6mm) larger than damper dimension and should be straight and level.



Do not twist or bow. Mount damper plumb in the opening.



2. If more than two sections wide, unit ships as a multiple section assembly and a single section together. The single section is joined to the side of the multiple section where the jackshaft extends past the frame 4 inches (see Figure 1 & 2).
3. A damper assembly is not restricted to a maximum number of sections, but must not exceed the section sizes and overall sizes shown at the right.
4. The damper sections must be attached together with #10 x 3/4in.(19mm) max. sheet metal screws, ¼ in. (6mm) diameter nuts and bolts, tack or spot welds, or 3/16 in. (4mm) diameter steel pop rivets. Attachments must be spaced a maximum of 6 in. (152mm) on centers and a maximum of 2 in. (50mm) from corners. Attachments must be made on front face and back face (air entering and air exiting side) of damper sections.
5. Two section high dampers require reinforcement using a 14 gauge (2mm), 5 in. (127mm) wide mullion or two individually sleeved units stacked vertically. When using two individually sleeved units, the sleeve acts as the mullion, therefore no mullion is required (Mullions are not provided by Greenheck).

Damper Model	Maximum Single Section Size W x H in. (mm)	Maximum Overall Size for Multi-Section Dampers
VCD-15, VCD-18	48 x 60 (1219 x 1524)	84 in. W x 60 in. H (2133mm x 1524mm)
VCD-20, VCD-23	48 x 74 (1219 x 1880)	Unlimited
VCD-33, VCD-34, VCD-40, VCD-42, VCD-43	60 x 74 (1524 x 1880)	Unlimited
VCD-20V, VCD-23V	74 x 48 (1879 x 1219)	NA
VCD-33V, VCD-42V, VCD-43V	74 x 60 (1879 x 1524)	NA
FBH-43	Face: 60 x 74 (1524 x 1880) Bypass: 60 x 74 (1524 x 1880)	Face: 96 x 74 (2438 x 1880)
FBV-43	Face: 60 x 74 (1524 x 1880) Bypass: 60 x 74 (1524 x 1880)	Face: 96 x 74 (2438 x 1880) Bypass: 96 x 74 (2438 x 1880)

Installation (continued)

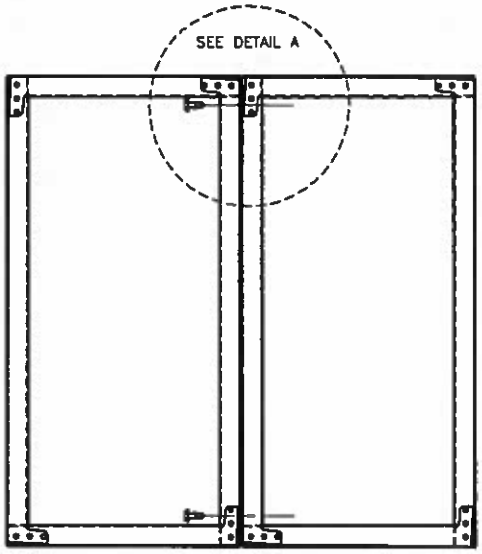


Figure 1

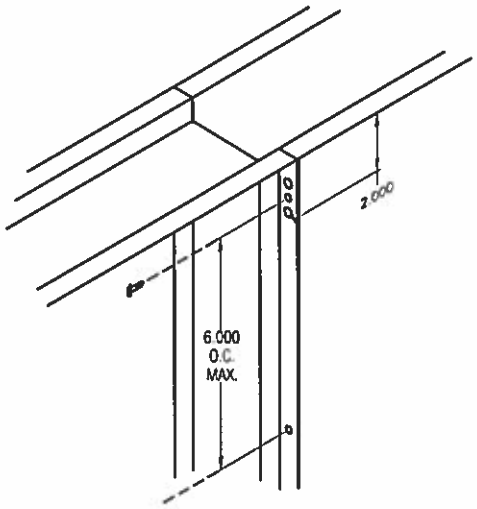


Figure 2

6. When the height of a Face & Bypass vertical style (FBV) is greater than 84 in. (2134mm), the damper sections are shipped separate and field assembly is required. Before fastening damper sections together, the non-actuated damper section will need to be flipped upside down so that the linkage is on the same side as the actuated damper. After damper sections are fastened together, attach interconnecting angle as shown in **Figure 3.** (Interconnecting angle is shipped with actuated damper section.)

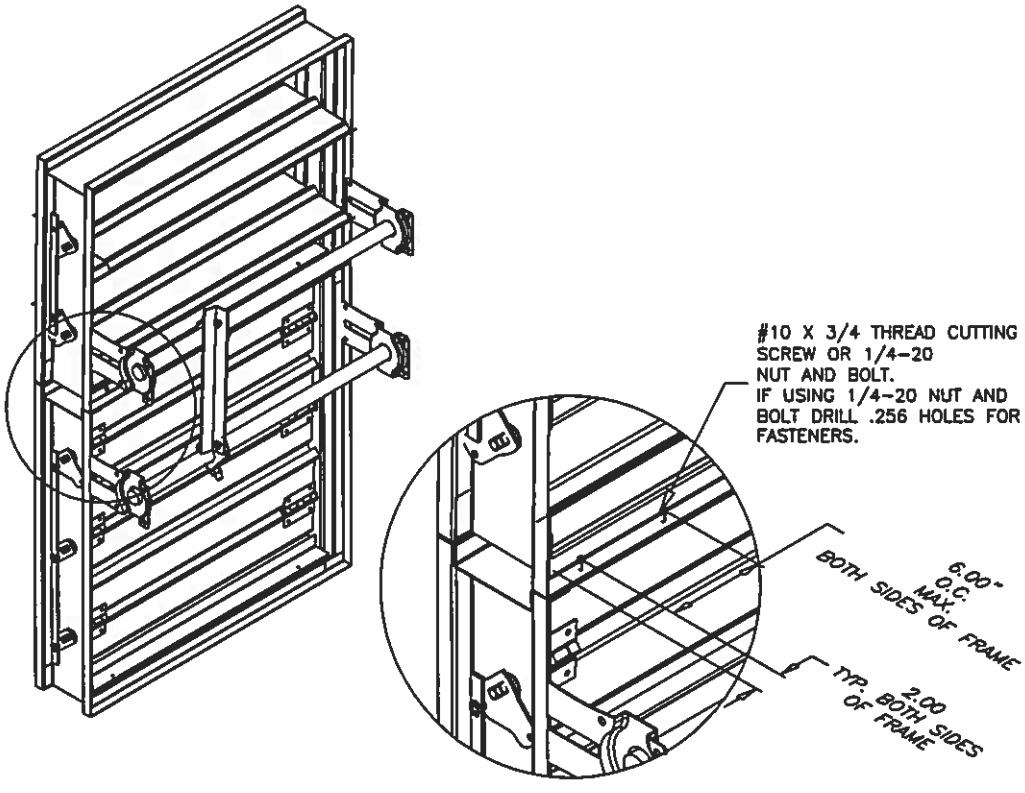


Figure 3

Installation (continued)

7. If no holes are present in frame, drill ¼ inch (6mm) diameter holes at 6 inch (52mm) centers and fasten frames together with ¼ inch (6mm) #20 (.03mm) bolts and nuts (see Figure 1 & 2).
8. Use shims between damper frame and duct opening or opening space to prevent distortion of frame by fasteners holding it in place. Brace at every horizontal mullion and vertically brace at every 8 feet (2.4m) of damper width for strength. Dampers in high velocity (2000 fpm [610m per second]) may require more bracing. Note: Greenheck dampers are specifically designed and engineered for structural integrity based on model and conditions. Attachment, framing, mating flanges, and anchoring of damper assemblies into openings, ductwork, or walls is the responsibility of the installer. Design calculations for these retaining and supporting members should be determined by field engineers for that particular installation.
9. If damper actuator is to be mounted out of the airstream, the extension pin should extend approximately 6 inches (152mm) beyond the frame. On jackshafted units, the jackshaft should extend through the jackshaft bearing assembly and approximately, 6 inches (152mm) beyond the frame.
10. Individual damper sections, as well as entire multiple section assemblies must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each section.
11. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle dampers after installation to assure proper operation. On multiple section assemblies, all sections should open and close simultaneously.

Note: When you have a vertical damper installation, blades must be horizontal. When blades need to be vertical, you need a vertical blade damper (example: VCD-23V). These dampers are built so they don't crush the jamb seal.

Damper Maintenance

Greenheck's dampers are designed to be trouble free and hassle free under normal operation. Dampers are to be installed square and straight so as to prevent binding during operation. The following annual damper maintenance suggestions will help to insure proper damper operation and increase the life expectancy of the damper.

Foreign Matter	Over the course of time, dirt and grime may collect on damper surfaces. The damper surfaces should be cleaned to prevent hindrance to airflow.
Moving Parts	Make sure that parts such as linkage, bearings, blades, etc. that are intended to move freely, can do so. Lubricating these components can prevent possible rusting and unnecessary friction increase. Use only a moli-spray oil or similar graphite based oil as regular lubricating oil will attract dirt. *Bearings.* Synthetic, oil impregnated, and ball bearings (without grease fittings) do not require lubrication. Ball bearings with grease fittings require only minimal grease.
Closure	Remove foreign materials that may be interfering with blade closure or effective sealing of the blades with each other or with the frame.
Operation	While operating the damper through its full cycle, check to see that the blades open and close properly. If there is a problem, check for loose linkage, especially at the actuator. Tighten the linkage where required.

Damper Trouble Shooting

The following is a cause and correction list for common concerns with the dampers.		
Symptom	**Possible Cause**	**Corrective Action**
Damper does not fully open and/or fully close	Frame is 'racked' causing blades to bind on jamb seals	Adjust frame such that it is square and plumb
	Actuator linkage loose	Close damper, disconnect power, adjust and tighten linkage
	Defective motor	Replace
	Screws in damper linkage	Locate screws and remove
	Actuator linkage hitting wall or floor	Damper installed too far into wall. Move out to line designated on damper label
	Contaminants on damper	Clean with a non oil-based solvent (see Damper Maintenance)
Actuator runs hot or makes a humming noise	Actuator type is MP-3754 or MP-3756 (stall type actuator)	None required since this normal for stall type actuators
	Actuator prohibited from reaching end of stroke	Disconnect linkage from jackshaft, open damper, power actuator to end of spring, tighten linkage. Verify amp draw.

WARRANTY

Greenheck warrants this equipment to be free from defects in material and workmanship for a period of one year from the shipping date. Any units or parts which prove to be defective during the warranty period will be repaired or replaced at our option. Greenheck shall not be liable for damages resulting from misapplication or misuse of its products. Greenheck will not be responsible for any installation or removal costs. Greenheck will not be responsible for any service work or backcharges without prior written authorization.

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This pressure drop testing was conducted in accordance with AMCA Standard 500-D using the three configurations shown. All data has been corrected to represent standard air at a density of .075 lb/ft³(1.2 kg/m³).

Actual pressure drop found in any HVAC system is a combination of many factors. This pressure drop information along with an analysis of other system influences should be used to estimate actual pressure losses for a damper installed in a given HVAC system.

AMCA Test Figures

Figure 5.3 Illustrates a fully ducted damper. This configuration has the lowest pressure drop of the three test configurations because entrance and exit losses are minimized by straight duct runs upstream and downstream of the damper.

Figure 5.2 Illustrates a ducted damper exhausting air into an open area. This configuration has a lower pressure drop than Figure 5.5 because entrance losses are minimized by a straight duct run upstream of the damper.

Figure 5.5 Illustrates a plenum mounted damper. This configuration has the highest pressure drop because of extremely high entrance and exit losses due to the sudden changes of area in the system.

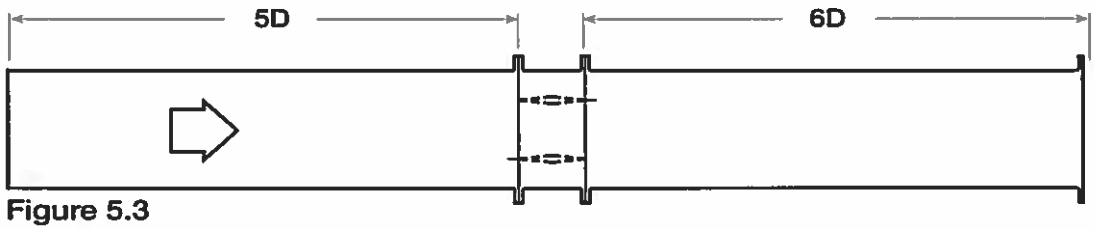


Figure 5.3

Figure 5.2

$$D = \sqrt{\frac{4\,(W)\,(H)}{3.14}}$$

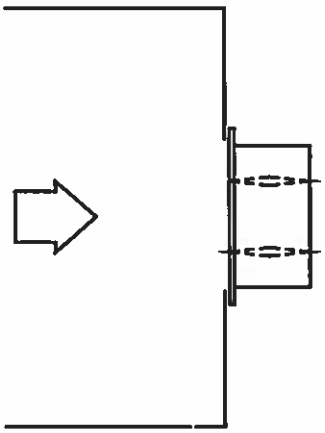
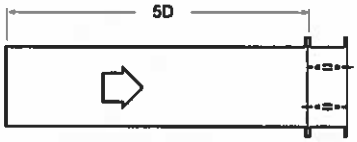


Figure 5.5

AMCA Certified Pressure Drop Data VCD-18, 23 & SEVCD-23

Greenheck Fan Corporation certifies that the model VCD-18, 23 and SEVCD-23 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs.The AMCA Certified Ratings Seal applies to Air Leakage and Air Performance ratings.

AMCA 5.2



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.05
1500	0.11
2000	0.19
2500	0.29
3000	0.41
3500	0.55
4000	0.72

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.10
2500	0.16
3000	0.23
3500	0.30
4000	0.40

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.05
2000	0.09
2500	0.14
3000	0.19
3500	0.27
4000	0.35

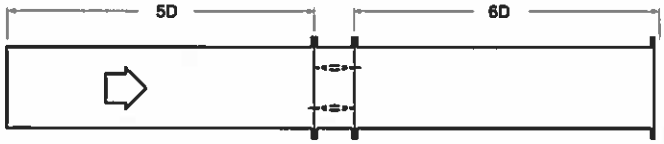
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.04
1500	0.08
2000	0.15
2500	0.22
3000	0.32
3500	0.43
4000	0.56

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.07
2000	0.12
2500	0.18
3000	0.26
3500	0.36
4000	0.47

AMCA 5.3



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.13
2500	0.20
3000	0.29
3500	0.40
4000	0.51

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.04
2000	0.07
2500	0.11
3000	0.15
3500	0.21
4000	0.28

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.02
1500	0.03
2000	0.06
2500	0.09
3000	0.13
3500	0.19
4000	0.25

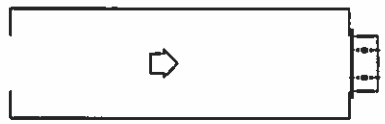
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.07
2000	0.12
2500	0.18
3000	0.26
3500	0.36
4000	0.48

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.10
2500	0.16
3000	0.22
3500	0.30
4000	0.39

AMCA 5.5



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.13
1500	0.30
2000	0.53
2500	0.82
3000	1.19
3500	1.62
4000	2.10

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.26
2000	0.47
2500	0.75
3000	1.04
3500	1.41
4000	1.90

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.02
1000	0.10
1500	0.22
2000	0.40
2500	0.62
3000	0.90
3500	1.23
4000	1.62

12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.27
2000	0.47
2500	0.75
3000	1.07
3500	1.45
4000	1.91

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.28
2000	0.49
2500	0.77
3000	1.12
3500	1.53
4000	2.01

AMCA Certified Leakage Data — VCD-18, 23 & SEVCD-23

Air leakage is based on operation between 32°F (0°C) and 120°F (49°C).
Tested for leakage in accordance with ANSI/AMCA Standard 500-D, Figure 5.5.
Tested for air performance in accordance with ANSI/AMCA Standard 500-D, Figures 5.2, 5.3 and 5.5.

Torque
Data are based on a torque of 5.0 in.lb./ft² (0.56 N·m) applied to close and seat the damper during the test.

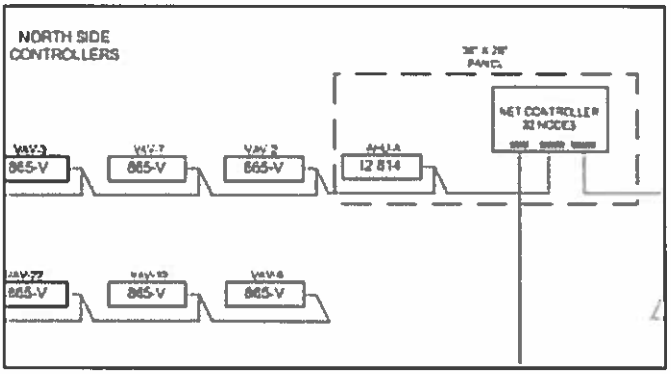
VCD-18, 23 SEVCD-23	Leakage Class*	
Maximum Damper Width	1 in. wg (0.25 kPa)	4 in. wg (1 kPa)
48 in. (1219mm)	1A	1

Greenheck Fan Corporation certifies that the model VCD-18, 23 and SEVCD-23 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs.The AMCA Certified Ratings Seal applies to Air Leakage and Air Performance ratings.

***Leakage Class Definitions**

The *maximum* allowable leakage is defined by AMCA as the following:

- Leakage Class 1A - 3 cfm/ft^2 @ 1 in. wg (class 1A is only defined at 1 in. wg).
- Leakage Class 1
  - 4 cfm/ft^2 @ 1 in. wg
  - 8 cfm/ft^2 @ 4 in. wg
  - 11 cfm/ft^2 @ 8 in. wg
  - 12.6 cfm/ft^2 @ 10 in. wg



Section 4: Project Documents

Sequence of Operations

Drawings

EXECUTION

GENERAL REQUIREMENTS

A. The following general applications software shall be required on all appropriate equipment (i.e. rooftop units, exhaust fans, terminal unit equipment, etc.) for the purpose of optimizing energy consumption while maintaining occupant comfort:

B. Time of Day Scheduling (TOD): The system shall be capable of the following scheduling features:
   1. Scheduling by building, area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes). A weekly repeating schedule, i.e. between 8:00 a.m. and 5:00 p.m., Monday through Friday shall constitute one schedule, not five.
   2. Dated schedule shall be entered up to 9 (nine) years in advance.
   3. Schedules shall be self-deleting when effective dates have passed.
   4. Leap years shall be adjusted automatically without operator intervention.
   5. For maximum speed in the communication of schedules, the operator shall have the ability to communicate schedules at the most efficient level with one scheduling command through the mouse interface. This ranges from system wide to individual zones, groups or pieces of equipment.
   6. The system shall allow the operator to designate any combination of equipment to form a group that can be scheduled with a single operator command through the mouse interface at the workstation. Any designated group shall have the capability to be a member of another group.
   7. The operator shall be able to make all schedule additions, modifications and deletions using the mouse and appropriate dialog boxes. In addition, the operator shall have the capability to edit all schedules off line and then download any or all schedule changes to the control modules with a single operator command through the mouse interface. In the event that a schedule in the control module is different from the workstation, the operator shall have the capability to upload any or all schedules from the control module to the workstation.
   8. The operator shall be able to view a color-coded forecast of schedules for instant overview of facilities schedules. Schedule graphic forecast shall include colored coded indication of all types of schedules, i.e. normal, holiday and override.

C. Optimum Start/Stop (OSS) /Optimum Enable/Disable (OED):
   1. Provide software to start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity in ØF/hour of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable. Temperature compensated peak demand limiting shall remain in effect during morning start up to avoid setting a demand peak.

D. Day/Night Setback (DNS):

1. The system shall allow the space temperature to drift down (up) within a preset (adjustable) unoccupied temperature range. The heating (cooling) shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.
2. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100% outside air units.
3. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room in the building if full DDC control is not being affected.
4. User shall be able to define, modify, or delete the following parameters.
    i. DNS setpoint temperatures(s)
    ii. Temperature band for night heating operation
    iii. Period when the DNS is to be activated

E. Timed Local Override (TLO):
1. The system shall have TLO input points that permit the occupants to request an override of equipment that has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (monetary contact), win-up times, or ON/OFF switches as detailed in the I/O summary.
2. If a push button is used, the system operator shall be able to define the duration of equipment ON time per input pulse and the total maximum ON time permitted. Override time already entered shall be cancelled by the occupant at the input point. If a wind-up timer is used, the equipment will stay in override mode until the timer expires. Year- to- date, month-to-date and current day override history shall be maintained for each TLO input point, History data shall be accessible by the operator at any time and shall be capable of being automatically stored on hard disk and/or printed on a daily basis.

F. Space Temperature Control (STC): There shall be two space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one of the two setpoints shall be operative at any time. The cooling setpoint is operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint. The heating setpoint is operative if the actual space temperature has more recently been equal to or less than the heating setpoint. There are two modes of operation for the setpoints, one for the occupied mode (example: heating = 72° F or 22° C, cooling = 76° F or 24.4° C) and one for the unoccupied mode (example: heating = 55° F or 12.7°C, cooling =90°F or 32° C).

G. The occupied/unoccupied modes may be scheduled by time, date, or day of week.
1. If the actual space temperature is in the dead band between the heating setpoint and the cooling setpoint, the color displayed shall be green for the occupied mode, representing ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing "after-hours" conditions.
2. If the space temperature rises above the cooling setpoint, the color shall change to yellow.

3. When space temperature falls below the heating setpoint, the color shall change to light blue.
4. All setpoints and off sets shall be operator definable. When in the occupied mode, startup mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.
5. When comfort conditions are warmer than ideal, indicated by the color yellow a request for additional cooling shall be sent over the network to other cooling equipment in the HVAC chain, such as a chiller. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
6. When comfort conditions are cooler than ideal; indicated by the color light blue, a request for additional heating shall be sent over the network to other heating equipment in the HVAC chain, such as a boiler. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
7. The cooling (and heating) setpoints may be increased (decreased) under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of setpoint increase (decrease) for each of the three levels. Each space temperature sensor in the building may be programmed independently.
8. An optimum startup program transitions from the unoccupied setpoints to the occupied setpoints. The optimum startup algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope (AI: Space Temperature).
9. A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers (and heating coil valve or heating stages in sequence) to achieve the setpoint target.

VAV RTU AND AHU FAN (DISCHARGE DUCT) STATIC PRESSURE SETPOINT OPTIMIZATION

A. The building automation system (BAS) shall continuously monitor the damper position of all VAV terminal units. The discharge duct static pressure shall be sensed directly at the discharge of each AHU and RTU. The sensor must be mounted in a non-turbulent location.
B. When any VAV damper is more than 95% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset upward by 0.1 in W.C. (adj.) at a frequency of 15 minutes (adj.) until one of the following occur:
    1. No damper is more than 95% open.

2. The static pressure setpoint has reset upward to the system maximum duct static pressure setpoint.
3. The AHU and RTU variable-frequency drive is at the maximum speed setting.

C. When all VAV dampers are less than 85% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset downward by 0.1 in W.C. (adj.) at a frequency of 15 minutes (adj.) until one of the following occur:
   1. At least one damper is more than 65% open or the static pressure setpoint has reset downward to the system minimum duct static pressure setpoint.
   2. The AHU and RTU variable-frequency drive is at the minimum speed setting.

D. The control bands, setpoint increment values, setpoint decrement values and adjustment frequencies shall be adjusted to maintain maximum static pressure optimization with stable system control and maximum comfort control.

E. The BAS shall have the capability of performing the following functions:
   1. Allow the operator to exclude "problem" zones that should not be considered when determining the optimized setpoint.
   2. Read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
   3. Identify, and display to the user, the VAV box that serves the Critical Zone (that is, the zone with the most wide-open VAV damper). This information shall update dynamically as the location of the Critical Zone changes based on building load, and duct static pressure setpoint optimization control.

F. During the commissioning process, the ATC Subcontractor shall demonstrate the performance of fan pressure optimization.

VENTILATION OPTIMIZATION

A. The AHU and RTU outdoor-air damper shall be controlled to deliver required outdoor airflow at all load conditions during the occupied mode. The outdoor airflow setpoint for each AHU and RTU shall be as scheduled on the drawings or shall be as indicated in its sequence of operations contained in this Section. The actual outdoor airflow shall be sensed at the outdoor air intake.

B. The building DDC system shall include a time-of-day schedule to indicate whether the AHU and RTU is in the occupied mode or the unoccupied mode. When the schedule indicates that the AHU and RTU is in the unoccupied mode, the required outdoor airflow for the system shall be zero. When the schedule indicates that the AHU and RTU is in the occupied mode, the required outdoor airflow for the AHU and RTU shall equal the design minimum outdoor airflow rate, unless one of the following is true:
   1. The AHU and RTU serves one or more zones or spaces equipped with a carbon dioxide (CO2) sensor.
      i. For those zones equipped with a CO2 sensor, the required outdoor airflow for the zone shall be continuously calculated using the measured CO2 concentration as an indicator of the current per person ventilation rate.

2. Ambient conditions are such that the AHU and RTU is operating in the economizer mode.

C. If an AHU and RTU serves one or more zones or spaces equipped with a CO2 sensor the DDC system shall modulate the outdoor air and return air dampers as follows:
   1. If the CO2 level in all spaces containing CO2 sensors are below setpoint, then the outdoor air damper shall be placed in its low occupancy minimum outdoor position. The low occupancy minimum outdoor air position for each AHU and RTU is indicated in the AHU and RTU Schedules on the Drawings or is indicated in its sequence of operations contained in this Section.
   2. If the CO2 level in any space rises above setpoint, and its terminal box primary air damper is in its maximum position, then the DDC system shall increase the unit's outdoor air quantity in 1% increments every 30 seconds until all space CO2 levels are 50 ppm (adjustable) below their setpoint or the high occupancy minimum outdoor air position is reached.
   3. If the CO2 level in all spaces is below setpoint, the DDC system shall reduce the unit's outdoor air quantity in 1% increments every 30 seconds until any space CO2 level rises to within 25 ppm (adjustable) of its setpoint or the unit's low occupancy outdoor air position is reached.

D. The CO2 setpoint in each space shall be one of the following:
   1. An Owner determined setpoint.
   2. A DDC determined setpoint t that is 500 ppm above the outdoor air CO2 concentration level as measured and averaged by two CO2 sensors.

E. If a space or zone containing a CO2 sensor is served by a VAV terminal box or fan powered terminal box and its CO2 level rises above setpoint, the DDC system shall increase the terminal box primary air damper position in increments of 25 cfm every 15 seconds until space CO2 drops to a level of 50 ppm (adjustable) below its setpoint or the terminal box primary air damper reaches its maximum position. The DDC system shall not adjust/modulate the AHU and RTU outdoor air damper from its low occupancy minimum outdoor air position until the terminal box primary air damper reaches its maximum position and the space CO2 level continues to remain above setpoint for a time period of 90 seconds (adjustable).

F. The DDC system shall not request a quantity of outdoor air that is above the AHU and RTU high occupancy minimum outdoor air position/quantity unless the current outdoor air temperature and humidity conditions permit economizer use and a system need for cooling exists.

PUMP PRESSURE SETPOINT OPTIMIZATION

A. This operating sequence shall apply to the building hot water pumps and the building chilled water pumps that are provided with variable frequency drives.

B. The building automation system shall continuously monitor the control valve position of all air handling units.
   1. At system startup, the pump pressure setpoint shall be 100% of the maximum pressure setpoint.

2. When any control valve is more than 95% (adjustable) open, the pump pressure setpoint shall be reset upward by 10% (adjustable) of the current pump pressure setpoint at a frequency of every 2 minutes (adjustable) until one of the following occur.
    i. No control valve is more than 95% open (adjustable).
    ii. The pump pressure setpoint has reset upward to the system maximum setting.
    iii. The pump variable frequency drive(s) are at their maximum setting.
3. When all system control valves are less than 85% open (adjustable), the pump pressure setpoint shall be reset downward by 5% (adjustable) of the current pump pressure setpoint at a frequency of every 2 minutes (adjustable) until one of the following occur:
    i. At least one control valve is more than 85% open (adjustable).
    ii. The pump's flow rate is equal to the chiller(s) or boiler(s) minimum flow rate.
    iii. The pump variable frequency drive(s) are at their minimum setting.
4. The control bands, setpoint increments, setpoint decrements, and adjustment frequencies shall be adjusted to maintain maximum pump pressure optimization with stable system control.

FIREFIGHTERS SMOKE CONTROL STATION AND INDICATOR PANEL (FSCS)

A. Provide a Firefighters Smoke Control Station and Indicator Panel (FSCS) to allow for firefighter monitoring and automatic or manual control of all HVAC smoke control devices (smoke supply and exhaust fans, stair pressurization supply fans, dampers, and smoke control devices). The wall mounted panel shall be a schematic representation, in plain English, that defines the location and status of all HVAC equipment smoke control devices.
B. The FSCS shall have the highest priority control over all smoke control systems and equipment. FSCS control shall override or bypass other building controls such as hand-off-auto and start/stop witches located on fan motor controllers, freeze detection devices, and duct smoke detectors.
C. The FSCS shall provide status indication and fault condition indication via pilot lights. Manual control of all smoke-control system components shall be provided at the FSCS. Status indicators and controls shall be arranged and labeled to convey the intended system objectives. Provision shall be included for testing the pilot lamps on the FSCS smoke-control panel(s) by means of one or more "LAMP TEST" momentary push buttons.
D. "On" status for supply or exhaust fans shall be sensed by a pressure difference across each fan. Positive status indication (fully open and fully closed) of for smoke damper position shall be via end switches at each damper.
E. All HVAC fans and dampers, controlled devices, and controls required for complete operation of the smoke control sequences shall be on emergency power.
F. The ATC contractor and HVAC Contractor shall demonstrate successful operation of all smoke control systems.
G. AHU-1, SF-1, SF-2 related system dampers, and related system smoke dampers are a part of the building smoke control system. For definition of system and component operation, refer to the control sequences for each device.

EGRESS CORRIDOR PRESSURIZATION:

A. AHU-1 and the associated system smoke dampers are a part of this system. For definition of system and component operation, refer to the control sequences for each device. All smoke dampers shall be UL 555 rated.
B. Monitor each duct smoke detector condition at each supply air fan discharge. If smoke is detected at any given supply fan, de-energize the fan and indicate a "smoke at supply fan discharge" alarm condition, for the device, at the FSCS. Allow for manual override of the smoke detector shutdown at the FSCS.
C. At the FSCS provide:
    1. ON/OFF/AUTO control of each supply fan
    2. OPEN/CLOSED control for each automatic control air damper which will override the sequence of control the damper.
    3. OPEN/CLOSED control for each smoke damper.
D. When smoke is detected in a given corridor, via ceiling mounted smoke detectors, the corridor is indexed via the HVAC DDC system as a "smoke condition level (SCL)". Any single building corridor floor level directly above and/or below an SCL, if not an SCL, is given the nomenclature "pressurization control level or PCL." Coordinate with the Fire Alarm Contractor to obtain a signal from the smoke detector(s) on each floor level. The ATC Contractor shall run wiring to a location as dictated by the Fire Alarm Contractor. The Fire Alarm Contractor shall make all final connections to the Fire Alarm System.
E. SCL floors: The supply air smoke control dampers shall be closed at this floor, and the exhaust air smoke control air dampers shall be open.
F. PCL floors: The supply air smoke control dampers shall be open, and the exhaust air smoke control dampers shall be closed.
G. Vary the speed of each supply fan, via adjustable frequency drive to limit the supply duct static pressure within the shaft or duct main. Confirm that the installed location for each duct static pressure sensor is not isolated via smoke dampers, or provide additional duct static pressure sensors dedicated for smoke control mode only.

HOT WATER SYSTEM

A. The building hot water system shall be controlled via the building DDC system and the boiler master controller. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
    1. The boiler manufacturer will furnish a boiler master controller to control the operation of the hot water plant in conjunction with the DDC system. The ATC Subcontractor shall coordinate his control requirements with the requirements of the boiler master controller described in Division 23 Section "Condensing Boilers."
B. Three new condensing type boilers shall supply hot water to the areas in the building being renovated via three integral primary (boiler) pumps – one each per boiler – and two secondary (building) pumps.

C. The ATC Subcontractor shall provide all field labor to install all sensors shipped loose by the boiler manufacturer. In addition, the ATC Subcontractor shall provide all field labor, wiring and conduit to connect all sensors shipped loose to the boiler master controller.

D. The ATC Subcontractor shall provide controls necessary for the DDC system to perform the following:

1. The DDC system shall activate and de-activate the heating system as follows:
    a) When the building is occupied, the DDC system shall send a signal to the boiler master controller to activate the heating system.
    b) When the building is unoccupied and the outside air temperature drops below 60°F (adjustable), the DDC system shall send a signal to the boiler master controller to activate the heating system.
    c) When the building is unoccupied and the outside air temperature rises above 65° F (adjustable), the DDC system shall send a signal to the boiler master controller to de-activate the heating system.
    d) Provide an edit point at the DDC panel and/or at the DDC system operator's workstation to allow an authorized operator to manually override the DDC system to energize or de-energize the heating system. The override shall have an adjustable time period. The override point shall be accessed and addressed at the DDC system operator's workstation or remotely via web access. When this event occurs, a message shall be recorded at the DDC system operator's workstation.
2. When the DDC system sends a signal to the boiler master controller to activate the heating system, the DDC system shall start the lead building loop (secondary) hot water pump. A differential pressure sensor mounted in the branch piping between the building loop (secondary) hot water pumps and the hydraulically most remote outlet shall control the speed of the lead building loop hot water pump.
    a) If the lead secondary (building) pump fails to start (or fails during operation) as proven by a current switch, an alarm shall be sent to the DDC system operator's workstation, informing the operator of the malfunction. The signal to the original lead secondary (building) pump shall be disabled through DDC. The DDC system shall then send a signal for the lag/standby secondary (building) pump to start.
    b) The DDC system shall contain a run time program to automatically rotate the lead and lag/standby secondary (building) pumps when the accumulated run time exceeds predetermined number of hours. Ensure that the first lead secondary (building) pump is stopped before the new lead secondary (building) pump is started. Only one secondary (building) pump shall be energized at any one time.
3. When the DDC system indicates that the heating system shall be activated, the boiler master controller shall determine which boiler shall be activated. Refer to Division 23 Section "Condensing Boilers" for requirements.

E. A boiler master controller will be furnished by the boiler manufacturer for lead-lag control of boilers, for modulating and on-off burner control, for reset of hot water supply temperature in accordance with outdoor air temperature, for monitoring and alarming high boiler water pressure, and for on-off control of the integral primary (boiler) blend pumps. The boiler master controller shall include the following components, functions and capabilities:

1. Sensors for system hot water return temperature, hot water supply temperature at the outlet of each boiler, hot water supply temperature to the load (building), and outside air temperature.
2. When it receives a signal from the DDC system to activate the heating system, the boiler master controller shall energize the integral primary (boiler) pump associated with the lead boiler. Once it determines that flow is proven through the lead boiler, the boiler master controller shall energize the lead boiler and control its burner.
    a) The boiler master controller shall also determine through its optimization program when each of the two lag boilers should be energized.
    b) When a boiler is de-energized by the boiler master controller, its integral primary (boiler) pump shall continue to operate for a period of thirty (30) minutes (adjustable) before it too is de-energized by the boiler master controller.
3. The boiler master controller shall extend the burner firing periods to increase seasonal efficiency by reducing burner on-off cycles and avoiding thermal losses with excessive pre-purge and post-purge cycles. The boiler master controller shall adjust boiler response to load changes by analyzing building return water temperature, outside air temperature, boiler hot water supply temperature and building supply water temperature.
4. The boiler master controller shall alternate the designation of the lead boiler and the two lag boilers after 250 hours (adjustable) of cumulative firing time of the lead boiler.
5. The boiler master controller shall have a display on the front panel that shall indicate the following conditions:
    a) Heating system enable
    b) Boiler 1 enable
    c) Boiler 2 enable
    d) Boiler 3 enable
    e) Boiler 1 down on failure condition
    f) Boiler 2 down on failure condition
    g) Boiler 3 down on failure condition
    h) Primary (boiler) pump 1 failure
    i) Primary (boiler) pump 2 failure
    j) Primary (boiler) pump 3 failure
    k) High boiler water pressure
6. The boiler master controller shall generate a line voltage on-off switched signal and a 135 ohm or "4-20 ma" modulating signal for each burner.

7. The boiler master controller shall energize one of the two lag/standby boilers if the lead boiler has a flame failure or other safety shutdown.
8. The boiler master controller shall control the operation and firing of the boilers to control the building loop hot water supply temperature (to load) as follows:

Hot Water Supply Temperature	Outside Air Temperature
140°F (adjustable)	15°F and below (adjustable)
135°F (adjustable)	30° F (adjustable)
130°F (adjustable)	40° F (adjustable)
120°F (adjustable)	50° F (adjustable)
120°F (adjustable)	60° F (adjustable)
110°F (adjustable)	70°F and above (adjustable)

9. The boiler master controller shall stage the three boilers on and off in an energy efficient manner.
10. A boiler pressure transducer shall monitor boiler water pressure to avoid relief valve weeping or opening caused by failure of pressure regulating valve on glycol feed unit make-up line or caused by incorrect pressurization of the bladder-type expansion tank. A common manual reset alarm light shall be provided.

F. The ATC Subcontractor's field technician shall coordinate with the Boiler manufacturer's factory certified technician during startup. The ATC Subcontractor's field technician shall be available to the Boiler manufacturer's factory certified technician during his necessary testing procedure as outlined in Division 23 Section "Condensing Boilers."

G. The ATC Subcontractor shall provide the interlock wiring at the boiler as required by the boiler manufacturer including but not limited to the low water cut-off, high limit, main gas valve proof of closure switch, safety gas valve, high and low gas switches, and to the boiler master controller.

H. The boiler manufacturer will furnish a boiler master controller that is BACNET compatible. The ATC Subcontractor shall connect the DDC system to the boiler master controller to monitor operation of the heating system and to adjust setpoints.
   1. If the ATC system is no BACNET compatible, the ATC Subcontractor shall provide an interface device that will provide full compatibility between the ATC system and the boiler master controller.

I. The ATC Subcontractor shall provide break-glass switches where indicated. The switches shall be wired to de-energize the boilers and domestic hot water heaters when the switches are in an alarm condition.

J. DDC Points List for Heating System:
   1. AI – Outside Air Temperature
   2. AI – Building Loop Hot Water Supply Temperature (downstream of the secondary pumps)
   3. AI – Boiler Loop hot Water Supply Temperature, (one at each boiler, 3 required)
   4. AI – Building Loop hot Water Return Temperature (located in the common return)
   5. AO – Variable Speed signal to Secondary (Building) Pump (2 Required)

6. DI – Boiler Status(each boiler)
7. DI – Hot Water Pump Status (each pump)
8. DI – Boiler Water Flow Switch, Differential Pressure Type (each boiler)
9. DI – Boiler Emergency Shutdown Alarm
10. DI – Domestic Hot Water Boiler Status
11. DI – Boiler Alarm (each boiler)
12. DO – Boiler Start/Stop (each boiler)
13. DO – Boiler High Stage Control (each boiler)
14. DO – Boiler Low Stage Control (each boiler)
15. DO – Hot Water Pump Start/Stop (each pump)

CHILLED WATER SYSTEM WITH ICE STORAGE

A. The chilled water system shall consist of one air cooled rotary screw chiller, two constant speed primary (chiller loop) chilled water pumps, two variable speed secondary (building loop) chilled water pumps, and three ice storage tanks.
B. The chiller will be furnished with microprocessor-based controls along with an interface device. The chiller's microprocessor-based controls will have a chiller optimization program that will control the operation of the chiller when the DDC system requests the chiller to operate. The ATC Subcontractor and the chiller manufacturer shall coordinate their controls to provide a fully functional system that shall operate according to the sequence described herein.
C. The building DDC system shall start the chilled water system according to any of the following conditions:
    1. The DDC system time schedule determines that the building is in the occupied mode.
    2. The DDC system time schedule determines that the ice making mode shall start.
    3. The chilled water supply temperature has risen more than 5 F (adjustable) above a setpoint of 38 F (adjustable).
D. The chilled water system shall de-energize when the building is in the unoccupied mode, the chiller is not in the ice making mode, all AHUs and RTU chilled water valves are open less than 5% for more than 10 minutes, and the chiller has run a minimum of 30 minutes. Maintain chiller minimum and maximum *"On and Off"* times (Refer to *"Off"* mode as described in this article).
E. The DDC system in conjunction with the chiller manufacturer controls shall enable the chillers to run on a lead-lag basis to provide equal run-time on the chillers. The compressor staging of the chillers shall be controlled via the chiller manufacturer's microprocessor-based controls. The chiller manufacturer's microprocessor-based controls shall stage the chillers to provide the most efficient chiller loading.
F. Prior to a chiller becoming enabled, its primary (chiller loop) chilled water pump shall start. Once flow is proven via a differential pressure sensor the chiller shall start.
    1. If a chiller's primary chilled water pump fails to start or operate as proven by a differential pressure sensor after 30 seconds (adjustable), an alarm shall be sent to the central site after 30 seconds (adjustable) informing the operator; and the standby pump shall be indexed to start. When that occurs, the 2-way, 2-position automatic control

valves that isolate the failed pump shall close and the2-way, 2-position automatic control valves that isolate the stand-by pump shall open.

2. The DDC system shall contain a run time program to automatically rotate the lead and lag/standby secondary (building) pumps when the accumulated run time exceeds a predetermined number of hours. Ensure that the first lead secondary (building) pump is stopped before the new lead secondary (building) pump is started. Only one secondary (building) pump shall be energized at any one time.

G. The chiller sequencing software shall include the following:
   1. Chiller plant system scheduling
   2. Color graphic based chiller plant status screens
   3. Color graphic based chiller status screens
   4. System and chiller diagnostic messages
   5. System and chiller reports
   6. Ice hours remaining
      i. The control system shall continually calculate the hours of ice remaining based upon the current load and historical data. The calculation shall be based upon ice tank level, current rate of consumption, current load and historical depletion rates.

H. General Modes of Operation: The system shall be capable of operating in six different modes:
   1. Cooling Mode – ***Water Chiller only Operation*** to cool the building: During the cooling mode with the chiller, the ice cells are bypassed (V1 is closed to flow through the ice storage tanks and V2 is open for full flow from the primary pumps/chillers. The chiller leaving water temperature is 38° F. The chillers modulate to maintain 38° F leaving water temperature (LWT). One or two primary chilled water pumps, one or two chillers, and the lead secondary chilled water pump are running. The lead secondary pump is operationed/controlled by a VFD and pressure transducer that is located in the branch piping.
   2. Cooling Mode – ***Ice Melting only Operation*** to cool the building: In the cooling mode using only ice storage tanks, the chillers are not operating. The lead secondary chilled water pump is operating. Valve V1 is positioned to permit full flow through the ice storage tanks and valve V2 is modulating to maintain design chilled water temperature to the secondary loop at 38°F. The lead secondary pump is operated/controlled by a VFD and pressure transducer that is located in the branch piping.
   3. Cooling Mode – **Water Chiller Operation and Ice Melting Operation** to cool the building: During the cooling mode with the chiller (s) operating and ice in the ice storage tanks being melted, valve V1 is open to permit full flow through the ice storage tanks and valve V2 is open to permit full flow to the secondary pumps. One or both air cooled chillers will operate with a LWT target of 46°F (adjustable) and then valve V1 will modulate the chilled water flow through the ice storage tanks to produce a LWT of 38°F. The lead secondary chilled water pump will operate and valve V2 will be open for full cooling to the building. The lead secondary pump is operated/controlled by a VFD and pressure transducer that is located in the branch piping.

4. Ice Making Mode – ***Water Chiller Operation to recharge the Ice Storage Tanks***: In the ice making mode, both chillers will operate at full load for the duration. Both primary chilled water pumps are operating. The lead secondary chilled water pump is not operating. Valve V1 is open to the ice storage tanks for full flow through the tanks and valve V2 is closed to the bypass to prevent flow to the secondary (building) loop. The chillers shall shut down when chiller LWT drops to 22° F (adjustable), indicating that the ice storage tanks are at 100% of capacity.
5. Ice Making Mode – **Simultaneous Water Chiller Operation to recharge the Ice Storage Tanks and Ice Melting to cool the building:** In the ice making and cooling mode, valve V1 is positioned to permit full flow through the ice storage tanks and valve V2 modulates to maintain design chilled water supply temperature of 38°F (to the secondary (building) loop. Both chillers will operate at full load during the ice making mode. Both primary chilled water pumps will operate. The lead secondary chilled water pump will operate and modulate to maintain building differential pressure. The chillers shall shut down when chiller LWT drops to 22°F (adjustable), indicating that the ice storage tanks are at 100% of capacity. At this point, the system will switch to the cooling mode chiller only operation to cool the building. The lead secondary pump is operated/controlled by a VFD and pressure transducer that is located in the branch piping.
6. System Off: The chilled water system will be shut down. Both chillers and all primary chilled water pumps and all secondary chilled water pumps will not operate.

In each mode the automation system shall control the chiller/thermal storage system as indicated in the following table and descriptions:

Mode Control Table:

Chiller Plant Cooling Function	*Chiller*	*Chiller Ice Tank Pump*	*Distribution Pump*	*Ice Bank Control Valve V1*	*Distribution Control Valve V2*
Chiller only cooling	On	On	On	Bypass Tanks	Open to Primary Loop
Ice Tank only cooling	Off	Off	On	Modulating	Open to Primary Loop
Simultaneous Chiller Cooling & Ice Tank Cooling	On	On	On	Modulating	Open to Primary Loop
Ice Tank Charging	On	On	Off	Open to Tanks	Bypass to Primary Loop
Simultaneous ice Tank Charging & Ice Tank				Open to	

Cooling	On	On	On	Tanks	Modulating
Off	Off	Off	Off	Off	Off

l. Occupied Mode: When the building DDC system indexes the chilled water system to the Occupied mode, the following shall occur:

1. The lead building loop (secondary) chilled water pump shall operate. A local differential pressure sensor, reset by a differential pressure sensor mounted 2/3 the distance between the pump and the most remote outlet, shall control the speed of the lead building loop (secondary) chilled water pump.
    a. If the lead building loop (secondary) chilled water pump fails to start or operate as proven by a differential pressure sensor after 30 seconds (adjustable), an alarm shall be sent to the central site after 30 seconds (adjustable) informing the operator and the standby building loop chilled water pump shall be indexed to start.
    b. The base differential pressure setpoint will be determined during the water balancing of the system.
    c. The required base differential pressure setpoint will be conveyed in writing to the controls contractor.
    d. Refer to the "Pump Pressure Setpoint Optimization" article in this Section for additional control requirements for the operation of the secondary chilled water pump.
2. The chilled water system shall operate in one of the following operating modes when the system is in the Occupied mode.
    a. Occupied Operating Mode #1 (Default Mode): Under this occupied operating mode, the lead chiller and its associated primary chilled water pump shall operate and shall be the first stage of chilled water system cooling, the lag chiller and its associated primary chilled water pump shall operate and shall be the second stage of chilled water system cooling, and melting ice in the ice storage tanks shall be the third stage of chilled water system cooling in order to maintain the building (secondary) loop chilled water supply temperature setpoint at 38 degrees F (adjustable). The lead secondary (building) chilled water pump shall also operate.
        1) When either one or both chillers are operating but ice melting is not required to take place in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled **"Cooling Mode --- Water Chiller only Operation to Cool the Building."**
        2) When both chillers are operating and ice melting is required to take place in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled **"Cooling Mode –**

Water Chiller Operation and Ice Melting Operation to Cool the Building."

3) This shall be the default mode of operation during the occupied mode. At the beginning of each day, the DDC system shall automatically index the system into this occupied operating mode and a change from this mode for that day must be done manually.

b. Occupied Operating Mode #2 (Moderate Cooling Load Day): Under this occupied operating mode, the lead chiller and its associated primary chilled water pump shall operate and shall be the first stage of chilled water system cooling, melting ice in the ice storage tanks shall be the second stage of chilled water system cooling, melting ice in the ice storage tanks shall be the second stage of chilled water system cooling, and the lag chiller and its associated primary chilled water pump shall operate and shall be the third stage of chilled water system cooling in order to maintain the building (secondary) loop chilled water supply temperature setpoint at 38 degrees F (adjustable). The lead secondary (building) chilled water pump shall also operate. (Note: Use of this mode could be considered on a day when a moderate cooling load is expected).

1) When only one chiller is needed to operate and ice melting is not necessary in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled "Cooling Mode – Water Chiller only Operation to Cool the Building."

2) When one chiller is operating and ice melting is required to take place in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled **"Cooling Mode – Water Chiller Operation and Ice Melting Operation to Cool the Building."**

3) When both chillers are needed to operate and icemelting is required to take place in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled **"Cooling Mode – Water Chiller Operation and Ice Melting Operation to ool the Building."**

4) If this is the desired occupied mode of operation for a particular day, the DDC system must be manually indexed to this mode either at the beginning of the day or sometime during the day in order for the system to be changed from Occupied Operating Mode #1 to this occupied operating mode. At the end of that particular day, the DDC system shall be automatically indexed back into Occupied Operating Mode #1.

c. Occupied Operating Mode #3 (Low Load Cooling Day): Under this occupied operating mode, melting ice in the ice storage tanks shall be the first stage of chilled water system cooling, the lead chiller and its associated primary chilled water pump shall operate and

shall be the second stage of chilled water system cooling, and the lag chiller and its associated primary chilled water pump shall operate and shall be the third stage of chilled water system cooling in order to maintain the building (secondary) loop chilled water supply temperature setpoint at 38 degrees F (adjustable). The lead secondary (building) chilled water pump shall also operate. (Note: Use of this mode could be considered on a day when a low cooling load is expected).

1) When only ice melting is necessary in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation entitled **"Cooling Mode – Ice Melting Only Operation to Cool the Building."**
2) When both ice melting and the operation of the lead chiller are necessary in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation **entitled "Cooling Mode – Water Chiller Operation and Ice Melting Operation to Cool the Building."**
3) When ice melting and the operation of both chillers are necessary in order to maintain the building (secondary) loop chilled water supply temperature at setpoint, the system shall be controlled as described in the General Mode of Operation **entitled "Cooling Mode – Water Chiller Operation and Ice Melting Operation to Cool the Building."**
4) If this is the desired occupied mode of operation for a particular day, the DDC system must be manually indexed to this mode either at the beginning of the day or sometime during the day in order for the system to be changed from Occupied Operating Mode #1 to this occupied operating mode. At the end of that particular day, the DDC system shall be automatically indexed back into Occupied Operating Mode #1.

J. Unoccupied Mode: When the building DDC system indexes the chilled water system to the Unoccupied mode, the following shall occur:

1. The lead building loop (secondary) chilled water pump shall operate. A local differential pressure sensor, reset by a differential pressure sensor mounted 2/3 the distance between the pump and the most remote outlet, shall control the speed of the lead building loop (secondary) chilled water pump. The building automation system shall continuously monitor the chilled water control valve position of all air handling units.
   a. If the lead building loop (secondary) chilled water pump fails to start or operate as proven by a local differential pressure sensor after 30 seconds (adjustable), an alarm shall be sent to the central site after 30 seconds (adjustable) informing the operator and standby building loop chilled water pump shall be indexed to start.
   b. Refer to the ***"Pump Pressure Setpoint Optimization"*** article in this Section for additional control requirements for the operation of the secondary chilled water pump.

2. Non-Ice Making Mode: The building DDC system in conjunction with the chiller controls shall control the chilled water system as follows:
    a. If ice is still available, the system shall controlled as described in the General Mode of operation entitled ***"Cooling Mode – Ice Melting only Operation to Cool the Building"*** and ice shall be melted in order to maintain chilled water supply temperature setpoint of 45 degrees F (adjustable).
    b. If ice is not available, the system shall be controlled as described in the General Mode of Operation entitled "Cooling Mode – Water Chiller only Operation to Cool the Building" and the lead chiller shall operate to maintain building chilled water supply temperature setpoint of 45 degrees F (adjustable).
3. Ice Making Mode: The building DDC system in conjunction with the chiller controls shall control the chilled water system as follows:
    a. If building chilled water supply temperature is below setpoint of 45 degrees F (adjustable), the system shall be controlled as described in the General Mode of Operation entitled "Ice Making Mode – Water Chiller Operation to recharge the Ice Storage Tanks" in order to make ice and charge the ice storage tanks.
    b. If building chilled water supply temperature is above setpoint of 45 degrees F (adjustable), the system shall be controlled as described in the General Mode of Operation entitled "Ice Making Mode – Simultaneous Water Chiller Operation to recharge the Ice Storage Tanks and Ice Melting to cool the Building" in order to make ice and charge the ice storage tanks and to maintain the building chilled water supply temperature setpoint of 45 degrees F (adjustable).
4. Ice making shall begin daily at 2100 hours (adjustable) in the capacity of ice stored in any single ice storage tank is below 85% (adjustable). Ice making shall end daily whenever all ice storage tanks reach full capacity or at 0700 hours the following morning (adjustable).

K. The remaining hours of ice inventory shall be continually calculated and updated on a graphics screen. An alarm shall be triggered when the ice inventory gets to a critical level. This calculation shall be made based upon ice tank levels, current chilled water demand, and historical depletion data.

L. Each ice storage tank shall be provided with a sensor that shall have the capability of determining the quantity of ice remaining in the tank.

M. In addition to the secondary (building-loop) pumps, each primary (chiller-loop) pump shall be provided with a variable frequency drive. Unlike the secondary (building-loop) pumps, the primary (chiller-loop) pump shall not vary once its speed is determined through the wate balancing operation. The primary (chiller-loop) pumps shall operate at constant speed and the variable frequency drive shall be used for balancing purposes only.

N. The ATC contractor shall provide all wiring and conduit for factory provided controls shipped loose for field installation. Coordinate requirements with the chiller manufacturer or his supplier.

O. DDC Points for the Chilled Water System: In addition to the points indicated below, refer to Division 23 Section" Scroll Water Chillers" for additional points that shall be incorporated into the building DDC system.
   1. AI – Chiller Supply Temperature
   2. AI – Chiller Return Temperature
   3. AI – Building Loop Chilled Water Supply Temperature
   4. AI – Building Loop Chilled Water Return Temperature
   5. AI – Chiller Loop Chilled Water Supply Temperature
   6. AI – Chiller Loop Chilled Water Return Temperature
   7. AI – Chilled Water System Differential Pressure
   8. AI – Chiller Amps
   9. AI – Chiller Loop Chilled Water Supply Flow
   10. AI – Ice Tank Level (typical of 3)
   11. DI – Chiller Loop Chilled Water Pump Status (each pump)
   12. DI – Building Loop Chilled Water Pump Status (each pump)
   13. AO – Building Loop Chilled Water Pump Speed (each pump)
   14. DI – Chiller Fault Alarm from Chiller Mfg. Panel
   15. AO – Chiller CHWS Reset Signal
   16. AO – Ice Tank 3-way control valve (V-1)
   17. AO – Distribution 3-way control valve (V-2)
   18. DO – Chiller Enable
   19. DO – Chiller Loop Chilled Water Pump Start/Stop (each pump)
   20. DO – Building Loop Chilled Water Pump Start/Stop (each pump)

P. Software/calculated points available for display on graphics:
   1. Chiller Design Flow
   2. Chiller Design Capacity
   3. Chilled Water Flow Status
   4. Current Limit Setpoint
   5. Compressor Current Draw
   6. Compressor Power
   7. Chiller Enable/Disable
   8. Chiller Status
   9. Chiller Available
   10. Chiller Failure 1
   11. Chiller Mode (Ice Making)
   12. Minimum Condenser Pressure Differential
   13. Chiller Operating Mode
   14. Communication Status
   15. Hours of Ice Inventory Remaining

Q. Coordinate the control system requirements with the requirements described in Division 23 Section "Scroll Water Chillers."

Note: Chilled Water Section revised on 7/16/2014/mt, per Nick Duncan

VARIABLE AIR VOLUME AIR HANDLING UNITS AHU-2 and RTU-1

A. The variable air volume (VAV) air handling unit (AHU) and the VAV rooftop unit (RTU) shall be controlled via DDC type controls. The Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. The VAV AHU and the VAV RTU each consist of an outside-air damper, return air damper, hot water heating coil, chilled water cooling coil, supply fan with variable frequency (VF) drive, and an exhaust/relief fan with VF drive. The VAV AHU and the VAV RTU shall be controlled by a DDC controller furnished by the Subcontractor. Actuators shall be electronic.
    1. Each unit shall be provided with an airflow station mounted in the outdoor airstream to measure the exact amount of outdoor air the unit introduces into the system. The HVAC Trade shall determine whether the ATC subcontractor or the VAV AHU and VAV RTU manufacturer shall provide the airflow station.
C. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the VAV AHU and VAV RTU for the warm-up mode prior to the areas they serve being occupied. The start/stop optimization program and time schedule program shall also determine when to de-energize the VAV AHU and VAV RTU.
D. When the VAV AHU and/or VAV RTU is indexed to the warm-up or cool-down mode, the DDC system shall control it according to the following sequence:
    1. During the warm-up mode:
        i. The supply fan(s) shall be de-energized.
        ii. The outside air damper shall be closed and its return air damper shall be open.
        iii. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
        iv. The chilled water cooling coil control valve shall be closed to the coil.
        v. The hot water heating coil control valve shall be closed to the coil.
        vi. All warm-up modes' heating shall be accomplished by the fan powered terminal boxes and VAV terminal boxes and their associated reheat coils according to the sequences described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" and "Variable Air Volume Terminal Boxes with Hot Water Reheat Coils" articles in this Section.
    2. During the cool-down mode:
        i. The supply fan(s) shall be energized and shall run continuously while in the morning cool down mode.
            1) A static pressure sensor, mounted 2/3 the distance from the VAV AHU or VAV RTU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing

operations. Refer to the article entitle "VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization" in this Section for additional requirements.

ii. The outside air damper shall be closed and its return air damper shall be open.

iii. The exhaust/relief fan shall be de-energized and its associated motorized dampers shall be closed.

iv. The chilled water cooling coil control valve shall be placed in its full open position to permit full flow to the coil and then shall be modulated to avoid overshoot and to maintain a space air temperature setpoint of 75 F (adjustable).

v. The hot water heating coil control valve shall be closed to the coil.

vi. The fan powered terminal boxes and VAV terminal boxes shall be controlled according to the sequences described in the "Fan powered Terminal Boxes with Hot Water Reheat Coils" and "Variable Air Volume Terminal Boxes with Hot Water Reheat Coils" articles in this Section.

E. When the VAV AHU and/or VAV RTU is indexed to the Occupied operating mode, the DDC system shall control it according to the following sequence:

1. Supply Fan: The supply fan shall be energized and shall run continuously.
    i. A Static pressure sensor, mounted 2/3 the distance from the VAV AHU or VAV RTU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled "VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization" in this Section for additional requirements.
2. Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer): When the VAV AHU and/or VAV RTU is initially energized, the normally closed outdoor air damper shall remain in its full closed position and the normally open return air damper shall remain in its full-open position for a period of 60 seconds. After 60 seconds has elapsed, the outdoor air damper and return air damper shall be controlled as follows:
    i. Normal Mode: The outdoor air damper shall initially be placed in its low occupancy minimum outdoor air position of 3220 cfm for AHU-2 and 2850 cfm for RTU-1 as determined by an airflow station mounted in the unit's outdoor airstream. The DDC system shall then control the position of the outdoor air damper via the various space CO2 sensors located in high occupancy spaces served by the system according to the "Ventilation Optimization" article in this Section. The high occupancy minimum outdoor air damper position shall be as indicated in the schedule on the Drawings.
    ii. Economizer Mode: When free cooling is available and space temperature is above setpoint, the outside air damper and the return air damper shall be modulated to maintain the unit's discharge air temperature setpoint. The DDC

system shall compare the enthalpy of the outside air to the enthalpy of the return/exhaust air to determine whether free cooling is available.

1) The exhaust/relief air fan shall be energized and its associated motorized damper shall be open. The exhaust/relief fan's VF drive shall then be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.

3. Cooling Mode:
   i. The DDC system shall first determine whether free cooling is available. If free cooling is available, then the unit's outdoor air damper, return air damper, and exhaust fan and associated motorized damper, shall be controlled as previously described in the subparagraph entitled "Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer)" in this article.
   ii. If free cooling is not available, the DDC system shall:
      1) (AHU-2 Only): Modulate the 3-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil and open to the bypass.
      2) (RTU-1 Only): Modulate the 2-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55 F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil.
   iii. If the primary air damper in all VAV terminal boxes and all fan powered terminal boxes are at their minimum position, the discharge air temperature shall be reset upwards by 0.10°F every 30-seconds (adjustable) until one of the primary air dampers opens beyond its minimum position or until discharge air temperature reaches 60°F (adjustable).
4. Heating Mode:
   i. (AHU-2 only): The DDC system shall modulate the 2-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil.
   ii. (RTU-1 only): The DDC system shall modulate the 3-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil and open to the bypass.
5. Dehumidification: Provide space humidity sensor(s) and space temperature sensor(s) in the location(s) shown on the plans. The DDC system shall calculate actual space dew point temperature based upon actual space temperature and actual space humidity. When space dew point temperature rises above a setpoint of 55°F (adjustable), the unit

shall be placed in its dehumidification mode. When space dew point temperature drops below 54°F (adjustable), the unit shall be returned to its normal control mode. When placed in its dehumidification mode, the following shall occur:

i. (AHU-2 only): The 3-way chilled water cooling coil control valve shall be full open to the cooling coil and full closed to the bypass to provide maximum cooling.

ii. (RTU-1 only): The 2-way chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.

iii. Each fan powered terminal box hot water reheat coil and each VAV terminal box reheat coil shall be controlled to maintain space temperature according to the sequences described in the "Fan Powered Terminal Boxes with hot Water Reheat Coils" and "Variable Air Volume Terminal Boxes with Hot Water Reheat Coils" articles in this Section.

F. When the VAV AHU and/or VAV RTU is indexed to the Unoccupied mode, the DDC system shall control it according to the following sequence:

1. The supply fan(s) shall be de-energized.
2. The outside air damper shall be closed and its return air damper shall be open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.
6. Dehumidification: When space dew point temperature rises above a setpoint of 55°F (adjustable), the unit supply fan shall be energized, the unit's heating coil control valve shall remain closed, and the unit's cooling system shall be controlled to provide full cooling as described below. The unit's exhaust fan shall remain de-energized, the return air damper shall remain open and the outdoor air damper shall remain closed. When space dew point temperature drops below 54°F (adjustable), the unit's supply and exhaust fans shall be de-energized, the unit's heating coil control valve shall remain closed, and the unit's chilled water coil shall be closed.

i. The chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.

ii. Each fan powered terminal box hot water reheat coil and each VAV terminal box reheat coil shall be controlled to maintain space temperature according to the sequences described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" and "Variable Air Volume Terminal Boxes with Hot Water Reheat Coils" articles in this Section.

G. Night Setback Mode: If space temperature drops below the night setback temperature setpoint of 60°F (adjustable) when the VAV AHU and/or VAV RTU is in the Unoccupied Mode, the following shall occur:

1. The supply fan(s) shall remain de-energized.
2. The outside air damper shall remain closed and its return air damper shall remain open.

3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.
    i. All night setback heating will be handled by the fan powered terminal boxes. Refer to the "Fan powered Terminal Boxes with Hot Water Reheat Coils" article in this Section for requirements.

H. Smoke Control: A duct mounted smoke detector, located in both the supply air and return air ducts, shall stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when products of combustion are detected in either the supply or return air streams.
    1. Whenever air handling unit AHU-1 is placed in the smoke control mode, air handling unit AHU-2 and rooftop air handling unit RTU-1 shall be de-energized.

I. Provide a freezestat mounted in the unit's outdoor airstream in a location downstream of the electric duct coil to stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when outdoor air temperature drops below 38 ° F (adjustable).

J. Provide a water level sensor mounted in the unit's drain pan to stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan.

K. DDC Input/Output Points for VAV Air Handling Units AHU-2 and RTU-1:
    1. AI – Mixed Air Temperature
    2. AI – Discharge Air Temperature (at unit outlet)
    3. AI – Space Air Temperature
    4. AI – Space/Return Air Humidity
    5. AI – Outdoor Air Temperature
    6. AI – Outdoor Air Humidity
    7. AI – Space Differential Pressure
    8. AI – Discharge Temperature Setpoint Adjust
    9. AI – Space CO2 Level
    10. AI – Outside Airflow Rate
    11. AI – Supply Fan Variable Frequency Drive Status
    12. AI – Exhaust/Relief Fan Variable Frequency Drive Status
    13. DI – Supply Fan Status
    14. DI – Exhaust Fan Status
    15. DI – Manual Override
    16. DI – Freezestat
    17. DI – Smoke Detector Alarm

18. DI – Drain Pan Water Level Alarm
19. DI – Low/High Outdoor Airflow Rate Alarm
20. AO – Outdoor Air Damper position
21. AO – Return Air Damper Position
22. AO – Hot Water Heating Coil Valve Position
23. AO – Supply Fan Variable Frequency Drive Speed
24. AO – Exhaust Fan Variable Frequency Drive Speed
25. AO – Chilled Water Cooling Coil Valve Position
26. DO – Relief Air Damper Open/Close
27. DO – Supply Fan Start/Stop

L. Coordinate the control system requirements described in this Section with the requirements described in Division 23 Sections "Indoor, Central-Station Air-handling Units" and "Outdoor, Central-Station Air-handling Units."

VARIABLE AIR VOLUME AIR HANDLING UNITS AHU-1

A. The variable air volume (VAV) air handling unit (AHU) shall be controlled via DDC type controls. The Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. Air handling unit AHU-1 is utilized to pressurize corridor floor levels under a smoke control mode. The smoke-control mode shall have the highest priority over all other operating control modes. The smoke control mode shall be automatically activated in response to signals received from corridor smoke detectors. Manual activation and deactivation of the smoke control system fans and smoke dampers shall be provided at Firefighters Smoke Control Panel. All smoke dampers and combination fire/smoke dampers shall be UL 555 rate. The smoke control mode shall be initiated within 10 seconds after an automatic or manual activation command is received at the smoke control system. Smoke control systems shall activate individual components (w.g., dampers, fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts, and other equipment.
C. The VAV AHU consists of an outside air damper, return air damper, hot water heating coil, chilled water cooling coil, supply fan with variable frequency (VF) drive, and an exhaust/relief fan with VF drive. The VAV AHU shall be controlled by a DDC controller furnished by the Subcontractor. Actuators shall be electronic.
    1. The VAV AHU shall be provided with an airflow station mounted in the outdoor air stream to measure the exact amount of outdoor air the unit introduces into the system. The HVAC Trade shall determine whether the ATC subcontractor or the VAV AHU manufacturer shall provide the airflow station.
D. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the VAV AHU for the warm up mode prior to the areas they serve being occupied. The start/stop optimization program and time schedule program shall also determine when to de-energize the VAV AHU.

E. When the VAV AHU is indexed to the warm-up or cool-down mode, the DDC system shall control it according to the following sequence:
    1. During the warm-up mode:
        i. The supply fan(s) shall be de-energized.
        ii. The outside air damper shall be closed and its return air damper shall be open.
        iii. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
        iv. The chilled water cooling coil control valve shall be closed to the coil.
        v. The hot water heating coil control valve shall be closed to the coil.
        vi. All warm up mode heating shall be accomplished by the fan powered terminal boxes and their associated reheat coils according to the sequence described in the "Fan Powered Terminal Boxes with hot Water Reheat Coils" article in this Section.
    2. During the cool down mode:
        i. The supply fan(s) shall be energized and shall run continuously while in the morning cool down mode.
            1. A static pressure sensor, mounted 2/3 the distance from the VAV AHU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to this article entitled "VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization" in this Section for additional requirements.
        ii. The outside air damper shall be closed and its return air damper shall be open.
        iii. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
        iv. The chilled water cooling coil control valve shall be placed in its full open position to permit full flow to the coil and then shall be modulated to avoid overshoot and to maintain a space air temperature setpoint of 75 ° F (adjustable).
        v. The hot water heating coil control valve shall be closed to the coil.
        vi. The fan powered terminal boxes shall be controlled according to the sequence described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" article in this Section.

F. When the VAV AHU is indexed to the Occupied operating mode, the DDC system shall control it according to the following sequence:
    1. Supply Fan: The supply fan shall be energized and shall run continuously.
        i. A static pressure sensor, mounted 2/3 the distance from the VAV AHU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC

Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled "VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization" in this Section for additional requirements.

2. Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer): When the VAV AHU is initially energized, the normally closed outdoor air damper shall remain in its full closed position and the normally open return air damper shall remain in its full-open position for a period of 60 seconds. After 60 seconds has elapsed, the outdoor air damper and return air damper shall be controlled as follows:
    i. Normal Mode: The outdoor air damper shall initially be placed in its low occupancy minimum outdoor air position of 730 cfm for AHU-1 as determined by an airflow station mounted in the unit's outdoor airstream. The DDC system shall then control the position of the outdoor air damper via the various space CO2 sensors located in high occupancy spaces served by the system according to the "Ventilation Optimization" article in this Section. The high occupancy minimum outdoor air damper position shall be as indicated in the schedule on the Drawings.
    ii. Economizer Mode: When free cooling is available and space temperature is above setpoint, the outside air damper and the return air damper shall be modulated to maintain the unit's discharge air temperature setpoint. The DDC system shall compare the enthalpy of the outside air to the enthalpy of the return/exhaust air to determine whether free cooling is available.
        1. The exhaust/relief air fan shall be energized and its associated motorized damper shall be open. The exhaust/relief fan's VF drive shall then be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.
    iii. The return air (mixed air) damper located internal t the unit shall be smoke rated in order to isolate the outdoor airstream from the exhaust airstream during the smoke control mode.
3. Unit Exhaust Fan: The DDC system shall control the operation of the unit's exhaust fan as follows:
    i. An adjustable outdoor air damper end switch shall start and stop the unit's exhaust fan. When the outdoor air damper end switch starts the exhaust fan , it shall open the exhaust air damper; similarly, when the outdoor air damper end switch stops the exhaust fan, it shall also close the exhaust air damper. The ATC Subcontractor shall determine through trial and error the optimum position of the end switch in which to start and stop the exhaust fan.
    ii. A space differential pressure sensor shall modulate the exhaust fan's variable frequency drive to maintain space pressure setpoint as follows:

1. The exhaust/relief air fan shall be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.

4. Cooling Mode:
   i. The DDC system shall first determine whether free cooling is available. If free cooling is available, then the unit's outdoor air damper, return air damper, and the exhaust fan and associated motorized damper and shall be controlled as previously described in the subparagraph entitled "Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer)" in this article.
   ii. If free cooling is not available, the DDC system shall modulate the 2-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55 ° F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil.
   iii. If the primary air damper in all fan powered terminal boxes are at their minimum position, the discharge air temperature shall be reset upwards by 0.10 ° F every thirty (30) seconds (adjustable) until one of the primary air dampers opens beyond its minimum position or until discharge air temperature reaches 60 ° F (adjustable).

5. Heating Mode:
   i. The DDC system shall modulate the three-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55 ° F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil and open to the bypass.

6. Dehumidification: Provide space humidity sensor(s) and space temperature sensor(s) in the location(s) shown on the plans. The DDC system shall calculate actual space dew point temperature based upon actual space temperature and actual space humidity. When space dew point temperature rises above a setpoint of 55 ° F (adjustable), the unit shall be placed in its dehumidification mode. When space dew point temperature drops below 54 ° F (adjustable), the unit shall be returned to its normal control mode. When placed in its dehumidification mode, the following shall occur:
   i. The 2--way chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.
   ii. Each fan powered terminal box hot water reheat coil shall be controlled to maintain space temperature according to the sequence described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" article in this Section.

G. When the VAV AHU is indexed to the unoccupied mode, the DDC system shall control it according to the following sequence:

1. The supply fan(s) shall be de-energized.
2. The outside air damper shall be closed and its return air damper shall be open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.
6. Dehumidification: When space dew point temperature rises above a setpoint of 55 ° F (adjustable), the unit supply fan shall be energized, the unit's heating coil control valve shall remain closed, and the unit's cooling system shall be controlled to provide full cooling as described below. The unit's exhaust fan shall remain de-energized, the return air damper shall remain open and the outdoor air damper shall remain closed. When space dew point temperature drops below 54 ° F (adjustable), the unit's supply and exhaust fans shall be de-energized, the unit's heating coil control valve shall remain closed, and the unit's chilled water coil shall be closed.
    i. The chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.
    ii. Each fan powered terminal box hot water reheat coil shall be controlled to maintain space temperature according to the sequence described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" article in this Section.

H. Night Setback Mode: If space temperature drops below the night setback temperature setpoint of 60 ° F (adjustable) when the VAV AHU is in the Unoccupied Mode, the following shall occur:
1. The supply fan(s) shall remain de-energized.
2. The outside air damper shall remain closed and its return air damper shall remain open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.
    i. All night setback heating will be handled by the fan powered terminal boxes. Refer to the "Fan powered Terminal Boxes with Hot Water Reheat Coils" article in this Section for requirements.

I. When the air handling unit is indexed to the Smoke Control Mode, the DDC system shall control it according to the following sequence:
1. The unit's supply fan(s) shall be energized.
2. The unit's internal exhaust fan shall be energized.
3. The unit's outside air damper shall be open, the unit's exhaust air damper shall be closed, and the unit's return air damper shall be closed.
4. The chilled water valve shall be closed.
5. The hot water heating coil control valve shall be modulated open and closed to the coil to maintain discharge air temperature of 38 ° F (adjustable).
6. The position of all unit dampers shall be proved via end switches and indicated at the FSCS. Manual open/closed/automatic control for each damper shall be provided at the FSCS.

7. The status of each system fan shall be proved via differential pressure and indicated at the FSCS. Manual on/off/automatic control for each fan shall be provided at the FSCS.

J. Smoke Control: Under normal mode (whenever the unit is not in the smoke control mode), a duct mounted smoke detector, located in both the return air and supply air ducts, shall stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass whenever products of combustion are detected in either the supply or return airstreams.

K. Provide a low temperature sensor mounted in the unit discharge to perform the following:
   1. Normal Mode: when discharge air temperature drops below 38 ° F (adjustable), the supply an shall stop, the exhaust fan shall stop, the outside air and exhaust air dampers shall close, the return air damper shall open, the chilled water control valve shall close, and the hot water coil control valve shall fully close to the coil and fully open to the bypass.
   2. Smoke Control Mode: When the air handling unit is place in the Smoke Control Mode, the DDC system shall override and lock out the low temperature sensor and the unit shall continue to operate regardless of the discharge air temperature.

L. Provide a water level sensor mounted in the unit's drain pan to perform the following:
   1. Normal Mode: When the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan, the supply fan shall stop, the exhaust fan shall stop, the outside air and exhaust air dampers shall close, the return air damper shall open, the chilled water control valve shall close, and the hot water coil control valve shall fully close to the coil and fully open to the bypass.
   2. Smoke Control Mode: when the air handling unit is placed in the Smoke Control Mode, the DDC system shall override and lock out the water level sensor and the unit shall continue to operate regardless of the water level in the unit's drain pan.

M. DDC Input/Output Points for VAV Air Handling Units AHU-1:
   1. AI – Mixed Air Temperature
   2. AI – Discharge Air Temperature (at unit outlet)
   3. AI – Space Air Temperature
   4. AI – Space/Return Air Humidity
   5. AI – Outdoor Air Temperature
   6. AI – Outdoor Air Humidity
   7. AI – Space Differential Pressure
   8. AI – Discharge Temperature Setpoint Adjust
   9. AI – Space CO2 Level
   10. AI – Outside Airflow Rate
   11. AI – Supply Fan Variable Frequency Drive Status
   12. AI – Exhaust/Relief Fan Variable Frequency Drive Status
   13. DI – Supply Fan Status
   14. DI – Exhaust/Relief FanStatus
   15. DI – Manual Override

16. DI – Low Temperature Alarm
17. DI – Smoke Detector Alarm
18. DI – Drain Pan Water Level Alarm
19. DI – Low/High Outdoor Airflow Rate Alarm
20. AO – Outdoor Air Damper Position
21. AO – Return Air Damper Position
22. AO – Hot Water Heating Coil Valve position
23. AO – Supply Fan Variable Frequency Drive Speed
24. AO – Exhaust Fan Variable Frequency Drive Speed
25. AO – Chilled Water Cooling Coil Valve Position
26. DO – Exhaust/Relief Air Damper Open/Close
27. DO – Supply Fan Start/Stop
28. DO – Exhaust/Relief Fan Start/Stop

N. Coordinate the control system requirements described in this Section with the requirements describe in Division 23 Sections "Indoor, Central-Station Air-handling Units."

STAIR PRESSURIZATION

A. Each stair pressurization system shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. Damper Control: Each fan shall be provided with a motorized damper.
    1. The ATC Subcontractor shall coordinate the furnishing of the motorized dampers with the HVAC Trade and the supply fan supplier.
        a) The ATC Subcontractor shall install all motorized dampers in the throat of the supply fan's roof curb.
        b) The ATC Subcontractor shall provide power to each motorized damper and the damper shall be controlled so that it is open when the fan is operating and it is closed when the fan is not operating.
        c) Each damper shall be the low temperature, thermally broken type. Refer to Division 23, Section "Automatic Temperature Control for HVAC" for damper requirements.
C. Stair Pressurization Control:
    1. Whenever a fire in the building occurs as indicated by the building fire alarm system, the DDC system shall start stair pressurization fans SF-1 and SF-2. Coordinate with the building fire alarm subcontractor to obtain the fire alarm signal.
    2. Each stair pressurization fan shall be controlled as follows:
        a) A space pressure sensor shall modulate the fan's variable frequency drive to maintain the pressure in the stairwell between 0.06-inches w.g. and 0.18-inches w.g.

b) As space pressure in the stair approaches the maximum allowable pressure of 0.18-inches w.g., an automatic air damper shall modulate open to prevent space pressure from rising above 0.18-inches w.g.

c) Should pressure in the stair drop below 0.06-inches w.g. or rise above 0.18-inches w.g. an alarm shall be registered with the operator workstation.

D. DDC Input/output points for Stair pressurization:
   1. AI – Space pressure (each)
   2. AO – Supply Fan VF Drive Speed (each)
   3. AO – Automatic Air Damper Position
   4. DI – Space Pressure Minimum Alarm (each)
   5. Di – Space Pressure Maximum Alarm (each)
   6. DI – Supply Fan Status (each)
   7. DI – Supply Fan Failure Alarm
   8. DO – Supply Fan Start/Stop (each)

EXHAUST FANS

A. Fan Status: Each fan shall be provided with a current sensor to monitor the operation of the fan.
B. Damper Control: Each fan shall be provided with a motorized damper.
   1. All centrifugal roof exhaust fans shall be provided with a motorized damper. The ATC Subcontractor shall coordinate the furnishing of the motorized dampers with the HVAC Trade and the exhaust fan supplier.
      i. The ATC Subcontractor shall install all motorized dampers in the throat of the roof curb.
      ii. The ATC Subcontractor shall provide power to each motorized damper and the damper shall be controlled so that it is open when the fan is operating and it is closed when the fan is not operating.
      iii. Each damper shall be the low temperature, thermally broken type. Refer to Division 23, Section "Automatic Temperature Control for HVAC" for damper requirements.
C. Continuous Control: Exhaust Fan EF-3 shall be wired to operate continuously.
D. DDC Scheduled Control: Exhaust Fans EF-1 and EF-2 shall be energized and de-energized according to a DDC Time Schedule. Exhaust fans EF-1 and EF-2 shall operate during the Occupied Mode and shall not operate during Unoccupied Mode.
E. DDC pints List for Exhaust Fans:
   1. AI – Space Temperature (each fan designated for temperature control)
   2. DI – Exhaust Fan Status (each fan)
   3. DO – Exhaust Fan Start/Stop (each fan, except those wired for continuous operation)

COMPUTER ROOM AIR CONDITIONING UNIT AND REMOTE AIR COOLED CONDENSER

A. Each computer room air conditioning unit shall be shipped from the factory with microprocessor-based controls furnished and installed by the computer room air conditioning unit manufacturer.
B. The computer room air conditioning unit manufacturer shall provide an interface device for each unit furnished so that the building DDC system can fully communicate with the computer room air conditioning unit manufacturer's microprocessor-based controls. Each unit will be furnished with a factory installed control system that will be fully BACNET compatible. The ATC Subcontractor shall interface with each computer room air conditioning unit to provide remote monitoring and control from the building DDC system.
    1. If the ATC system is not fully BACNET compatible, the ATC Subcontractor shall provide an interface device that will provide full compatibility between the ATC system and each computer room air conditioning unit.
C. The ATC Subcontractor shall install all sensors and other controls that are shipped loose from the factory for field installation. The ATC Subcontractor shall provide all interconnecting wiring and conduit required for the installation of sensors and controls shipped loose. In addition, the ATC subcontractor shall provide all interconnecting wiring between each computer room air conditioning unit and its remote air cooled condenser.
D. Provide a water level sensor mounted in each unit's drain pan to stop the unit fan(s) when the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan.
E. DDC Input/Output points for Computer "Room Air Conditioning Unit and Remote Air Cooled Condenser:
    1. AI – Space Air Temperature
    2. AI – Space Relative Humidity
    3. DI – Supply Fan Status
    4. DI – Low Space Temperature Alarm
    5. DI – High Space Temperature Alarm
    6. DI – Low Space Humidity Alarm
    7. DI – high Space humidity Alarm
    8. DI – Humidifier Status
    9. DI – Loss of Airflow Alarm
    10. DI – Loss of Power Alarm
    11. DI – Change Filters Alarm
    12. DI – Drain Pan Water Level
F. Coordinate the control system requirements with the requirements described in Division 23, Section "Computer Room Air Conditioners."

VARIABLE AIR VOLUME (VAV) TERMINAL BOXES WITH HOT WATE REHEAT COILS

A. Each VAV terminal box shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. Each VAV terminal box shall have a primary air damper and hot water reheat coil. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
C. The ATC Subcontractor shall furnish DDC controls to the VAV terminal box manufacturer for factory mounting and wiring by the terminal box manufacturer.
D. VAV Terminal Box Cool-Down Mode:
    1. In the Cool-down Mode the rooftop unit or air handling unit shall energize, the VAV terminal box primary air damper shall open to its maximum position, and the normally open hot water reheat coil control valve shall remain closed.
    2. As space temperature approaches its cooling setpoint of 74 ° F (adjustable), the VAV terminal box primary air damper shall be modulated to its minimum occupied position.
    3. If space temperature drops below the heating setpoint of 72 ° F (adjustable), the VAV terminal box's 2--way modulating hot water reheat coil control valve shall be modulated to maintain a minimum space temperature of 72 ° F (adjustable).
E. VAV Terminal Box Warm-up Mode:
    1. In the Warm-up Mode the rooftop unit or air handling unit shall energize and the VAV terminal box primary air damper shall open to its minimum positon.
    2. If space temperature is below the heating setpoint of 72 ° F (adjustable), the VAV terminal box's hot water reheat coil control valve shall open. As space temperature approaches the heating setpoint, the hot water control valve shall be modulated to maintain a minimum space temperature of 72 ° F (adjustable).
F. VAV Terminal Box Occupied Mode:
    1. In the Occupied Mode, the VAV terminal box primary air damper shall open to its minimum position. A space temperature sensor shall modulate the primary air damper between its minimum occupied position and its maximum occupied position to maintain cooling temperature setpoint of 74 ° F (adjustable).
    2. When space temperature drops below the cooling temperature setpoint of 74 ° F (adjustable) toward the heating setpoint of 72 ° F (adjustable), the VAV terminal box primary air damper shall be modulated to its minimum occupied position. If space temperature drops below the heating setpoint of 72 ° F (adjustable), then the VAV terminal box's hot water reheat coil control valve shall be modulated to maintain a minimum space temperature of 72 ° F (adjustable).

3. The VAV terminal boxes that serve rooms having CO2 sensors shall have dual minimum airflow setpoints. When the space or zone CO2 concentration is above setpoint, the VAV terminal box shall increase the lower minimum airflow to the higher minimum airflow setpoint in 25 cfm increments every 15 seconds until CO2 concentration in the space drops to a level of 50 ppm below setpoint or the terminal box primary air damper reaches its higher minimum airflow position. When the CO2 concentration in the space drops to a level of 50 ppm below setpoint, the VAV terminal box shall decrease its primary air damper position in 25 cfm increments every 30 seconds until space CO2 concentration rises to within 25 ppm of setpoint or the primary air damper's lower minimum airflow position is reached.

G. VAV Terminal Box Unoccupied/Night Setback Mode:
   1. In the Unoccupied/Night setback mode, the VAV terminal box primary air damper shall be closed and its hot water reheat coil control valve shall be closed.
   2. If system indoor humidity rises above the system dew point temperature setpoint of 55 ° F (adjustable), the rooftop unit or air handling unit supply fan shall energize, the VAV terminal box primary air damper shall open, and the VAV terminal box hot water reheat coil control valve shall modulate open and closed to the coil to maintain space/zone temperature at setpoint. Once the system humidity drops below the system dew point temperature setpoint of 54 ° F (adjustable), the rooftop unit or air handling unit supply fan shall de-energize, the VAV terminal box primary air damper shall close and the VAV terminal box hot water reheat coil control valve shall close.
   3. The override button on ay of the room sensors shall override the unoccupied/night set back mode and shall place the VAV terminal boxes and its associated rooftop unit or air handling unit into the Occupied Mode for a timed period of 2-hours (adjustable). Once the timed period is complete, the system shall revert back to the unoccupied/night setback mode.

H. Coordinate the control system requirements with the requirements as described in Division 23, Section "Air Terminal Units."

I. DDC Input/output Points for VAV Terminal Boxes with hot Water Reheat Coils:
   1. AI – Space/Zone Temperature
   2. AI – Discharge Air Temperature (downstream of the VAV terminal box)
   3. AI – Space/Zone Temperature Setpoint Adjustment
   4. AI – Space/Zone Airflow Rate
   5. AI – Space/Zone CO2 level
   6. AO – Terminal Box Damper
   7. AO – Hot Water Reheat Coil Control Valve
   8. DI – Local Occupied/Unoccupied Override

FAN POWERED TERMINAL BOXES WITH HOT WATER REHEAT COILS

A. Each fan powered terminal box shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. Each fan powered terminal box shall have a supply fan, a primary air damper, and a hot water reheat coil. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
C. The ATC Subcontractor shall furnish DDC controls to the terminal box manufacturer for factory mounting and wiring by the terminal box manufacturer.
D. Fan powered Terminal Box Cool-Down Mode:
    1. In the Cool-down Mode the rooftop unit or air handling unit shall energize; the fan powered terminal box supply fan shall energize; the terminal box primary air damper shall open to its maximum position; AND the normally open hot water reheat coil control valve shall remain closed.
    2. As space temperature approaches its cooling setpoint of 74 ° F (adjustable), the fan powered terminal box primary air damper shall be modulated to its minimum occupied position.
    3. If space temperature drops below the heating setpoint of 72 ° F (adjustable), the fan powered terminal box's 2--way modulating hot water reheat coil control valve shall be modulated open and closed to the coil to maintain a minimum space temperature of 72 ° F (adjustable).
E. Fan Powered Terminal Box Warm-up Mode:
    1. In the Warm-up Mode the rooftop unit or air handling unit shall remain de-energized.
    2. If space temperature is below the heating setpoint of 72 ° F (adjustable), the fan powered terminal box's supply fan shall be energized and its hot water reheat coil control valve shall open. As space temperature approaches the heating setpoint, the hot water control valve shall be modulated to maintain a minimum space temperature of 72 ° F (adjustable).
    3. If space temperature is above the heating setpoint of 72 ° F (adjustable), the fan powered terminal box's supply fan shall remain de-energized and its hot water reheat coil control valve shall remain closed to the coil.
F. Fan powered Terminal Box Occupied Mode:
    1. In the Occupied Mode, a space temperature sensor shall modulate the primary air damper between its minimum occupied position and its maximum occupied position to maintain cooling temperature setpoint of 74 ° F (adjustable).
    2. Whenever space temperature is above the heating setpoint, the fan powered terminal box supply fan shall be de-energized.
    3. When space temperature drops below the cooling temperature setpoint of 74 ° F (adjustable) toward the heating setpoint of 72 ° F (adjustable), the fan powered terminal box primary air damper shall be modulated to its

minimum occupied position. If space temperature drops below the heating setpoint of 72 ° F (adjustable), the following shall occur:

a) The fan powered terminal box's supply fan shall first be energized to recirculate space/zone air and mix it with primary air in order to raise the fan powered terminal box discharge air temperature.

b) If space temperature continues to drop then the fan powered terminal box's hot water reheat coil control valve shall be modulated open and closed to its reheat coil to maintain space temperature at a setpoint of 72 ° F (adjustable).

c) When space temperature rises above 72.5 ° F (adjustable), the reheat coil control valve shall close to the coil. As space temperature continues to rise and rises above 73 ° F (adjustable), the fan powered terminal box supply fan shall de-energize.

4. The fan powered terminal boxes that serve rooms have CO2 sensors shall have dual minimum primary airflow setpoints. When the space or zone CO2 concentration is above setpoint, the fan powered terminal box shall increase its primary air damper position from its lower minimum airflow toward its higher minimum airflow setpoint in 25 cfm increments every 15 seconds until CO2 concentration in the space drops to a level of 50 ppm below setpoint or the terminal box primary air damper reaches its higher minimum airflow position. When the CO2 concentration in the space drops to a level of 50 pm below setpoint, the VAV terminal box shall decrease its primary air damper position in 25 cfm increments every 30 seconds until space CO2 concentration rises to within 25 ppm of setpoint or the primary air damper's lower minimum airflow position is reached.

G. Fan powered Terminal Box Unoccupied/Night Setback Mode:

1. In the Unoccupied/Night Setback mode, the fan powered terminal box supply fan shall be de-energized, its primary air damper shall be closed, and its hot water reheat coil control valve shall be closed.
2. When room temperature drops below the night setback heating setpoint of 65 ° F (adjustable), the terminal box supply fan shall energize, the terminal box primary air damper shall remain closed, and the terminal box hot water reheat coil control valve shall open. Once the space temperature rises 2° F (adjustable) above the night setback temperature setpoint, the terminal box supply fan shall de-energize, the terminal box primary air damper shall remain closed, and the terminal box hot water reheat coil control valve shall close.
3. If system indoor humidity rises above the system dew point temperature setpoint of 55 ° F (adjustable), the rooftop unit or air handling unit supply fan shall energize, the fan powered terminal box primary air damper shall open, the fan powered terminal box supply fan shall energize to recirculate space/zone air and mix it with primary air in order to raise the fan powered

terminal box discharge air temperature and maintain space temperature at a cooling setpoint of 74° F.

a) If operation of the fan powered terminal box supply fan alone cannot maintain space temperature at setpoint, then hot water reheat coil control valve shall modulate open and closed to the coil to maintain space/zone temperature at setpoint.

b) Once the system humidity drops below the system dew point temperature setpoint of 54° F (adjustable), the rooftop unit or air handling unit supply fan shall de-energize, the fan powered terminal box supply an shall de-energize, the fan powered terminal box primary air damper shall close, and the fan powered terminal box hot water reheat coil control valve shall close.

4. The override button on any of the room sensors shall override the night setback mode and shall place the fan powered terminal boxes and its associated rooftop unit or air handling unit into the Occupied mode for a timed period of 2-hours (adjustable). Once the time period is complete, the system shall revert back to the night setback mode.

H. Coordinate the control system requirements with the requirements as described in Division 23 Section, "Air Terminal Units."

I. DDC Input/Output Points for Fan powered Terminal Boxes with Hot Water Reheat Coils:

1. AI – Space/zone Temperature
2. AI – Discharge Air Temperature (downstream of the fan powered terminal box)
3. AI – Space/zone Temperature Setpoint adjustment
4. AI – Space/Zone Airflow Rate
5. AI – Space/Zone CO2 level
6. AO – Terminal Box Damper
7. AO – Hot Water Reheat Coil Control Valve
8. DI – Local Occupied/Unoccupied Override
9. Di – Fan Status
10. DO – Fan Start/Stop

FAN COIL UNITS

A. Each fan coil unit shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Each fan coil unit shall have a supply fan and a chilled water coil.

C. Each fan coil unit shall be controlled as follows:

1. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the fan coil unit prior to the area being occupied. The start/stop optimization program and the time schedule program shall also determine when to de-energize the fan coil unit.

2. When the fan coil unit is indexed to the Occupied Operating Mode, the DDC system shall control it according to the following sequence:
    a) Supply Fan: The DDC system shall control the supply an as follows:
        1. The supply fan shall start and stop via the space temperature sensor based on a call for cooling.
    b) Chilled Water Coil: The 2-way normally closed chilled water control valve shall be modulated open and closed to the coil to maintain a space air temperature occupied cooling setpoint of 82° F (adjustable).
3. When the fan coil unit is indexed to the Unoccupied Operating Mode, the DDC system shall control it according to the following sequence:
    a) Supply Fan: The fan shall be de-energized.
    b) Chilled Water Coil: The unit's 2-way chilled water control valve shall be closed to the coil.
    c) If space temperature rises above an unoccupied cooling set point of 90° F (adjustable), the supply fan shall energize and the 2-way normally closed chilled water control valve shall be placed in its full open position to allow full flow through the unit's chilled water coil. Once space temperature drops below 85° F (adjustable), the supply fan shall de-energize and the chilled water coil control valve shall close.

D. Coordinate the control system requirements with the requirements as described in Division 23, Section "Fan Coil Units."
E. DDC Input/Output Points for Fan Coil Units:
    1. AI – Space/Zone Temperature
    2. AI – Discharge Air Temperature (downstream of the fan coil unit)
    3. AO – Chilled Water Coil Control Valve
    4. DI – Fan Status
    5. DO – Fan Start/Stop

HOT WATER CABINET UNIT HEATERS

A. Each hot water cabinet unit heater shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. A wall-mounted temperature sensor, through the building DDC system, shall cycle the cabinet unit heater's fan to maintain a space temperature heating setpoint of 65° F (adjustable). An aqua-stat shall prevent the cabinet unit heater's fan from operating when hot water supply temperature drops below set point of 100 ° F (adjustable).
C. Coordinate the control system requirements with the requirements as described in Division 23, Section "unit Heaters."
D. DDC Input/Output Points for Hot Water Cabinet Unit Heaters:
    1. AI – Space Air Temperature
    2. DO – Fan Start/Stop

HOT WATER UNIT HEATERS

A. Each hot water unit heater shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. A wall-mounted temperature sensor, through the building DDC system, shall cycle the unit heater's fan to maintain a space temperature heating setpoint of 65° F (adjustable). An aqua-stat shall prevent the unit heater's fan from operating when hot water supply temperature drops below setpoint of 100° F (adjustable).
C. Coordinate the control system requirements with the requirements as described in Division 23, Section "Unit Heaters."
D. DDC Input/output Points for Hot Water Unit Heaters:
    1. AI – Space Air Temperature
    2. DO – Fan Start/Stop

HOT WATER CONVECTORS

A. Each hot water convector shall be controlled via the building DDC system. The ATC Subcontractor shall provide DD control components to accomplish the sequence described below.
B. A wall-mounted temperature sensor, through the building DDC system, shall modulate a 2-way hot water control valve to maintain a space temperature heating setpoint of 70° F (adjustable).
C. Coordinate the control system requirements with the requirements as described in Division 23, Section "Convectors".
D. DDC Input/output Points for Hot Water Convectors:
    1. AI – Space Air Temperature
    2. AO – Hot Water Valve Open/Close

HOT WATER RADIANT CEILING PANELS

A. Each hot water radiant ceiling panel shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. A wall-mounted temperature sensor, through the building DDC system, shall modulate a 2-way (normally open) hot water valve to maintain a space temperature heating setpoint of 72° F (adjustable).
C. Coordinate the control system requirements with the requirements as described in Division 23, Section "Valance Heating Units".
D. DDC Input/output Points for Hot Water Radiant Ceiling Panels:
    1. AI – Space Air Temperature
    2. AO – Hot Water Valve Position
    3. AO – Setpoint Adjust

AUTOMATIC AIR DAMPERS

A. Automatic Air Dampers (outdoor air Intake): Two automatic air dampers shall be provided to segregate the outdoor air intake louver, located in the exterior wall of the First Floor outdoor air intake plenum, into two airstreams.
    1. One automatic air damper shall be associated with air handling unit AHU-1. The automatic air damper shall be fully open when AHU-1 is operating and shall be fully closed when AHU-1 is not operating.
    2. The other automatic air damper shall be associated with air handling unit AHU-2. The automatic air damper shall be fully open when AHU-2 is operating and shall be fully closed when AHU-2 is not operating.
B. Automatic Air Dampers (Relief): Two automatic air dampers shall be provided to segregate the relief air louver, located in the exterior wall of the First Floor relief air plenum, into two airstreams.
    1. One automatic air damper shall be associated with air handling unit AHU-1. The automatic air damper shall be full open when AHU-1 is operating and shall be fully closed when AHU-1 is not operating.
    2. The other automatic air damper shall be associated with air handling unit AHU-2. The automatic air damper shall be fully open when AHU-2 is operating and shall be fully closed when AHU-2 is not operating.
C. DDC Input/Output Points for Automatic Air Dampers:
    1. AI – Building Differential Pressure
    2. AO – Automatic Air Damper Position

SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Each smoke damper shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.
B. Smoke dampers and combination fire/smoke dampers that are part of the building smoke control system shall be controlled automatically as a part of the smoke control sequences, and manually (automatic/open/closed) at the FSCS. Provide end witches at each smoke damper to prove fully open/fully closed position. Provide indication of position, via pilot lights at the FSCS.
C. Duct mounted Smoke Dampers and Combination Fire/Smoke Dampers: For each smoke damper and combination fire/smoke damper, provide the following:
    1. Mount duct smoke detectors furnished by the Electrical Trade.
    2. Provide 120-volt power to smoke damper or combination fire/smoke damper.
    3. Provide control wiring between the associated duct smoke detector and the combination fire/smoke damper actuator or smoke damper actuator in order to close the damper when smoke is sensed.
D. Elevator Smoke Damper: Provide 120-volt power to smoke damper. Provide wiring between the elevator hoist-way detector's auxiliary contacts, the elevator lobby detector's auxiliary contacts, and the smoke damper actuator in order to pen the smoke damper when one of the following occurs:
    1. Smoke is sensed in the elevator hoist-way or in the elevator lobby.

2. Upon loss of power.
3. Upon activation of a manual override control.

E. DDC Input/output points for Smoke Dampers
   1. DI – Smoke Detector Alarm
   2. DO – Samper Open/Close

CARBON MONOXIDE SENSORS

A. The ATC Subcontractor shall provide the proper number of carbon monoxide sensors to monitor the First Floor boiler room for the presence of carbon monoxide. If carbon monoxide level in the boiler room exceeds the setpoint, then an alarm shall be registered at the central operator's workstation. In addition, an audible and visual alarm, provided by the ATC Subcontractor, shall sound within the boiler room.

MISCELLANEOUS COMMON POINTS

A. The ATC Subcontractor shall provide the following sensors that shall be common to all sequences:
   1. A minimum of two (2) outdoor air temperature sensors shall be provided. These sensors shall be mounted on the north facing side of the building and shall be provided with sun shields (if necessary). The temperature measurements from the two sensors shall be averaged. If a difference of more than 1 degree F is measured between the two sensors, an alarm shall be registered at the operator's workstation.
   2. A minimum of two (2) outdoor air humidity sensors shall be provided. The humidity measurements from the two sensors shall be averaged. If a difference of more than 2% RH is measured between the two sensors, an alarm shall be registered at the operator's workstation.
   3. A minimum of two (2) outdoor air CO2 sensors shall be provided. The CO2 measurements from the two sensors shall be averaged. If a difference of more than 30 ppm is measured between the two sensors, an alarm shall be registered at the operator's workstation.

B. DDC Input/Output Points for Miscellaneous Points
   1. AI – Outdoor Air Temperature (2 each)
   2. AI – Outdoor Air Relative Humidity (2 each)
   3. AI – Outdoor CO2 (2 each)

END OF SEQUENCE OF OPERATION

TOWER ENGINEERING

Submittal Cover Sheet

ESTC Project Name:	Fairmont Office Building	Date Received:	07-29-2014
ESTC Project No.:	2011227	Date Sent:	08-06-2014
Client:	Omni Architects		
Client Project No.:	20856	Contractor:	Stuart-McMunn Company

Manufacturer Or Supplier	Item or System	Recommended Action	Comments
Schneider Electric	Automatic Temperature Controls (ATC) Drawings	No Exceptions Taken	N/A

Comments:

Reviewed By: Cory Weiland

Cory Weiland
Tower Engineering

Note: Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

Stuart-McMunn Company

Air Conditioning • Refrigeration • Heating • Plumbing • Medical Gas • Digital Controls
Serving West Virginia, Virginia and Ohio Since 1917 !

Tuesday, July 29, 2014

PROJECT:	**NEW STATE OFFICE BUILDING**
ARCHITECTS:	**Omni Associates**
CONTRACTOR:	Stuart-McMunn Company 137 North Sixth Street Clarksburg WV 26301 Mechanical Contractor
MANUFACTURER:	**Andover Controls**
SPECIFICATION SECTION:	**230900 BUILDING AUTOMATION SYSTEM** **Drawings - Revised**

STUART-McMUNN COMPANY

SMCO JOB # 2013610

SMCO SUBMITTAL # 230900 - 2R

WE HEREBY STATE THAT THIS DOCUMENT HAS BEEN REVIEWED FOR CONFORMANCE WITH THE DESIGN CONCEPT AND GENERAL COMPLIANCE WITH THE CONTRACT DOCUMENTS. THIS IN NO WAY RELEASES THE SUBCONTRACTOR/SUPPLIER FROM HIS RESPONSIBILITY TO ADHERE TO THE REQUIREMENTS OF THE CONTRACT DRAWINGS AND SPECIFICATIONS, INCLUDING ALL DIMENSIONS, QUANTITIES AND PERFORMANCE CRITERIA.

_____ APPROVED AS SUBMITTED

_____ APPROVED AS NOTED

_____ REJECTED - REVISE AND RESUBMIT

BY: Law

DATE: 7/29/2014

137 North Sixth Street • Clarksburg, WV 26301
Voice: 304.623.6666 • Fax: 304.623.4646 • email: leeanne@smco.us

NEW STATE OFFICE BUILDING - FAIRMONT

Fairmont, WV

ANDOVER CONTROLS HVAC DDC TEMPERATURE CONTROLS

Project No. 843-13

SUBMITTED: May 1, 2014
REVISED: July 18, 2014

PROJECT TEAM:
ARCHITECT: OMNI ASSOCIATES ARCHITECTS
MECHANICAL ENGINEER: TOWER ENGINEERING
MECHANICAL CONTRACTOR: STUART-MCMUNN CO.
CONTROLS CONTRACTOR: MASON & BARRY, INC.

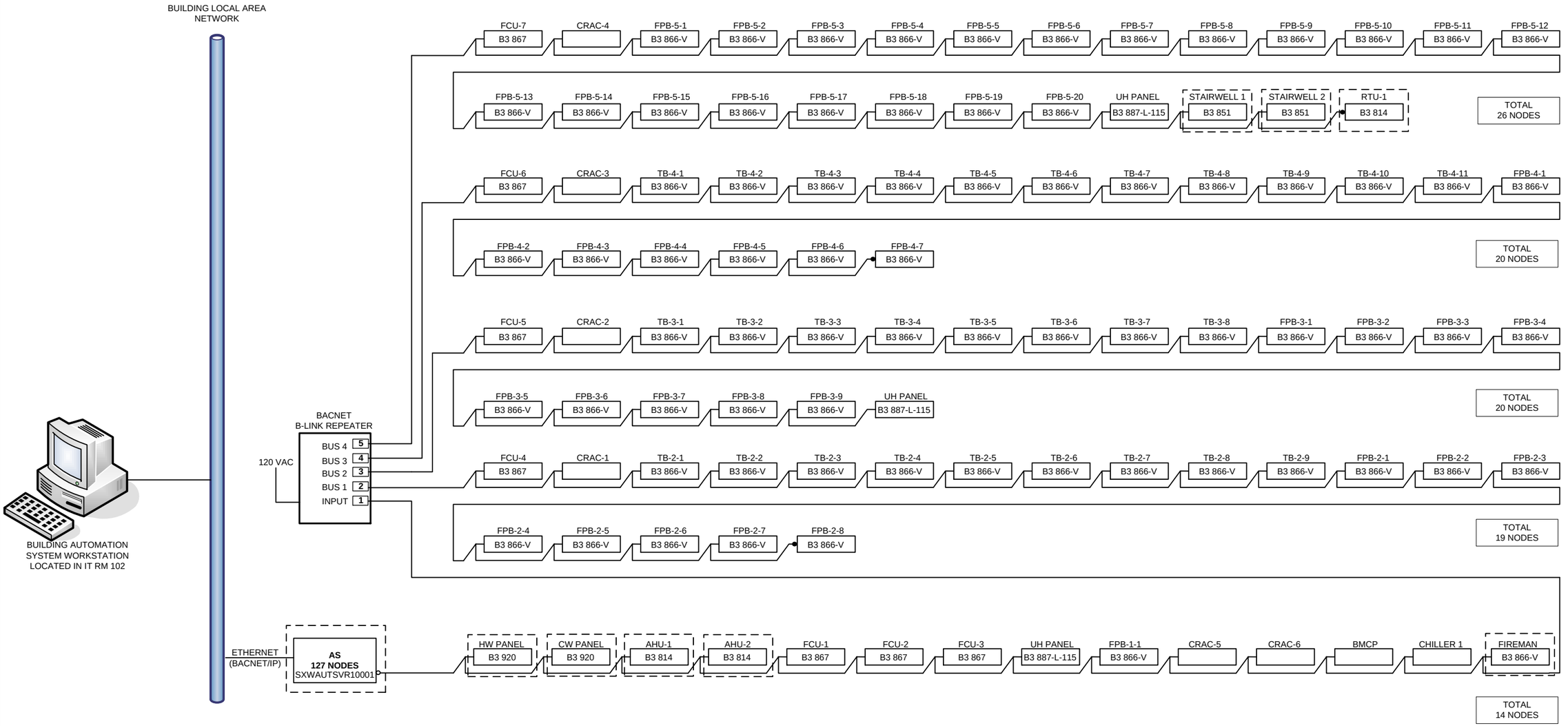
MASON & BARRY INC

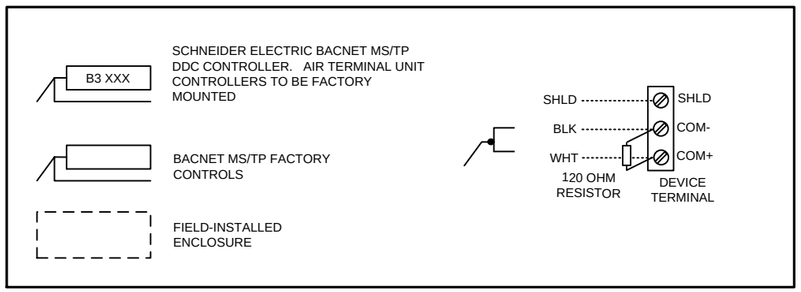
101 Smiley Drive
St. Albans, WV 25177

A Certified Representative of **Andover Controls**

DRAWING INDEX

NETWORK ARCHITECTURE





WIRING NOTES

1- ALL EXPOSED CABLE SHALL BE RUN IN CONDUIT, PLENUM RATED CABLE MAY BE USED WHERE CONCEALED.

2- DO NOT RUN HIGH VOLTAGE AND LOW VOLTAGE CABLES IN THE SAME CONDUIT.

3- USE OF SINGLE CONDUCTORS IS NOT PERMITTED, EACH WIRE RUN SHALL HAVE THE APPROPRIATE NUMBER OF CONDUCTORS.

4- USE 18 GAUGE STRANDED CONDUCTORS, SOLID CORE IS NOT ALLOWED.

5- COMMUNICATION BUS: 24 Ga. WCW 042002 1 PR. PLENUM RATED OR EQUAL.

6- COMMUNICATION BUS (IN CONDUIT): 24 Ga. WCW 042007 1 PR. NON-PLENUM RATED OR EQUAL.

7- OBSERVE POLARITY, ALL DEVICES ARE POLARITY SENSITIVE AND DAMAGE TO EQUIPMENT WILL BE OCCUR IF NOT OBSERVED.

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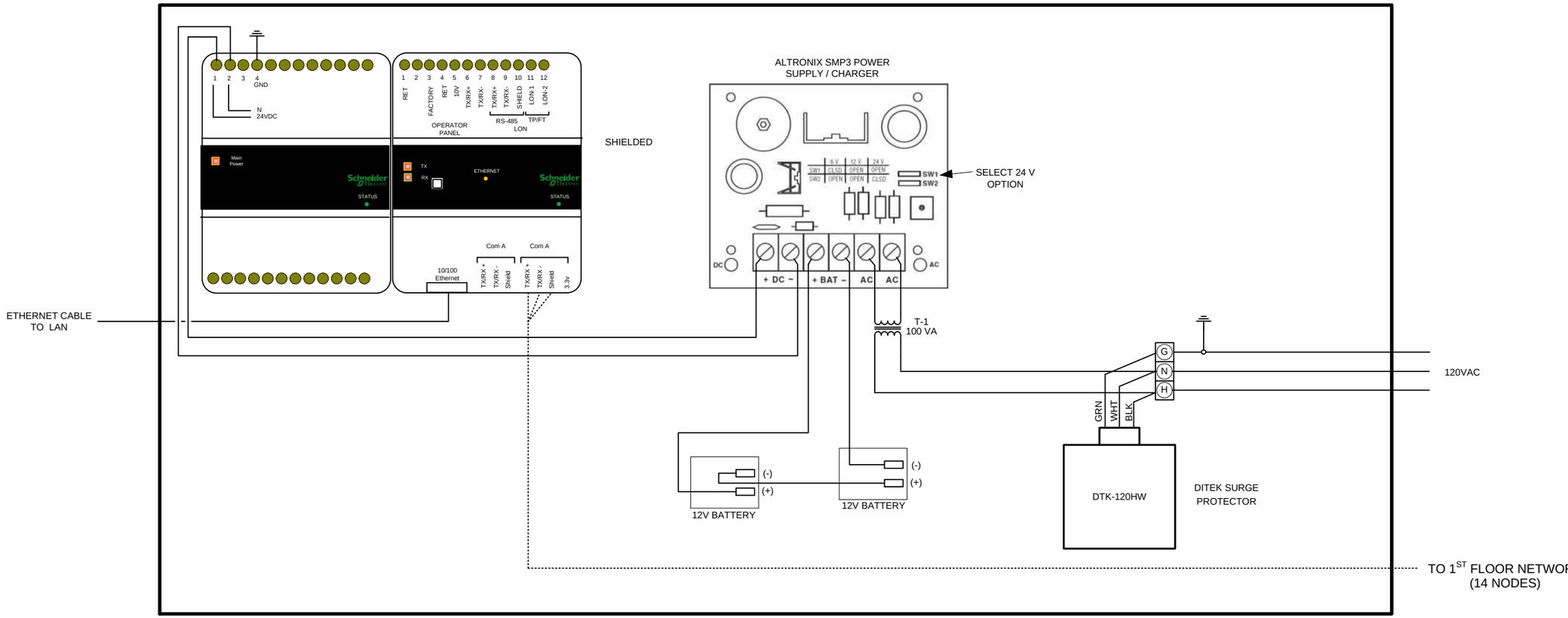
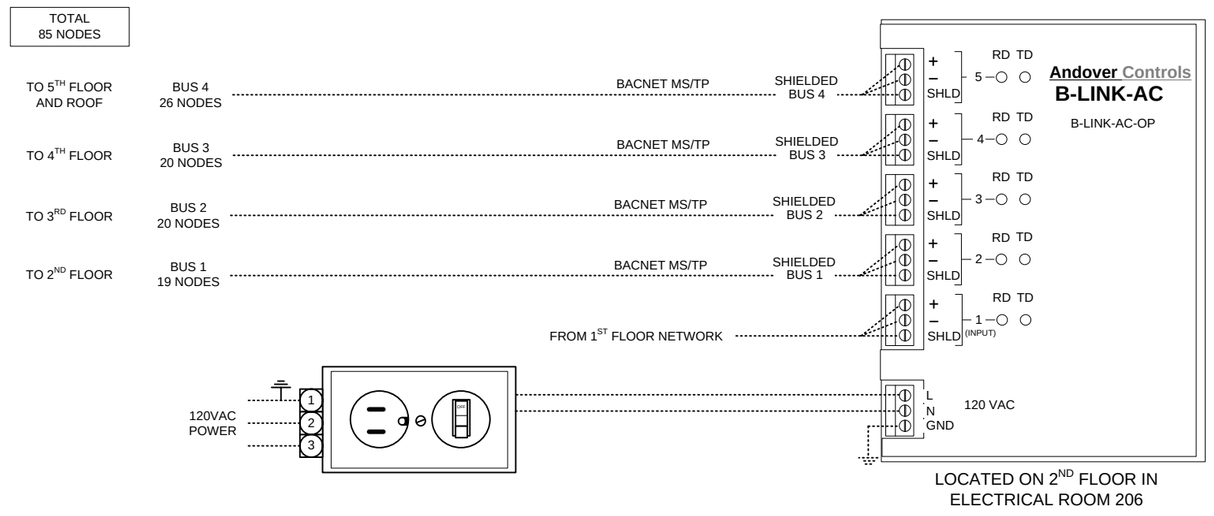
MASON & BARRY INC

NETWORK ARCHITECTURE
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

AUTOMATION SERVER PANEL





BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
KELE	RET-2620	1	ENCLOSURE - 26H X 20W X 7D, NEMA 1	1	1	ENCL	Panel Misc	ENCLOSURES
SE	01-2100-423	2	12V BATTERY FOR NETCONTROLLER POWER SUPPLY	1	2	BAT1, BAT2	Panel Misc	MISC
SE	SXWAUTSVR10001	1	AUTOMATION SERVER	1	1	AS	Panel Misc	CONTROLLERS
SE	SXWPS24VX10001	1	AUTOMATION SERVER POWER SUPPLY	1	1	PS	Panel Misc	CONTROLLERS
SE	B-LINK-AC	1	BACnet b-Link MS/TP Repeater	1	1	REP	Panel Misc	MISC
DITEK	DTK-120HW	1	SURGE SURPRESSOR - 120V INLINE`	1	1	SS	Panel Misc	MISC
ALTRONIX	SMP3	1	POWER SUPPLY / CHARGER (FOR BCX)	1	1	PS	Panel Misc	MISC

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AUTOMATION SERVER PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

CHILLED WATER SYSTEM

[AO] CW SYSTEM OUT10
DISTRIBUTION VALVE
(DistValve)

[AI] CW SYSTEM IN3
BLDG SUPPLY TEMP
(BldgSupTemp)

AB
A
B

CWR
CWS
WT4
WT4
DP-1
DP

TO BUILDING
CW SYSTEM

[DI] CW SYSTEM IN14
P-8 STATUS
(P_8Sts)

[DI] CW SYSTEM IN15
P-9 STATUS
(P_9Sts)

[AI] CW SYSTEM IN4
BLDG RETURN TEMP
(BldgRetTemp)

[AI] CW SYSTEM IN5
CHLR LOOP SUPPLY TEMP
(ChlrLoopSupTemp)

WT4

[AI] VAV_RH IN4
CW DIFFERENTIAL PRESSURE
(CwDiffPress)

[DO] CW SYSTEM OUT4
P-8 START/STOP
(P_8_SS)

[DO] CW SYSTEM OUT5
P-9 START/STOP
(P_9_SS)

[AO] CW SYSTEM OUT12
P-8 SPEED
(P_8Spd)

[AO] CW SYSTEM OUT13
P-9 SPEED
(P_9Spd)

AB
B
A

[AO] CW SYSTEM OUT9
ICE TANK VALVE
(IceTankValve)

ICE TANK 1

ICE TANK 2

ICE TANK 3

[AI] CW SYSTEM IN9
ICE TANK 1 LEVEL
(IceTank1Level)

[AI] CW SYSTEM IN10
ICE TANK 2 LEVEL
(IceTank2Level)

[AI] CW SYSTEM IN11
ICE TANK 3 LEVEL
(IceTank3Level)

FLOW SENSOR
FM
ONICON

[AI] CW SYSTEM IN8
CW FLOW
(CwFlow)

[AI] CW SYSTEM IN7
C-1 AMPS
(C_1Amps)

[AI] CW SYSTEM IN1
C-1 SUPPLY TEMP
(C_1SupTemp)

[DI] CW SYSTEM IN16
CHILLER FAULT ALARM
(ChillerAlrm)

WT4

CHILLER 1

WT4

WT4

[DO] CW SYSTEM OUT1
CHILLER ENABLE
(ChillerEnable)

[AO] CW SYSTEM OUT11
C-1 RESET SIGNAL
(C_1Reset)

[AI] CW SYSTEM IN2
C-1 RETURN TEMP
(C_1RetTemp)

[AI] CW SYSTEM IN6
CHLR LOOP RETURN TEMP
(ChlrLoopRetTemp)

[DI] CW SYSTEM IN12
P-6 STATUS
(P_6Sts)

[DI] CW SYSTEM IN13
P-7 STATUS
(P_7Sts)

[DO] CW SYSTEM OUT2
P-6 START/STOP
(P_6_SS)

[DO] CW SYSTEM OUT3
P-7 START/STOP
(P_7_SS)

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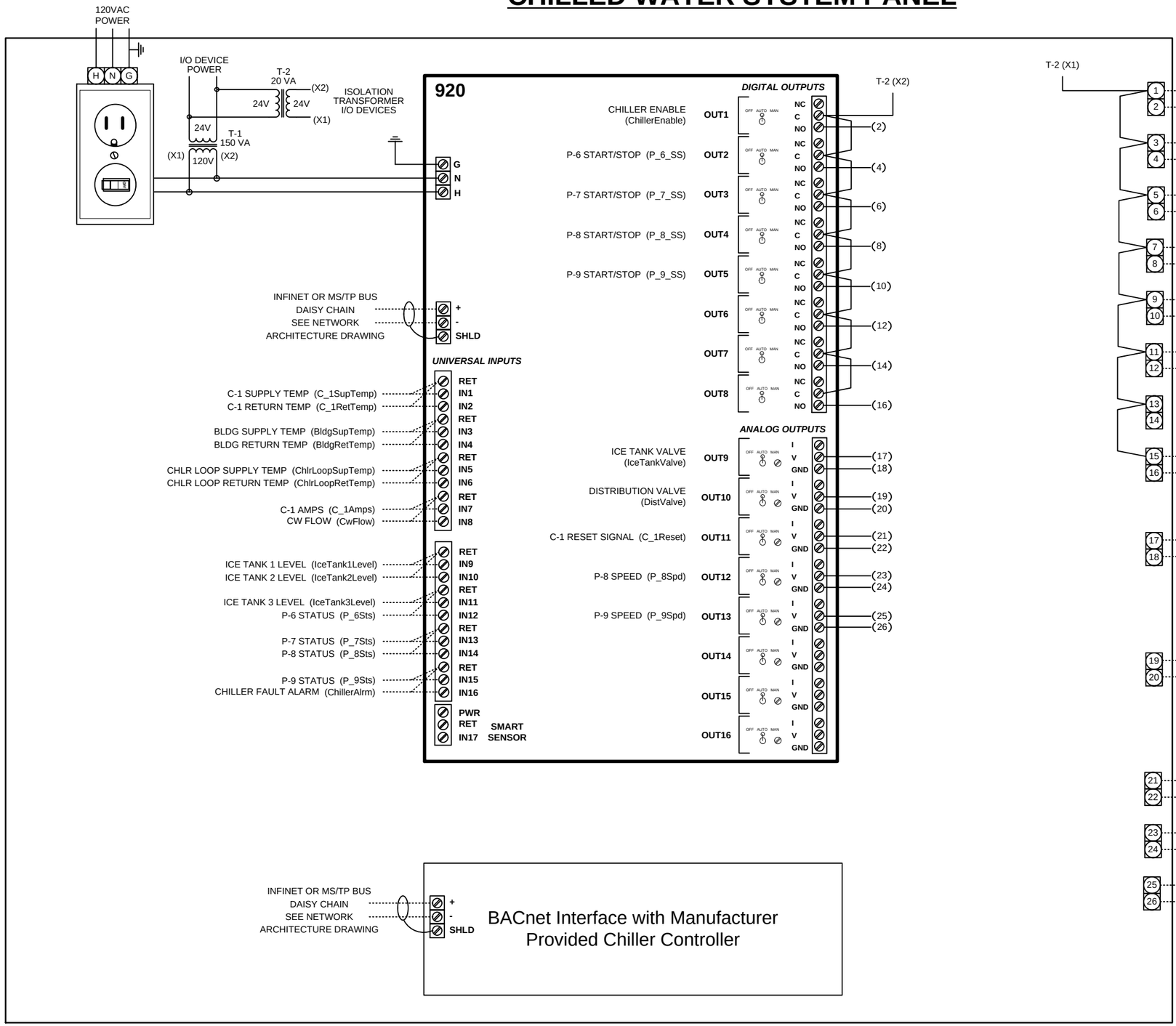
CHILLED WATER SYSTEM
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

CHILLED WATER SYSTEM PANEL



MASON & BARRY INC
101 Smiley Drive
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CHILLED WATER SYSTEM PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

CHILLED WATER SYSTEM BILL OF MATERIALS

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3920+XPDI8	1	CONTROLLER CONFIG - BACNET, 16 UI, 8 DO, 8 AO +8DI EXP.					
				1	1	I2920+EX1	Panel Misc	CONTROLLERS
VERIS	H735	2	COMBO SWITCH STATUS/ON-OFF 1AMP					
				1	1	CS	CW SYSTEM IN12	P-6 STATUS
				1	1	CS	CW SYSTEM IN13	P-7 STATUS
VERIS	H904	2	CURRENT SWITCH - SELF ADJ., USED W/ VFD					
				1	1	CS	CW SYSTEM IN14	P-8 STATUS
				1	1	CS	CW SYSTEM IN15	P-9 STATUS
KELE	RET-3626ULP	1	ENCLOSURE - 36H X 26W X 7D, NEMA 1					
				1	1	ENCL	Panel Misc	ENCLOSURES
ONICON	ONI-F-1210	1	WATER FLOW SENSOR - DUAL TURBINE - ANALOG OUTPUT					
				1	1	WF	CW SYSTEM IN8	CW FLOW
SE	EPW103	1	PRESS. SENSOR-DIFF, WET, 0-5/10/25/50 PSID RANGES					
				1	1	WDP	VAV_RH IN 4	DIFF PRESSURE
SE	ETI500-4	6	WATER SENSOR 4"					
				1	1	WT4	CW SYSTEM IN1	C-1 SUPPLY TEMP
				1	1	WT4	CW SYSTEM IN2	C-1 RETURN TEMP
				1	1	WT4	CW SYSTEM IN3	BLDG SUPPLY TEMP
				1	1	WT4	CW SYSTEM IN4	BLDG RETURN TEMP
				1	1	WT4	CW SYSTEM IN5	CHLR LOOP SUPPLY TEMP
				1	1	WT4	CW SYSTEM IN6	CHLR LOOP RETURN TEMP
SE	ETI-WELL-4S	6	4" STAINLESS STEEL WELL					
				1	1	WT4W	CW SYSTEM IN1	C-1 SUPPLY TEMP
				1	1	WT4W	CW SYSTEM IN2	C-1 RETURN TEMP
				1	1	WT4W	CW SYSTEM IN3	BLDG SUPPLY TEMP
				1	1	WT4W	CW SYSTEM IN4	BLDG RETURN TEMP
				1	1	WT4W	CW SYSTEM IN5	CHLR LOOP SUPPLY TEMP
				1	1	WT4W	CW SYSTEM IN6	CHLR LOOP RETURN TEMP
LECTRO	LE16550	2	TRANSFORMER - 50VA, 120/24VAC, UA					
				1	1	T-2	Panel Misc	TRANSFORMERS
				1	1	T-1	Panel Misc	TRANSFORMERS

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CHILLED WATER SYSTEM BILL OF MATERIALS
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

HOT WATER SYSTEM

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3814	1	CONTROLLER - BACNET, 8 UI / 4 DO, 4 AO W/OR					
				1	1	B3814	Panel Misc	CONTROLLERS
VERIS	H708	1	CURRENT SWITCH ON/OFF 1AMP W/ ST. PT.					
				1	1	CS	HW SYSTEM IN3	DOMESTIC HOT WATER BOILTER STATUS
VERIS	H904	2	CURRENT SWITCH - SELF ADJ., USED W/ VFD					
				1	1	CS	HW SYSTEM IN5	P-4 STATUS
				1	1	CS	HW SYSTEM IN6	P-5 STATUS
KELE	RET-3626ULP	1	ENCLOSURE - 36H X 26W X 7D, NEMA 1					
				1	1	ENCL	Panel Misc	ENCLOSURES
SENVA	CO2O-A	1	CO2 SENSOR - OA, LCD AND HEAT					
				1	1	OACO2	HW SYSTEM EXI IN3 (IN12)	OA CO2
VERIS	VER-GWVXS	1	CO SENSOR - WALL					
				1	1	WCO	HW SYSTEM IN7	CO ALARM
SE	EHD110-500	1	HUMIDITY SENSOR W/ TEMP					
				1	1	DH	HW SYSTEM EXI IN2 (IN11)	OA HUMIDITY
SE	EPW103	1	PRESS. SENSOR-DIFF, WET, 0-5/10/25/50 PSID RANGES					
				1	1	WDP	HW SYSTEM IN8	DIFF PRESSURE
SE	ETI500-4	2	WATER SENSOR 4"					
				1	1	WT4	HW SYSTEM IN1	SUPPLY TEMP
				1	1	WT4	HW SYSTEM IN2	RETURN TEMP
SE	ETI-WELL-4S	2	4" STAINLESS STEEL WELL					
				1	1	WT4W	HW SYSTEM IN1	SUPPLY TEMP
				1	1	WT4W	HW SYSTEM IN2	RETURN TEMP
LECTRO	LE16550	2	TRANSFORMER - 50VA, 120/24VAC, UA					
				1	1	T-2	Panel Misc	TRANSFORMERS
				1	1	T-1	Panel Misc	TRANSFORMERS

SEE BOILER MASTER CONTROL PANEL
WIRING DIAGRAM FOR DETAILS

BOILER 1

BOILER 2

BOILER 3

[DI] HW SYSTEM IN7
CO ALARM
(COAlm)

CO DETECTOR

[DI] HW SYSTEM IN4
BOILER EMERGENCY SHUTDOWN
(BoilerShutDown)

BREAK-GLASS BOILER EMERGENCY SHUTDOWN

[AI] HW SYSTEM EXI IN2 (IN11)
OA HUMIDITY
(OARH)

[AI] HW SYSTEM EXI IN1 (IN10)
OA TEMP
(OaTemp)

OARHT

MOUNT ON NORTH-FACING WALL

[AI] HW SYSTEM EXI IN3 (IN12)
OA CO2
(OaCo2)

OACO2

MOUNT ON NORTH-FACING WALL

[AI] HW SYSTEM IN1
SUPPLY TEMP
(SupTemp)

WT4

WT4

HWR

HWS

DP-1

DP

[AI] HW SYSTEM IN2
RETURN TEMP
(RetTemp)

[AI] VAV_RH IN4
HW DIFFERENTIAL PRESSURE
(HwDiffPress)

[DI] HW SYSTEM IN5
P-4 STATUS
(P_4Sts)

[DI] HW SYSTEM IN6
P-5 STATUS
(P_5Sts)

[DO] HW SYSTEM OUT1
P- 4 START/STOP
(P_4_SS)

[AO] HW SYSTEM OUT5
P-4 SPEED
(P_4Spd)

[DO] HW SYSTEM OUT2
P- 5 START/STOP
(P_5_SS)

[AO] HW SYSTEM OUT6
P-5 SPEED
(P_5Spd)

DOMESTIC HOT WATER BOILER

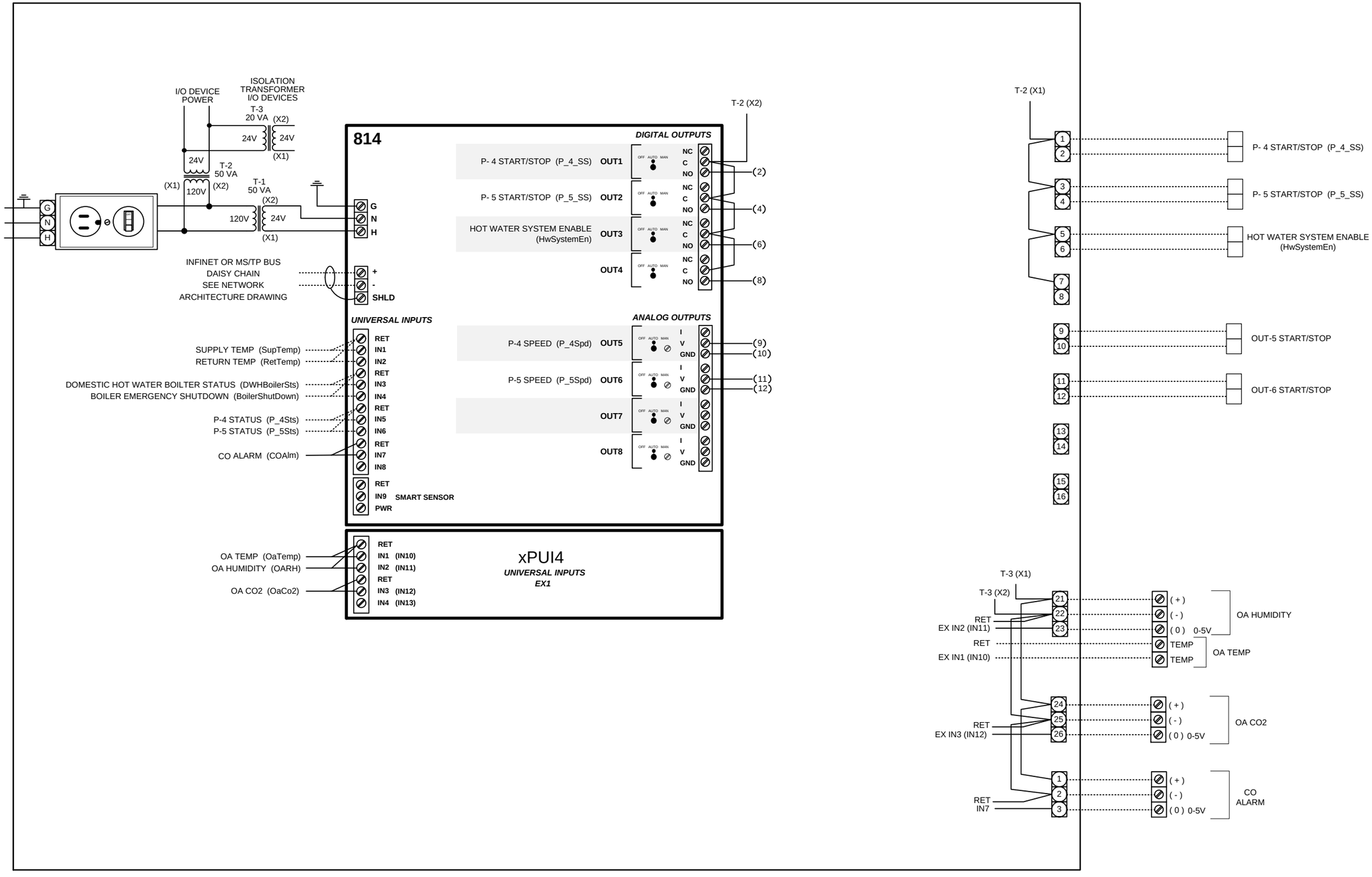
[DI] HW SYSTEM IN3
DOMESTIC HOT WATER BOILTER STATUS
(DWHBoilerSts)

101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

HOT WATER SYSTEM
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

HOT WATER SYSTEM PANEL



MASON & BARRY INC
101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls

HOT WATER SYSTEM PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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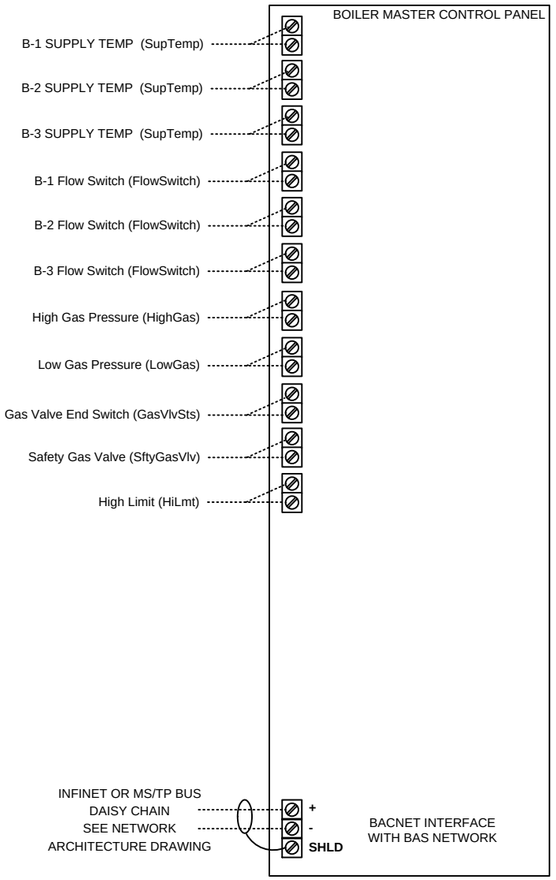
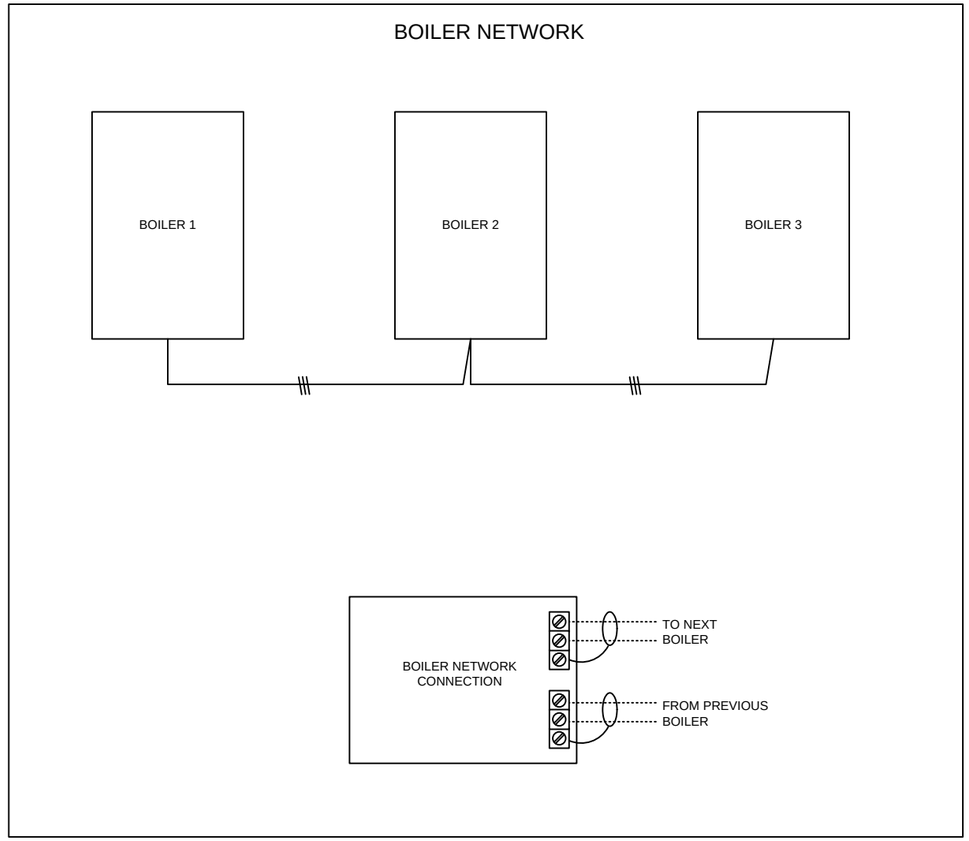
REVISE	NSD	07-18-2014

BOILER MASTER CONTROL PANEL





SEE PAGE 9 FOR BOILER MASTER CONTROL PANEL WIRING SCHEMATIC REFERENCE

MASON & BARRY INC
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101 Smiley Drive
St. Albans, WV 25177

BOILER MASTER CONTROL PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
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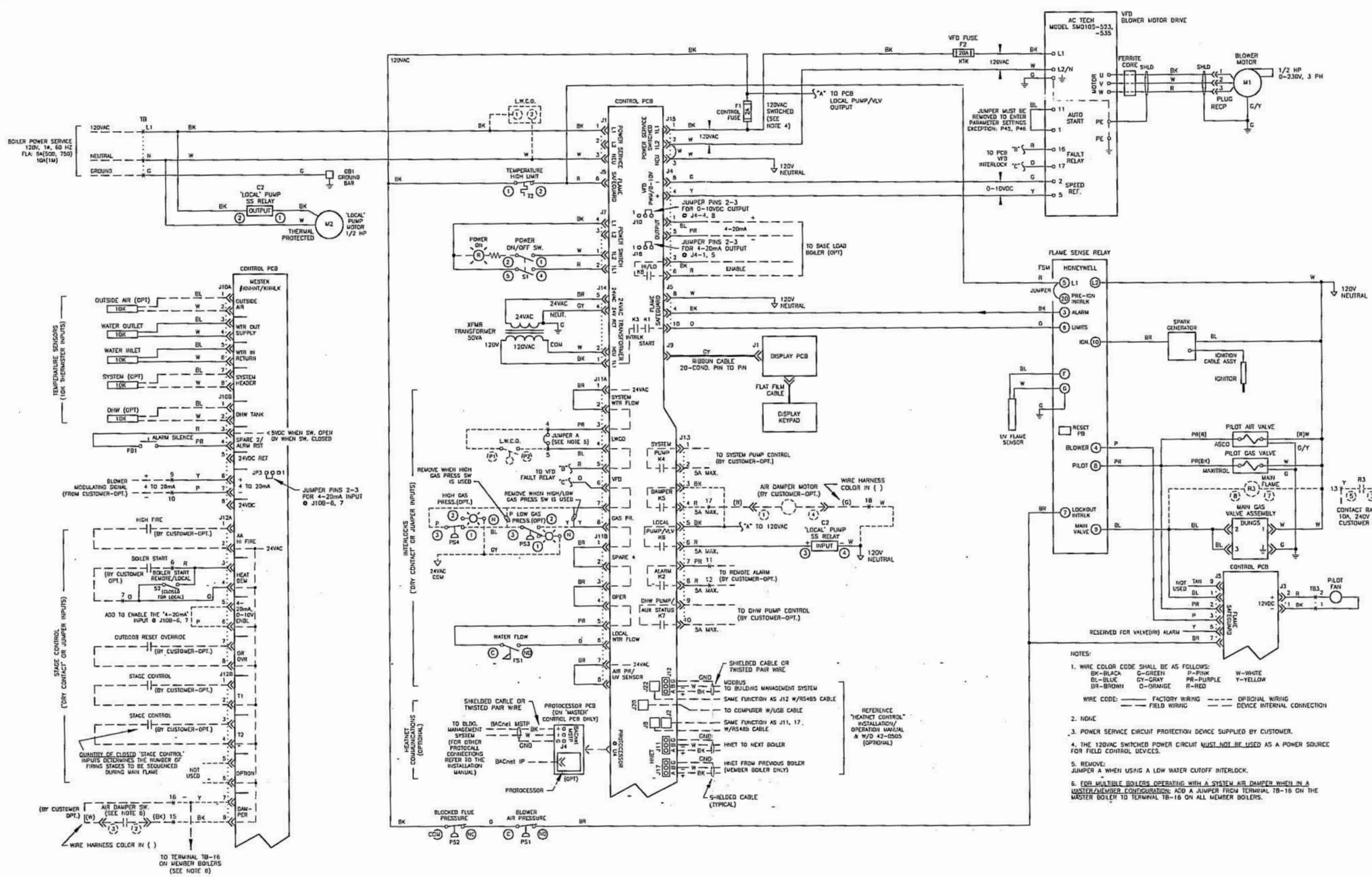
BMCP WIRING SCHEMATIC



NOTES:

1. WIRE COLOR CODE SHALL BE AS FOLLOWS:
   BK-BLACK G-GREEN P-PINK W-WHITE
   BL-BLUE GY-GRAY PR-PURPLE Y-YELLOW
   BR-BROWN O-ORANGE R-RED

   WIRE CODE: ——— FACTORY WIRING - - - - OPTIONAL WIRING
   ——— FIELD WIRING — — — DEVICE INTERNAL CONNECTION

2. NONE

3. POWER SERVICE CIRCUIT PROTECTION DEVICE SUPPLIED BY CUSTOMER.

4. THE 120VAC SWITCHED POWER CIRCUIT MUST NOT BE USED AS A POWER SOURCE FOR FIELD CONTROL DEVICES.

5. REMOVE JUMPER A WHEN USING A LOW WATER CUTOFF INTERLOCK.

6. FOR MULTIBLE BOILERS OPERATING WITH A SYSTEM AIR DAMPER WHEN IN A MASTER/MEMBER CONFIGURATION: ADD A JUMPER FROM TERMINAL TB-16 ON THE MASTER BOILER TO TERMINAL TB-16 ON ALL MEMBER BOILERS.

MASON & BARRY INC
101 Smiley Drive
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BMCP WIRING SCHEMATIC
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

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SUBMIT	NSD	05-01-2014
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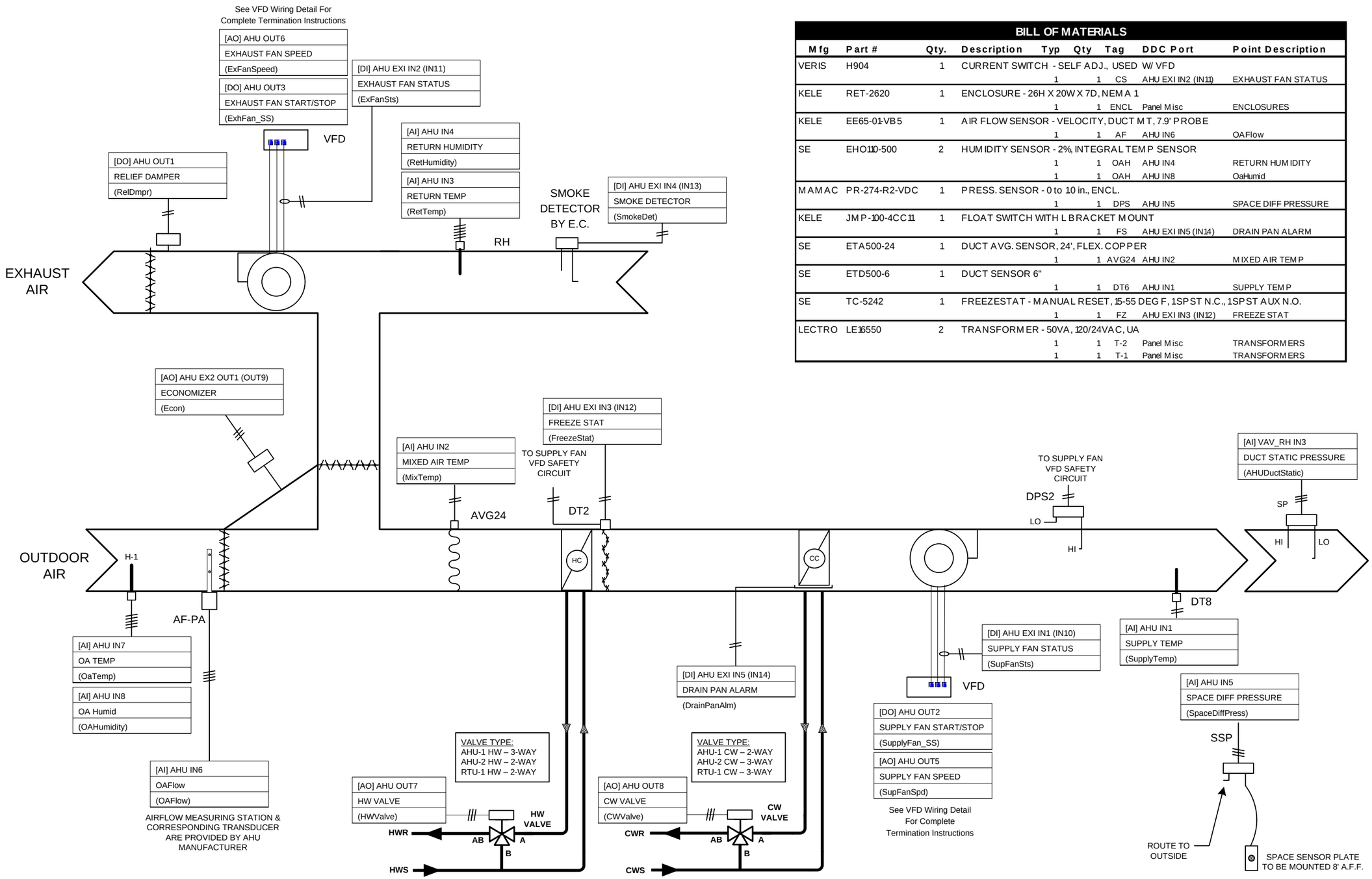
VAV AHU & RTU (AHU-1, AHU-2, RTU-3)

(TYPICAL OF 3)



BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
VERIS	H904	1	CURRENT SWITCH - SELF ADJ., USED W/ VFD					
				1	1	CS	AHU EXI IN2 (IN11)	EXHAUST FAN STATUS
KELE	RET-2620	1	ENCLOSURE - 26H X 20W X 7D, NEMA 1					
				1	1	ENCL	Panel Misc	ENCLOSURES
KELE	EE65-01-VB5	1	AIR FLOW SENSOR - VELOCITY, DUCT MT, 7.9' PROBE					
				1	1	AF	AHU IN6	OAFlow
SE	EHO110-500	2	HUMIDITY SENSOR - 2%, INTEGRAL TEMP SENSOR					
				1	1	OAH	AHU IN4	RETURN HUMIDITY
				1	1	OAH	AHU IN8	OaHumid
MAMAC	PR-274-R2-VDC	1	PRESS. SENSOR - 0 to 10 in., ENCL.					
				1	1	DPS	AHU IN5	SPACE DIFF PRESSURE
KELE	JMP-100-4CC11	1	FLOAT SWITCH WITH L BRACKET MOUNT					
				1	1	FS	AHU EXI IN5 (IN14)	DRAIN PAN ALARM
SE	ETA500-24	1	DUCT AVG. SENSOR, 24', FLEX. COPPER					
				1	1	AVG24	AHU IN2	MIXED AIR TEMP
SE	ETD500-6	1	DUCT SENSOR 6"					
				1	1	DT6	AHU IN1	SUPPLY TEMP
SE	TC-5242	1	FREEZESTAT - MANUAL RESET, 15-55 DEG F, 1SPST N.C., 1SPST AUX N.O.					
				1	1	FZ	AHU EXI IN3 (IN12)	FREEZE STAT
LECTRO	LE16550	2	TRANSFORMER - 50VA, 120/24VAC, UA					
				1	1	T-2	Panel Misc	TRANSFORMERS
				1	1	T-1	Panel Misc	TRANSFORMERS

101 Smiley Drive
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VAV AHU & RTU (AHU-1, AHU-2, RTU-3)
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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SUBMIT	NSD	05-01-2014
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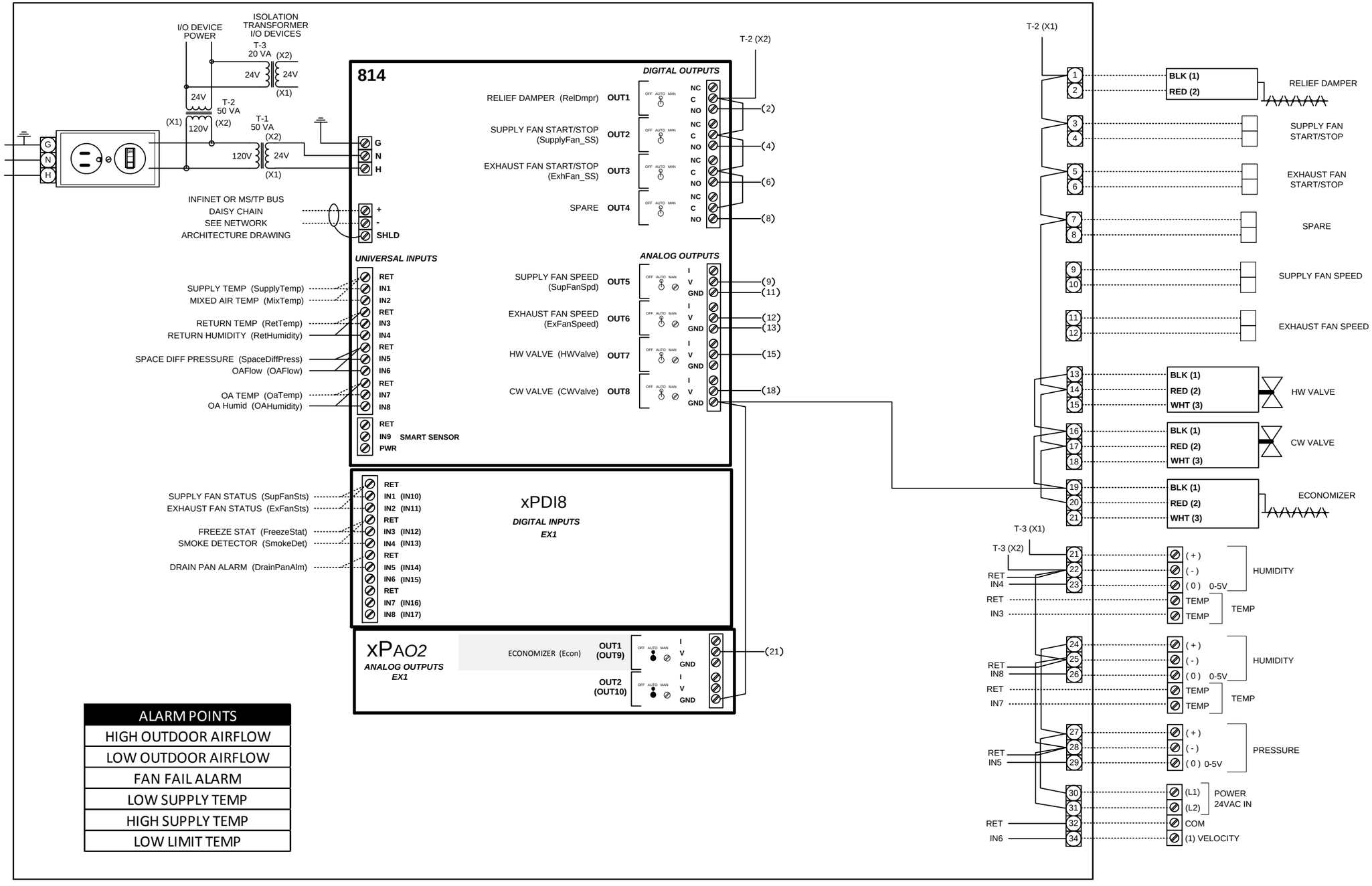
VAV AHU & RTU PANEL (AHU-1, AHU-2, RTU-1)

(TYPICAL OF 3)



ALARM POINTS
HIGH OUTDOOR AIRFLOW
LOW OUTDOOR AIRFLOW
FAN FAIL ALARM
LOW SUPPLY TEMP
HIGH SUPPLY TEMP
LOW LIMIT TEMP

101 Smiley Drive
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VAV AHU & RTU PANEL (AHU-1, AHU-2, RTU-1)
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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SUBMIT	NSD	05-01-2014
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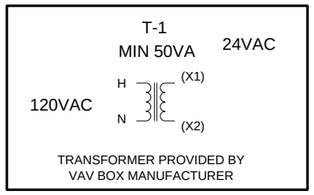
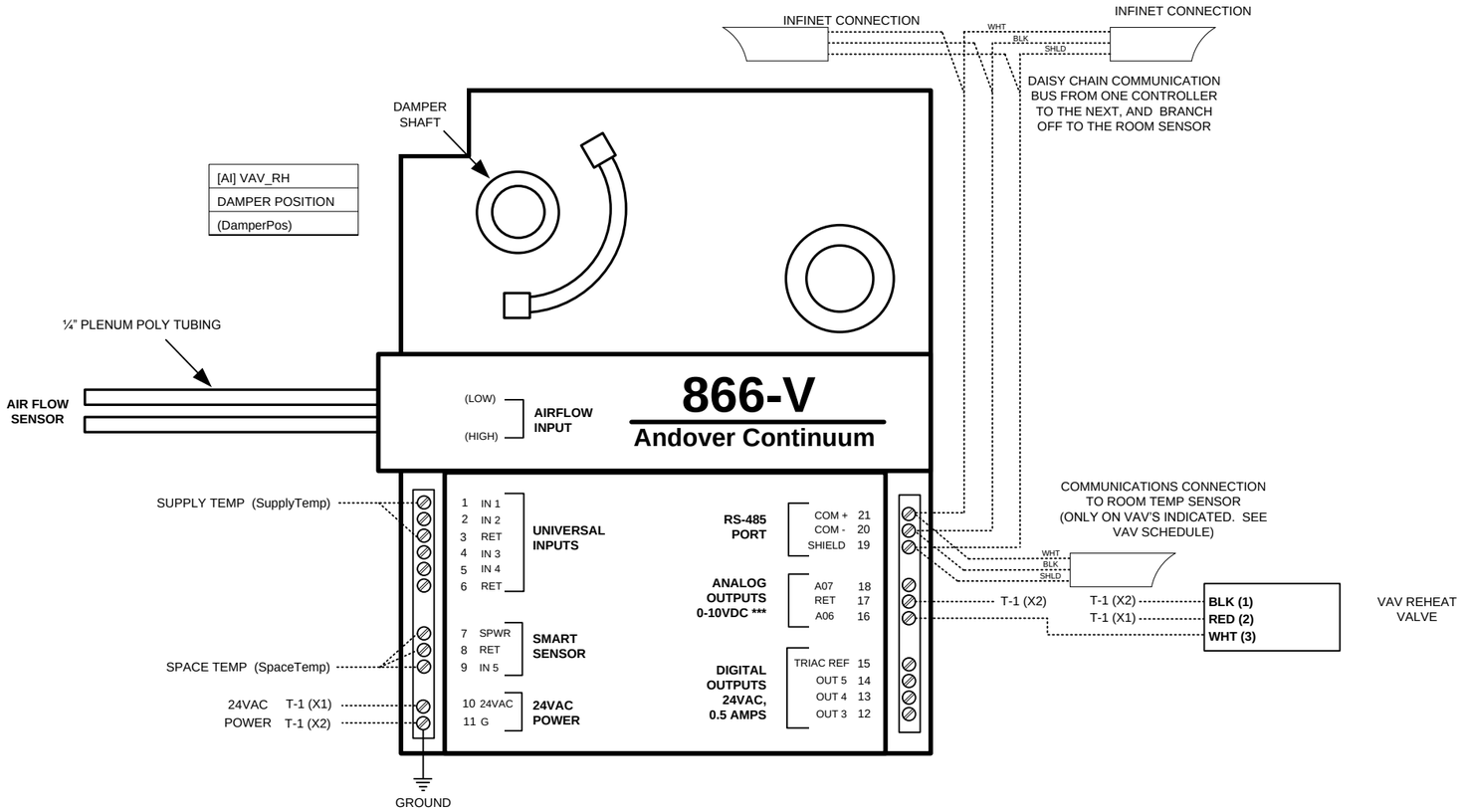
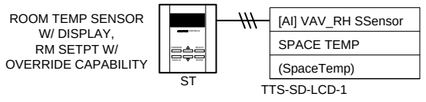
VAV w/HOT WATER REHEAT

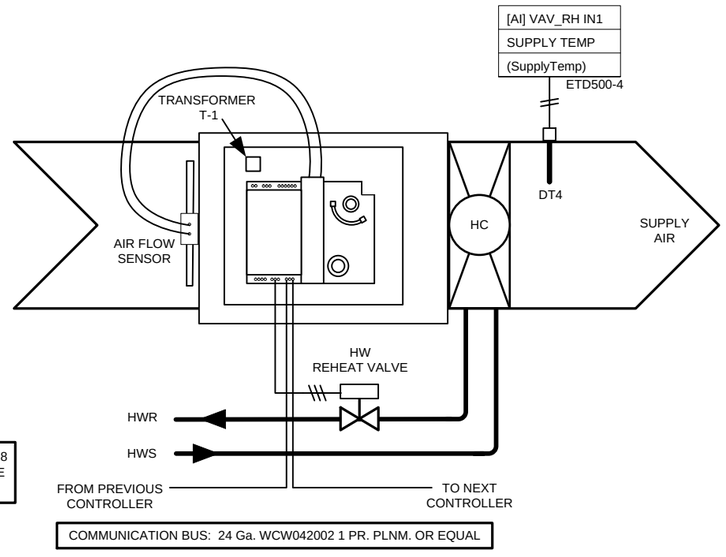
(TYPICAL OF 14)



TRANSFORMER PROVIDED BY
VAV BOX MANUFACTURER







ALL WIRING, EXCEPT WHERE SHOWN, SHALL BE 18 GAUGE STRANDED WIRE WITH THE APPROPRIATE NUMBER OF CONDUCTORS.

COMMUNICATION BUS: 24 Ga. WCW042002 1 PR. PLNM. OR EQUAL

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3866-V	14	CONTROLLER	14	1	I2866-V	Panel Misc	CONTROLLERS
SE	ETD500-4	14	DUCT SENSOR 4"	14	1	DT4	VAV_RH IN1	SUPPLY TEMP
SE	TTS-SD-LCD-1	14	SMART SENSOR LCD 4 CHARACTER DISPLAY	14	1	RT	VAV_RH SSensor	SPACE TEMP

101 Smiley Drive
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VAV w/HOT WATER REHEAT
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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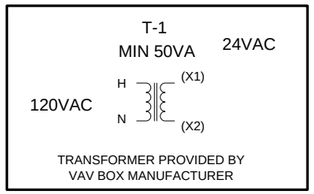
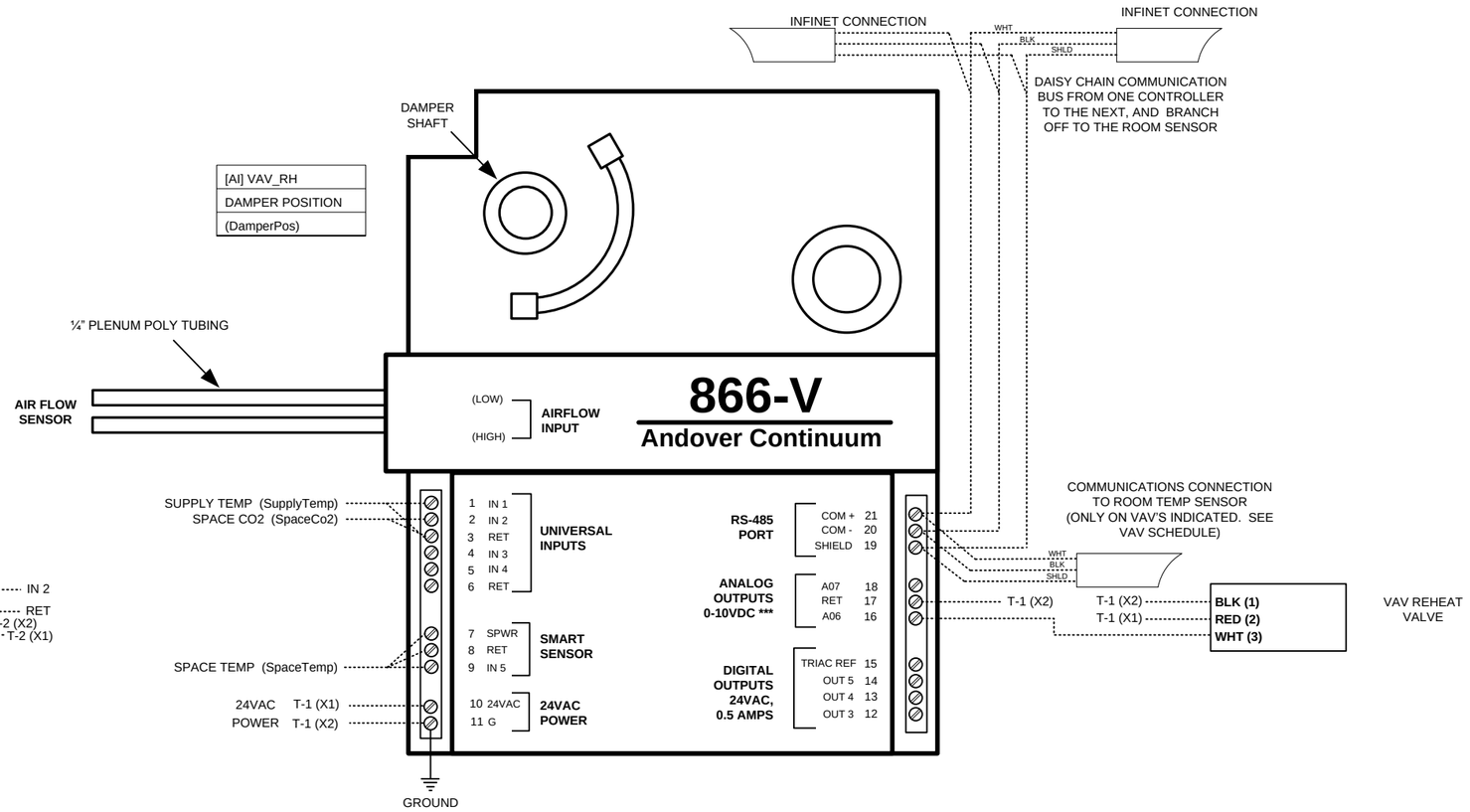
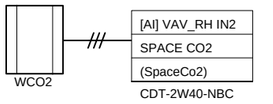
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

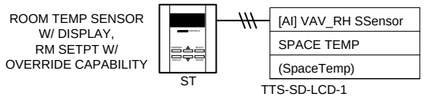
VAV w/HOT WATER REHEAT, CO2

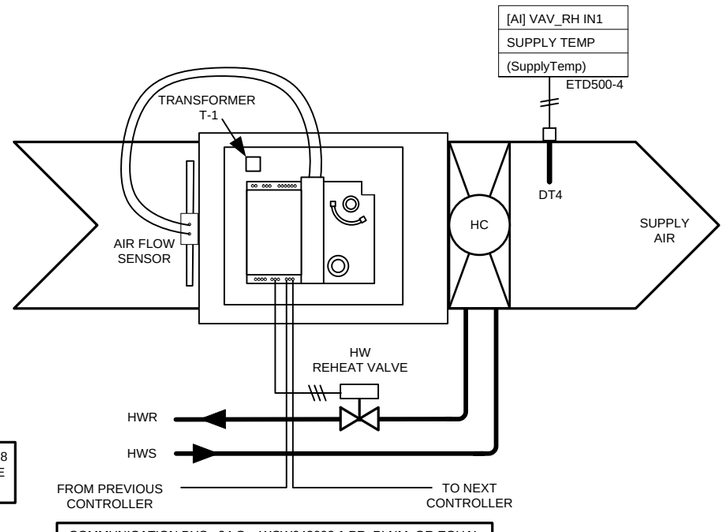
(TYPICAL OF 14)











ALL WIRING, EXCEPT WHERE SHOWN, SHALL BE 18 GAUGE STRANDED WIRE WITH THE APPROPRIATE NUMBER OF CONDUCTORS.

COMMUNICATION BUS: 24 Ga. WCW042002 1 PR. PLNM. OR EQUAL

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	I2866-V	14	CONTROLLER					
				14	1	I2866-V	Panel Misc	CONTROLLERS
DWYER	CDT-2W40-NBC	14	CO2 SENSOR - WALL, 0-5V, 0-2000 PPM					
				14	1	WCO2	VAV_RH IN2	SPACE CO2
SE	ETD500-4	14	DUCT SENSOR 4"					
				14	1	DT4	VAV_RH IN1	SUPPLY TEMP
SE	TTS-SD-LCD-1	14	SMART SENSOR LCD 4 CHARACTER DISPLAY					
				14	1	RT	VAV_RH SSensor	SPACE TEMP

101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

VAV w/HOT WATER REHEAT, CO2
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

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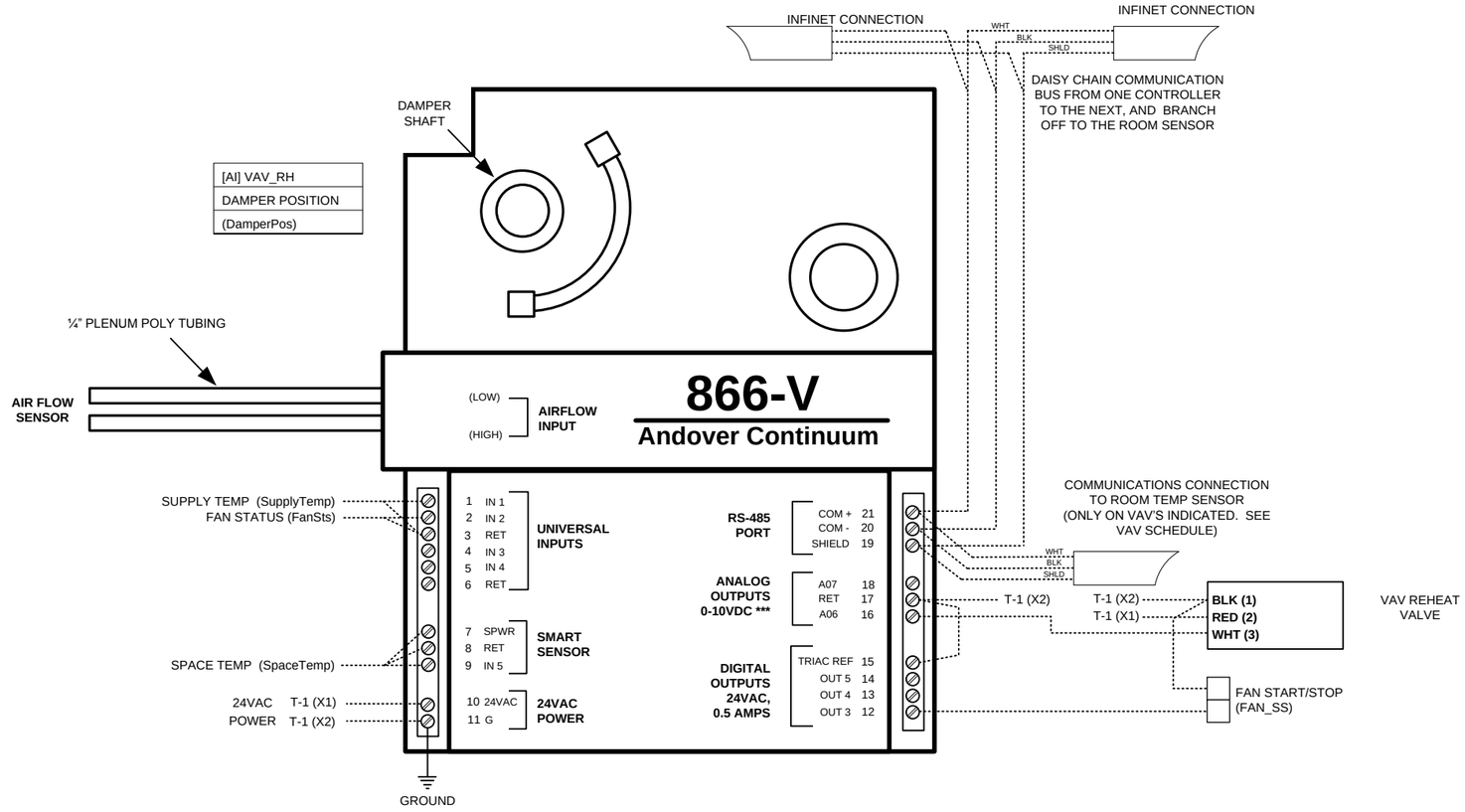
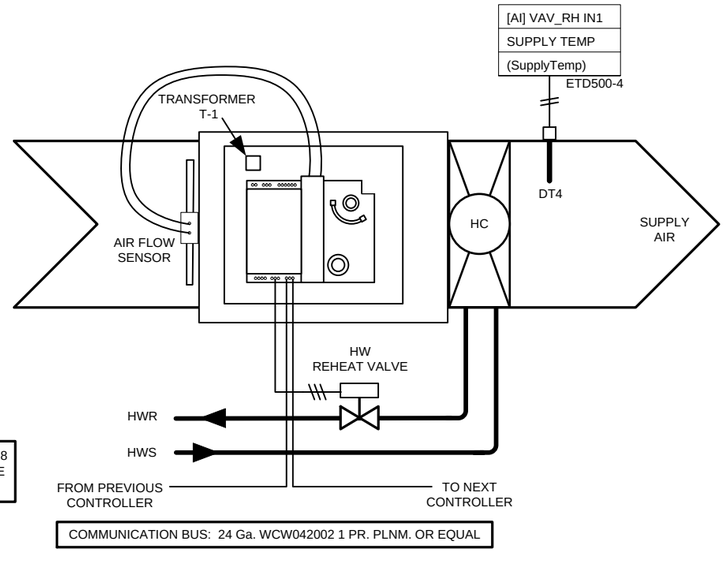
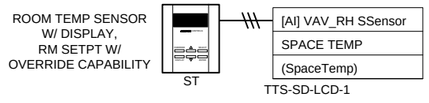
FAN POWERED VAV w/HOT WATER REHEAT

(TYPICAL OF 25)







ALL WIRING, EXCEPT WHERE SHOWN, SHALL BE 18 GAUGE STRANDED WIRE WITH THE APPROPRIATE NUMBER OF CONDUCTORS.

COMMUNICATION BUS: 24 Ga. WCW042002 1 PR. PLNM. OR EQUAL

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3866-V	25	CONTROLLER - BACNET, 5 INPUTS W/AF / 4 DIGITAL, 2 ANALOG OUTPUTS	25	1	VAV	Panel Misc	CONTROLLERS
SENVA	C-1220	25	CURRENT SENSOR - MINI SOLID CORE, .PRE-SET, 75A-50A, N.O. OUTPUT	25	1	CS	FPB-X IN2	FAN STATUS
KELE	PAM-1	25	RELAY - MULTIVOLTAGE, 24 VAC/DC, 115 VAC	25	1	R	FPB-X OUT4	
SE	ETD500-4	25	DUCT SENSOR 4"	25	1	DT4	FPB-X IN1	SUPPLY TEMP
SE	TTS-SD-LCD-1	25	SMART SENSOR LCD 4 CHARACTER DISPLAY	25	1	FPB-X RT	Panel Misc	MISC

101 Smiley Drive
St. Albans, WV 25177
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FAN POWERED VAV w/HOT WATER REHEAT
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

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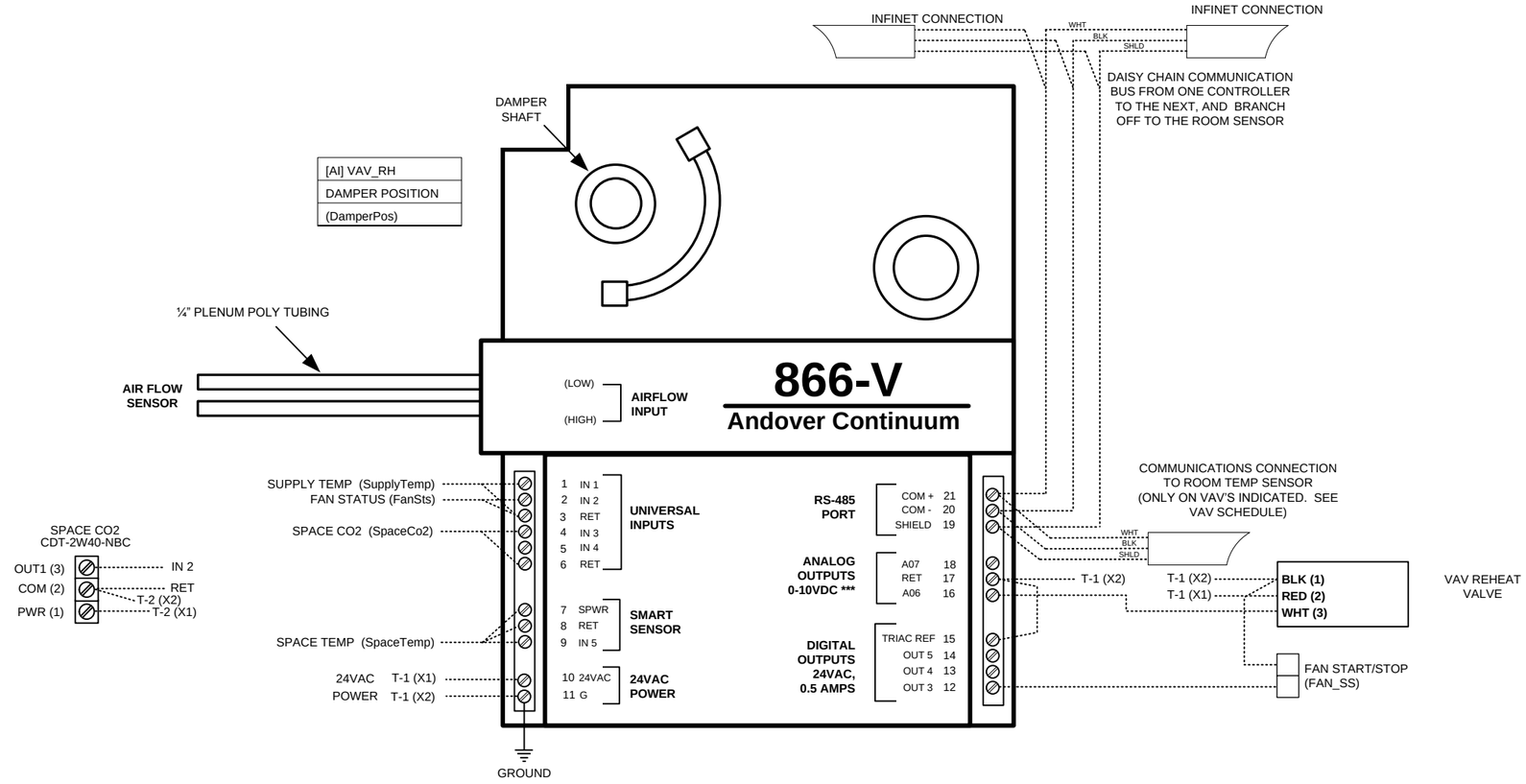
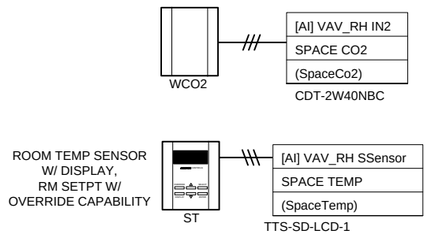
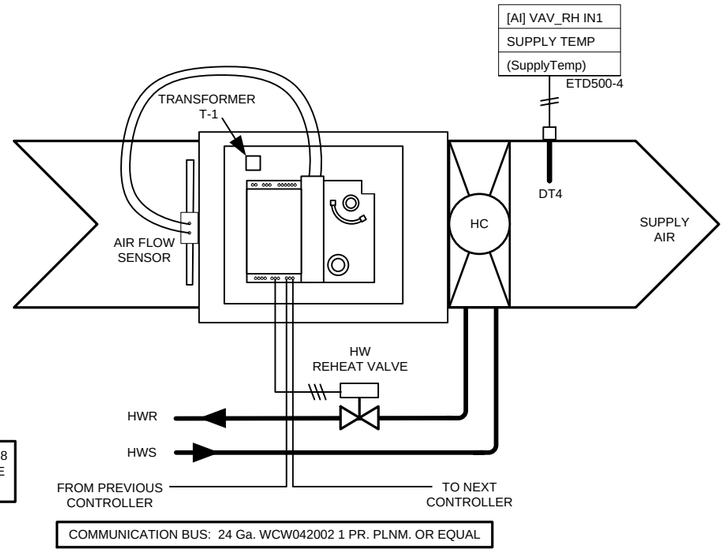
FAN POWERED VAV w/HOT WATER REHEAT, CO2

(TYPICAL OF 20)







ALL WIRING, EXCEPT WHERE SHOWN, SHALL BE 18 GAUGE STRANDED WIRE WITH THE APPROPRIATE NUMBER OF CONDUCTORS.

COMMUNICATION BUS: 24 Ga. WCW042002 1 PR. PLNM. OR EQUAL

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3866-V	20	CONTROLLER - BACNET, 5 INPUTS W/AF / 4 DIGITAL, 2 ANALOG OUTPUTS	20	1	VAV	Panel Misc	CONTROLLERS
SENVA	C-1220	20	CURRENT SENSOR - MINI SOLID CORE, .PRE-SET, 75A-50A, N.O. OUTPUT	20	1	CS	FPB-X IN2	FAN STATUS
DWYER	CDT-2W40-NB(	20	CO2 SENSOR - WALL, 0-5V, 0-2000 PPM	20	1	WCO2	VAV_RH IN2	SPACE CO2
KELE	PAM-1	20	RELAY - MULTIVOLTAGE, 24 VAC/DC, 115 VAC	20	1	R	FPB-X OUT4	
SE	ETD500-4	20	DUCT SENSOR 4"	20	1	DT4	FPB-X IN1	SUPPLY TEMP
SE	TTS-SD-LCD-1	20	SMART SENSOR LCD 4 CHARACTER DISPLAY	20	1	FPB-X RT	Panel Misc	MISC

101 Smiley Drive
St. Albans, WV 25177
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MASON & BARRY INC

FAN POWERED VAV w/HOT WATER REHEAT, CO2
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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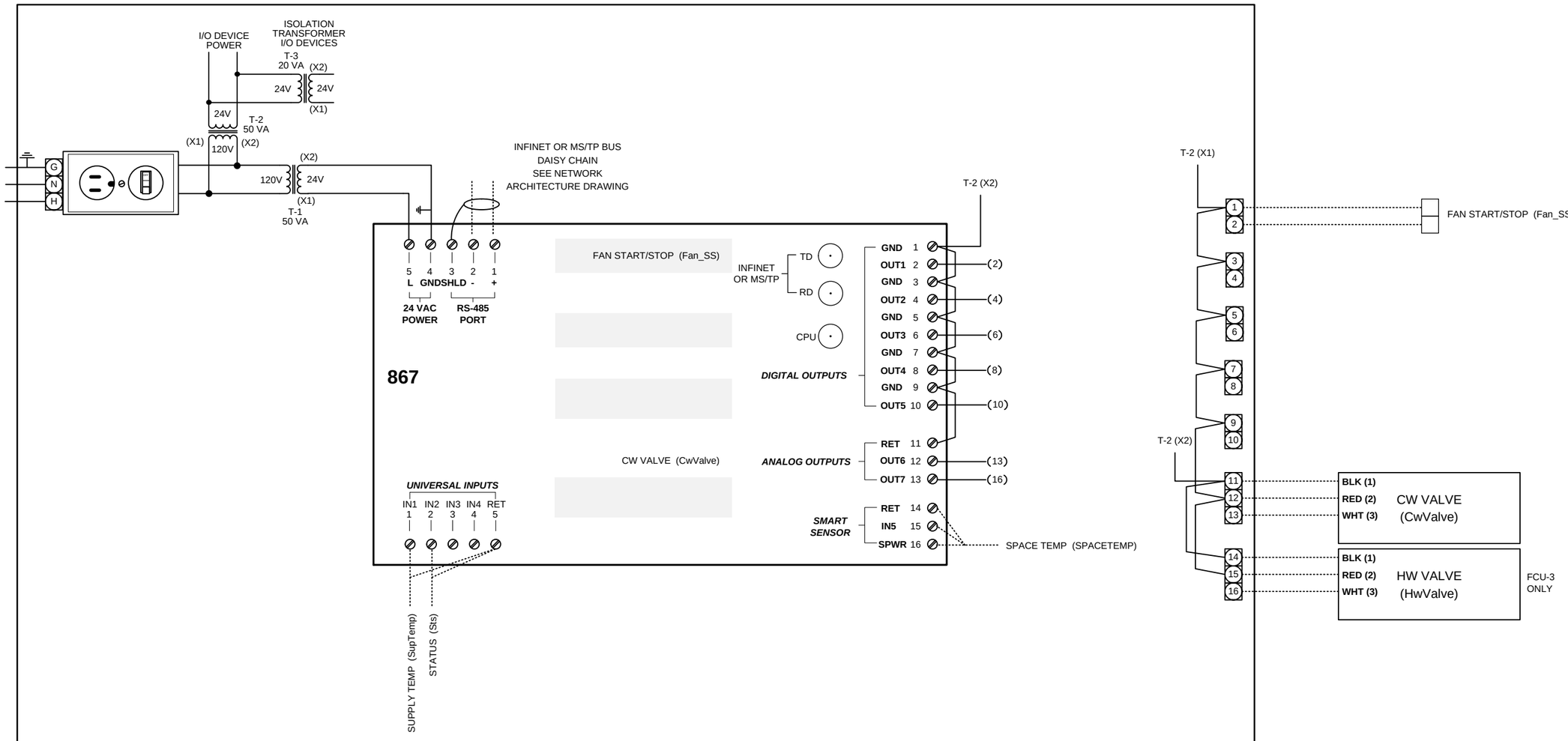
FAN COIL UNITS

(TYPICAL OF 7)



BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3867	1	CONTROLLER - BACNET, 4 UI +2 TRIAC/4DO +1DO +SS					
				1	1	B3 867	Panel Misc	CONTROLLERS
VERIS	H800	1	MINI CURRENT SWITCH ON/OFF .5 AMP					
				1	1	CS	FCU IN2	STATUS
KELE	PAM-1	1	RELAY - MULTIVOLTAGE, 24 VAC/DC, 115 VAC					
				1	1	R	FCU OUT1	FAN START/STOP
SE	ETD500-4	1	DUCT SENSOR 4"					
				1	1	DT4	FCU IN1	SUPPLY TEMP
SE	TTS-SD-LCD-1	1	SMART SENSOR LCD 4 CHARACTER DISPLAY					
				1	1	RT	FCU SSensor	SPACE TEMP

101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

FAN COIL UNITS
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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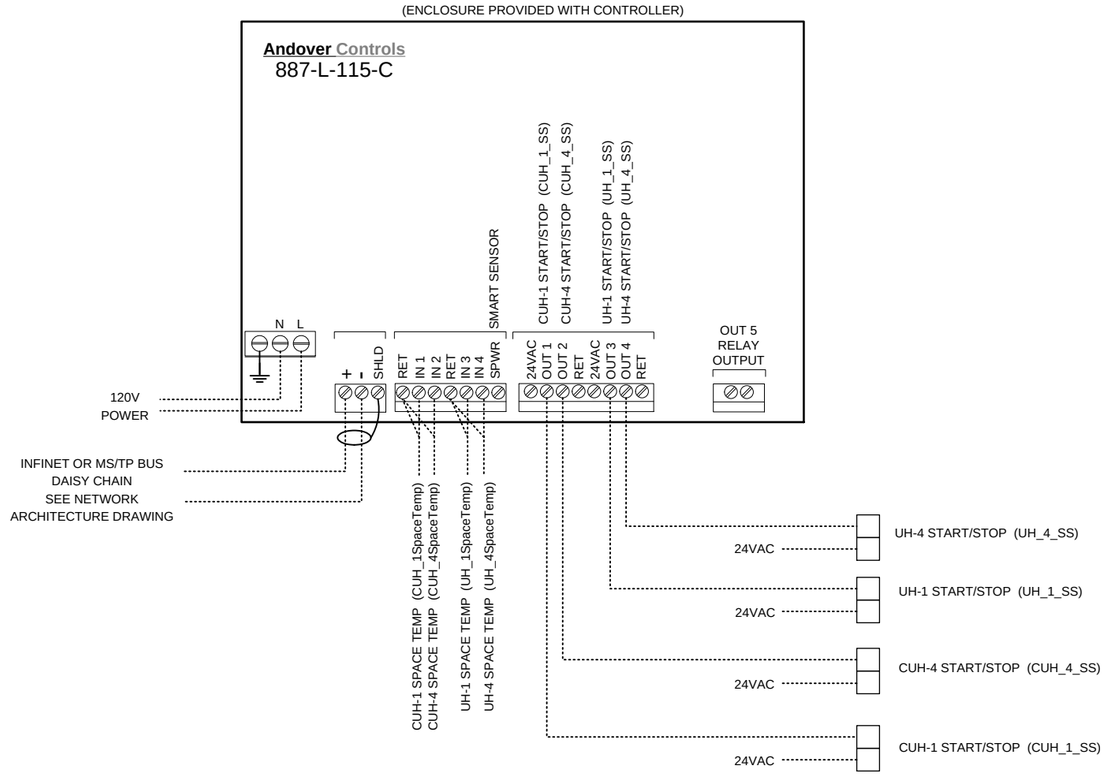
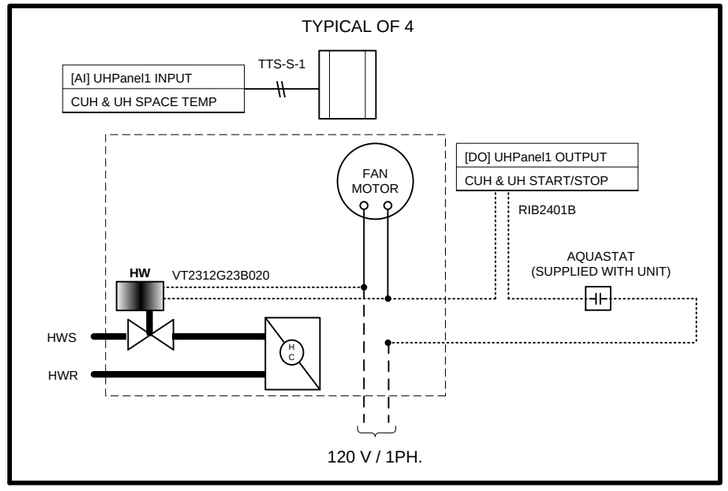
1ST FLOOR UNIT HEATER PANEL



BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3887-L-115-C	1	CONTROLLER - BACNET, 3UI, 1FORM A RELAY, 4 FORM A TRIAC OUT, 1SS, 1					
				1	1	UH	Panel Misc	CONTROLLERS
KELE	RIB2401B	4	RELAY - POWER, ENCL., SPDT, 24V/120VAC/DC COIL, 20A, 277V CONTACTS					
				1	1	R1	UHPanel1 OUT1	CUH-1 START/STOP
				1	1	R1	UHPanel1 OUT2	CUH-4 START/STOP
				1	1	R1	UHPanel1 OUT3	UH-1 START/STOP
				1	1	R1	UHPanel1 OUT4	UH-4 START/STOP
SE	TTS-S-1	4	SPACE SENSOR					
				1	1	RT	UHPanel1 IN1	CUH-1 SPACE TEMP
				1	1	RT	UHPanel1 IN2	CUH-4 SPACE TEMP
				1	1	RT	UHPanel1 IN3	UH-1 SPACE TEMP
				1	1	RT	UHPanel1 IN4 (Ssensor)	UH-1 SPACE TEMP



101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

1ST FLOOR UNIT HEATER PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
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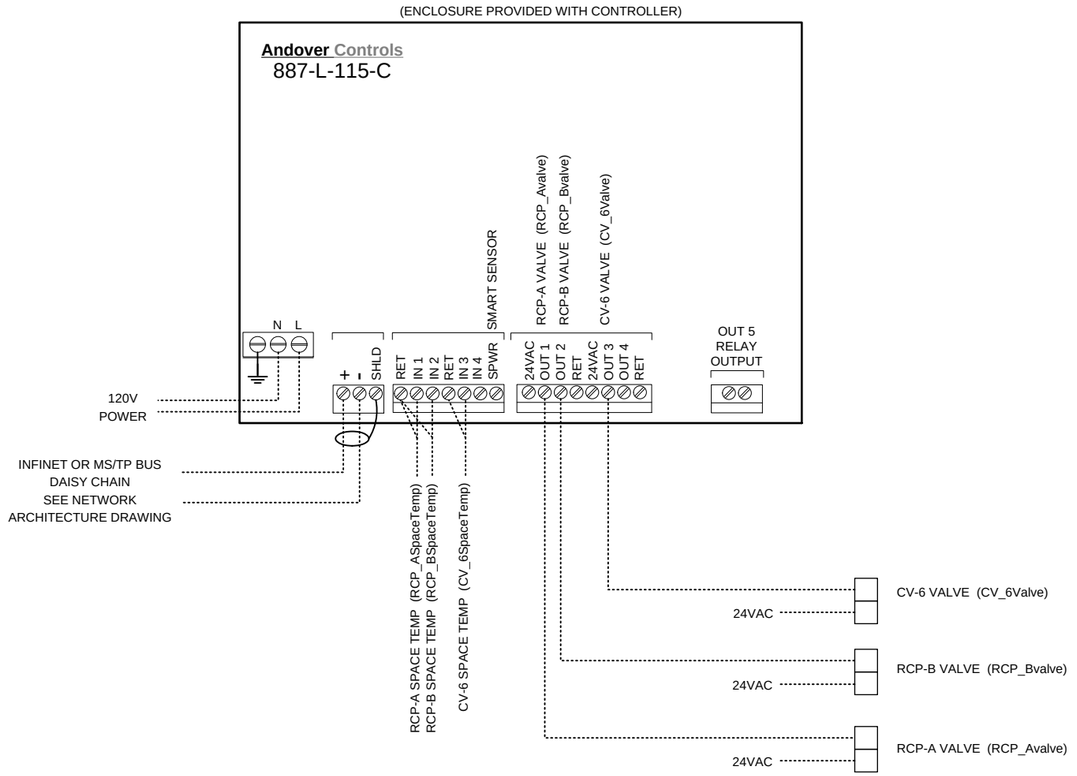
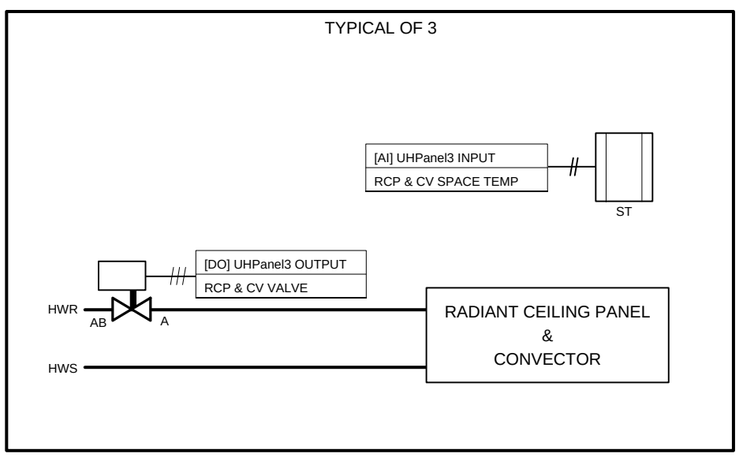
REVISE	NSD	07-18-2014

3RD FLOOR UNIT HEATER PANEL



BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3887-L-115-C	1	CONTROLLER - BACNET, 3UI, 1FORM A RELAY, 4 FORM A TRIAC OUT, 1SS, 115V					
				1	1	UH	Panel and Miscellaneous (CONTROLLERS)	CONTROLLERS
SE	TTS-S-1	3	SPACE SENSOR					
				1	1	RT	UHPanel3 IN1	RCP-A SPACE TEMP
				1	1	RT	UHPanel3 IN2	RCP-B SPACE TEMP
				1	1	RT	UHPanel3 IN3	CV-6 SPACE TEMP



101 Smiley Drive
St. Albans, WV 25177
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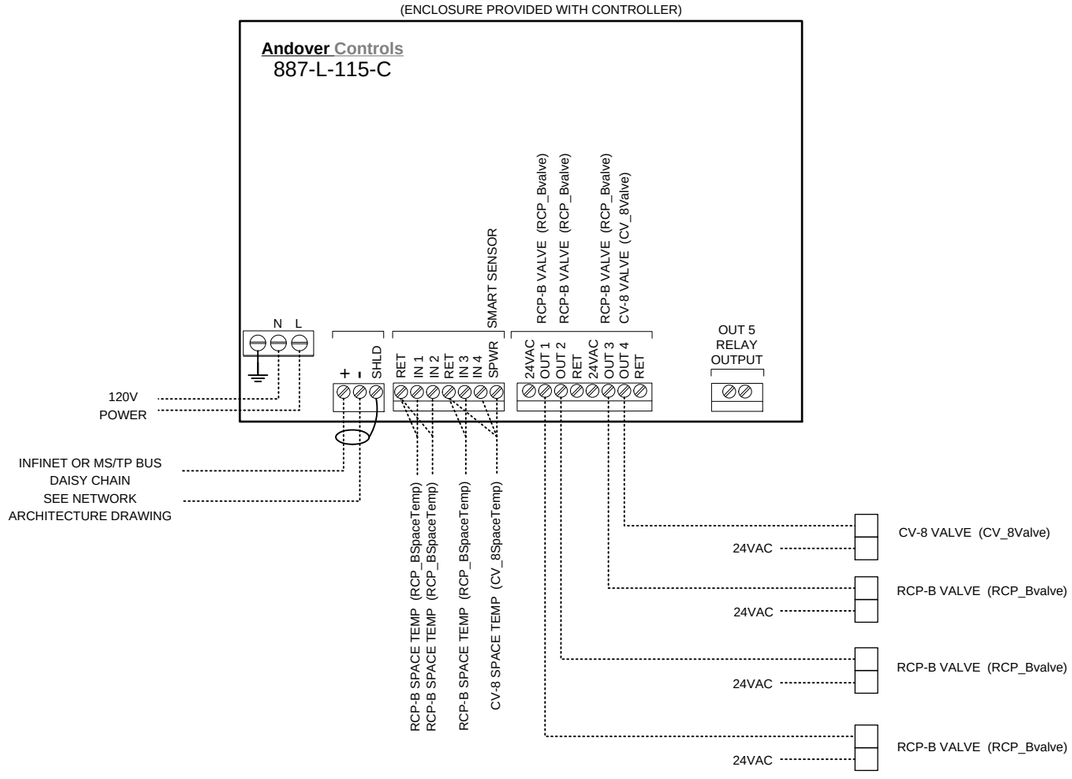
MASON & BARRY INC

3RD FLOOR UNIT HEATER PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

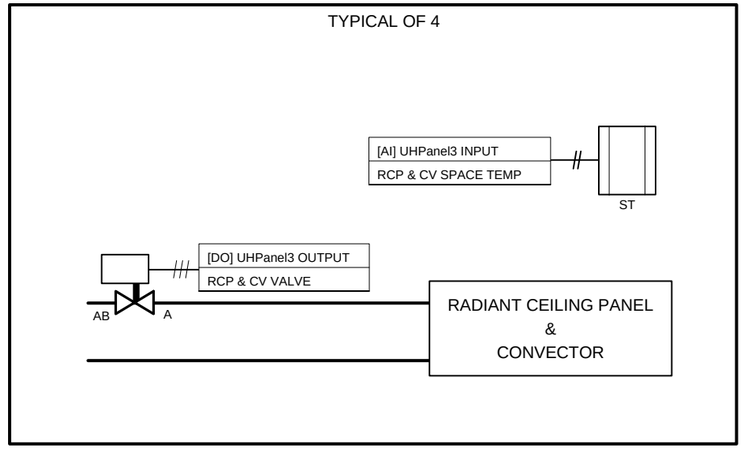
REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

5TH FLOOR UNIT HEATER PANEL



BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	B3887-L-115-C	1	CONTROLLER - BACNET, 3UI, 1FORM A RELAY, 4 FORM A TRIAC OUT, 1SS, 115V					
				1	1	UH	Panel and Miscellaneous (CONTROLLERS)	CONTROLLERS
SE	TTS-S-1	4	SPACE SENSOR					
				1	1	RT	UHPanel3 IN1	RCP-B SPACE TEMP
				1	1	RT	UHPanel3 IN2	RCP-B SPACE TEMP
				1	1	RT	UHPanel3 IN3	RCP-B SPACE TEMP
				1	1	RT	UHPanel3 IN4 (Ssensor)	CV-8 SPACE TEMP



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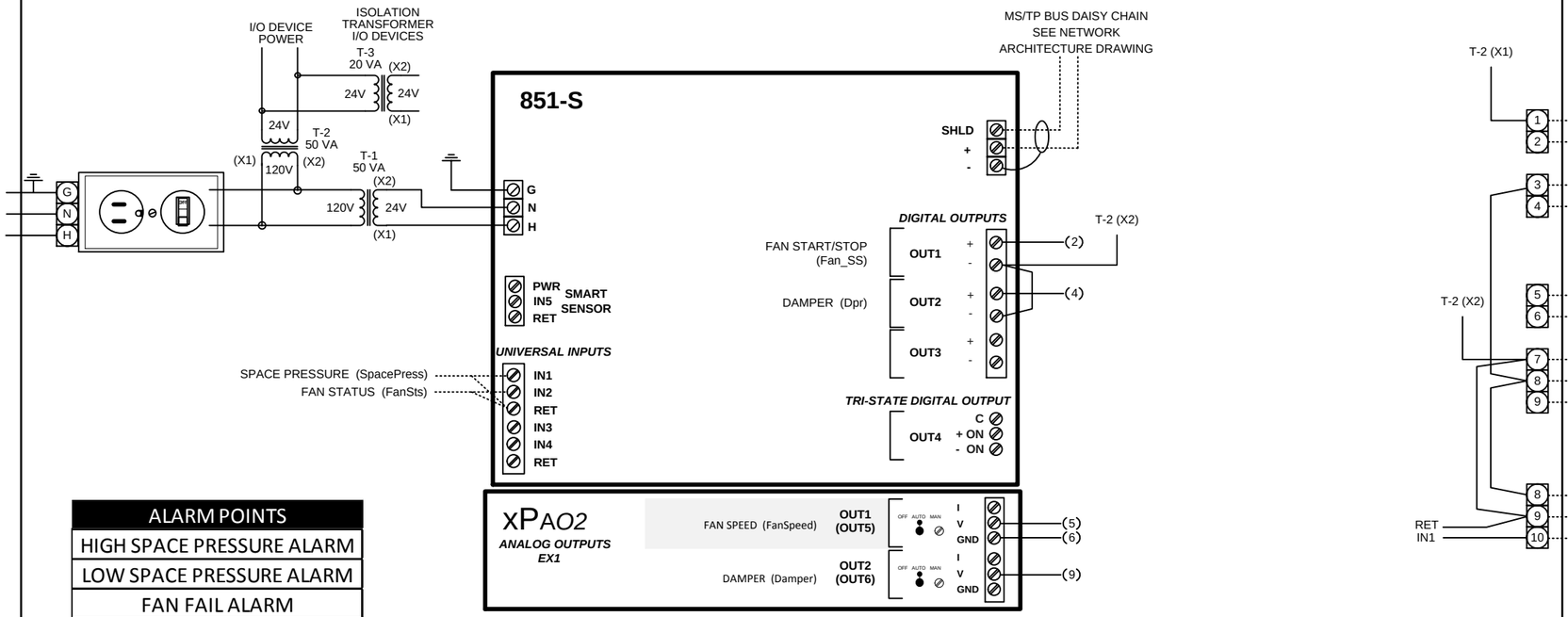
5TH FLOOR UNIT HEATER PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

STAIRWELL PRESSURIZATION FANS

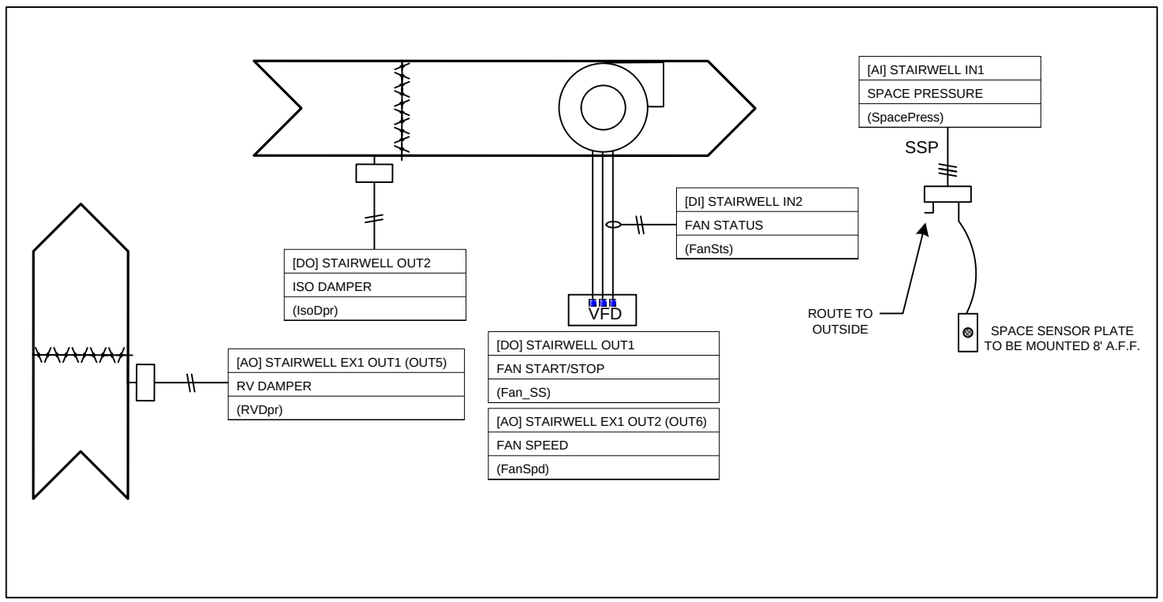
(TYPICAL OF 2)



ALARM POINTS
HIGH SPACE PRESSURE ALARM
LOW SPACE PRESSURE ALARM
FAN FAIL ALARM

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	DDC Port	Point Description
SE	XPAO2	1	2 ANALOG OUTPUT W/OR EXPANSION					
				1	1	EXP1	Panel Misc	XP MODULES
SE	B3851	1	BACNET CONTROLLER - 5 INPUTS / 3 DIGITAL, 1TRISTATE OUTPUTS					
				1	1	STAIRWELL	Panel Misc	CONTROLLERS
VERIS	H735	1	COMBO SWITCH STATUS/ON-OFF 1AMP					
				1	1	CS	STAIRWELL IN2	FAN STATUS
BELIMO	AF24 US	1	DAMPER ACT.- 24V, ON/OFF, SPRING, 133 IN-LB., 33 SF					
				1	1	D	STAIRWELL OUT2	ISO DAMPER
BELIMO	AFB24-SR	1	DAMPER ACT. - 24V, MODULATING, SPRING, 180 IN-LB, 45 SF					
				1	1	D	STAIRWELL EX1OUT1(OUT5)	RV DAMPER
KELE	RET-2018ULP	1	ENCLOSURE - 20H X 18W X 7D, NEMA 1					
				1	1	ENCL	Panel Misc	ENCLOSURES
MAMAC	PR-274-R2-VDC	1	PRESS. SENSOR - 0 to 10 in., ENCL.					
				1	1	DPS	STAIRWELL IN1	SPACE PRESSURE
KELE	RPS	1	AIR PRESSURE SENSOR PLATE - ROOM					
				1	1	SSP	STAIRWELL IN1	SPACE PRESSURE
LECTRO	LE16550	2	TRANSFORMER - 50VA, 120/24VAC, UA					
				1	1	T-2	Panel Misc	TRANSFORMERS
				1	1	T-1	Panel Misc	TRANSFORMERS



101 Smiley Drive
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MASON & BARRY INC

STAIRWELL PRESSURIZATION FANS
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
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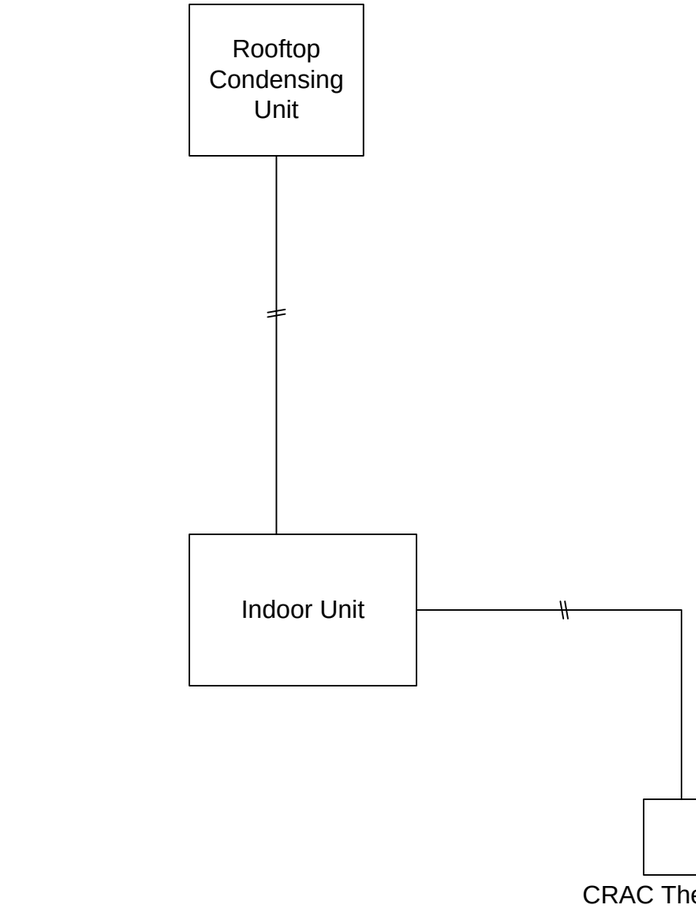
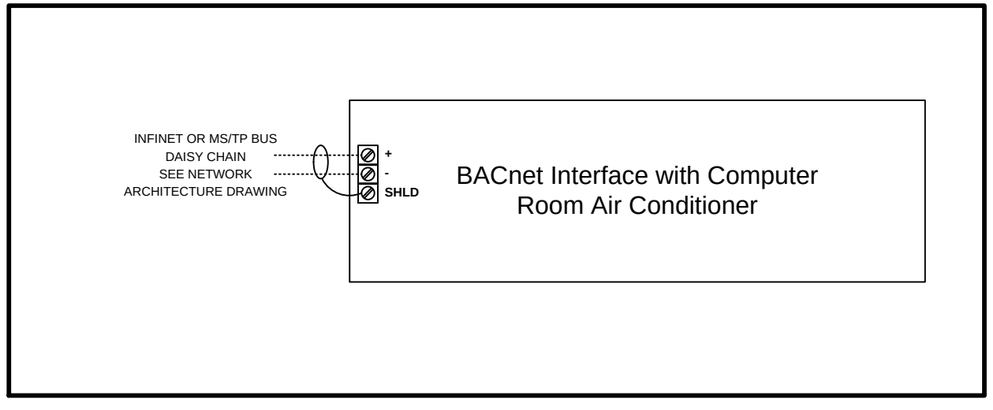
REVISE	NSD	07-18-2014

COMPUTER ROOM AIR CONDITIONERS





MASON & BARRY INC
101 Smiley Drive
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COMPUTER ROOM AIR CONDITIONERS
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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ADDITIONAL POINTS SCHEDULE

UH, CUH, CV, AND RCP SCHEDULE				
UNIT TAG	ROOM SERVED	CONTROLLED BY	INPUTS	OUTPUTS
UH-1	104 MECHANICAL	1ST FLOOR UH	SPACE TEMP	FAN S/S
UH-2	107 DATA	FCU-2	SPACE TEMP	FAN S/S
UH-3	NOT USED			
UH-4	109 WATER SERVICE	1ST FLOOR UH	SPACE TEMP	FAN S/S
UH-5	260 MAINTENANCE	TB-2-1	SPACE TEMP	FAN S/S
CUH-1	100 LOBBY	1ST FLOOR UH	SPACE TEMP	FAN S/S
CUH-2	200 VESTIBULE	FPB-2-6	SPACE TEMP	FAN S/S
CUH-3	200A VESTIBULE	FPB-2-5	SPACE TEMP	FAN S/S
CUH-4	ST1-1 STAIR 1	1ST FLOOR UH	SPACE TEMP	FAN S/S
CUH-5	ST1-1 STAIR 2	FPB-2-3	SPACE TEMP	FAN S/S
CUH-6	ST1-6 STAIR 1	STAIRWELL 1	SPACE TEMP	FAN S/S
CUH-7	ST1-6 STAIR 2	STAIRWELL 2	SPACE TEMP	FAN S/S
CV-1	ST1-2 STAIR1	FPB-2-2	SPACE TEMP	HW VALVE
CV-2	ST1-3 STAIR 1	FPB-3-3	SPACE TEMP	HW VALVE
CV-3	ST1-4 STAIR 1	TB-4-2	SPACE TEMP	HW VALVE
CV-4	ST1-5 STAIR 1	FPB-5-4	SPACE TEMP	HW VALVE
CV-5	NOT USED			
CV-6	ST1-3 STAIR 2	FPB-3-1	SPACE TEMP	HW VALVE
CV-7	ST1-4 STAIR 2	TB-4-10	SPACE TEMP	HW VALVE
CV-8	ST1-5 STAIR 2	FPB-5-2	SPACE TEMP	HW VALVE
CV-9	NOT USED			
CV-10	262 MECHANICAL	TB-2-8	SPACE TEMP	HW VALVE
RCP-A	350	FPB-3-7	SPACE TEMP	HW VALVE
RCP-A	455	FPB-3-9	SPACE TEMP	HW VALVE
RCP-B	351	FPB-4-6	SPACE TEMP	HW VALVE
RCP-B	456	FPB-4-7	SPACE TEMP	HW VALVE
RCP-B	502	FPB-5-3	SPACE TEMP	HW VALVE
RCP-B	503	FPB-5-4	SPACE TEMP	HW VALVE
RCP-B	590	FPB-5-20	SPACE TEMP	HW VALVE
RCP-B	591	FPB-5-19	SPACE TEMP	HW VALVE
EF-1	RESTROOMS	FPB-5-2	FAN STATUS	FAN S/S
EF-2	RESTROOMS	FPB-5-1	FAN STATUS	FAN S/S
EF-3	JANITORS CLOSETS	FPB-5-1	FAN STATUS	FAN S/S

FSD SCHECULE	
CONTROLLED BY	QTY CONTROLLED
1ST FLOOR	
FCU-2	2
FCU-3	2
2ND FLOOR	
FCU-4	2
TB-3-4	3
FPB-3-2	2
TB-2-1	2
TB-2-6	1
3RD FLOOR	
FCU-5	2
TB-3-4	3
FPB-3-2	2
TB-3-7	2
4TH FLOOR	
FCU-6	2
FPB-4-1	2
TB-4-5	2
TB-4-4	1
TB-4-7	1
TB-4-1	3
TB-4-11	3
TB-4-6	1
FPB-4-7	1
5TH FLOOR	
FCU-7	2
FPB-5-15	2
FPB-5-2	2
FPB-5-8	2
FPB-5-18	1

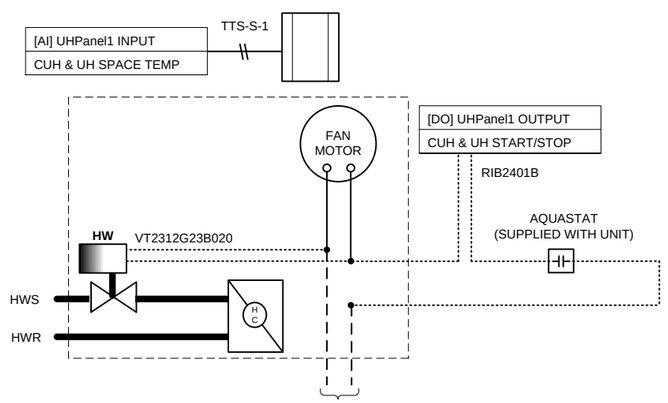
BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	Point Description
KELE	RIB2401B	48	RELAY - POWER, ENCL., SPDT, 24V/120VAC/DC COIL, 20A, 277V CONT				
				48	1	R1	SMOKE DAMPER
KELE	RIB2401D	48	RELAY IN BOX - DPDT, 24VAC/120VAC COIL, 10A				
				48	1	SD	SMOKE DETECTOR

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	Point Description
KELE	PAM-1	11	RELAY - MULTIVOLTAGE, 24 VAC/DC, 115 VAC				
				11	1	R	START/STOP
SE	TTS-S-1	30	SPACE SENSOR				
				30	1	RT	SPACE TEMP

TYPICAL OF 11



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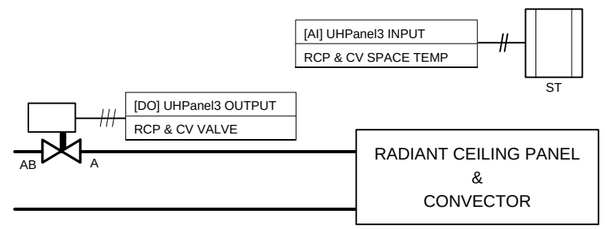

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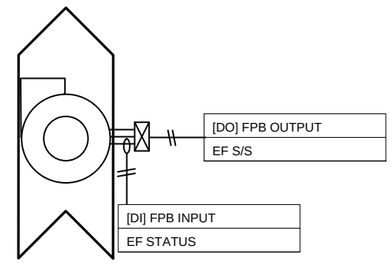

101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

ADDITIONAL POINTS SCHEDULE
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
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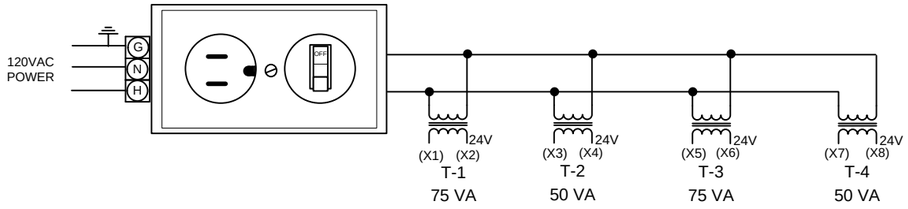
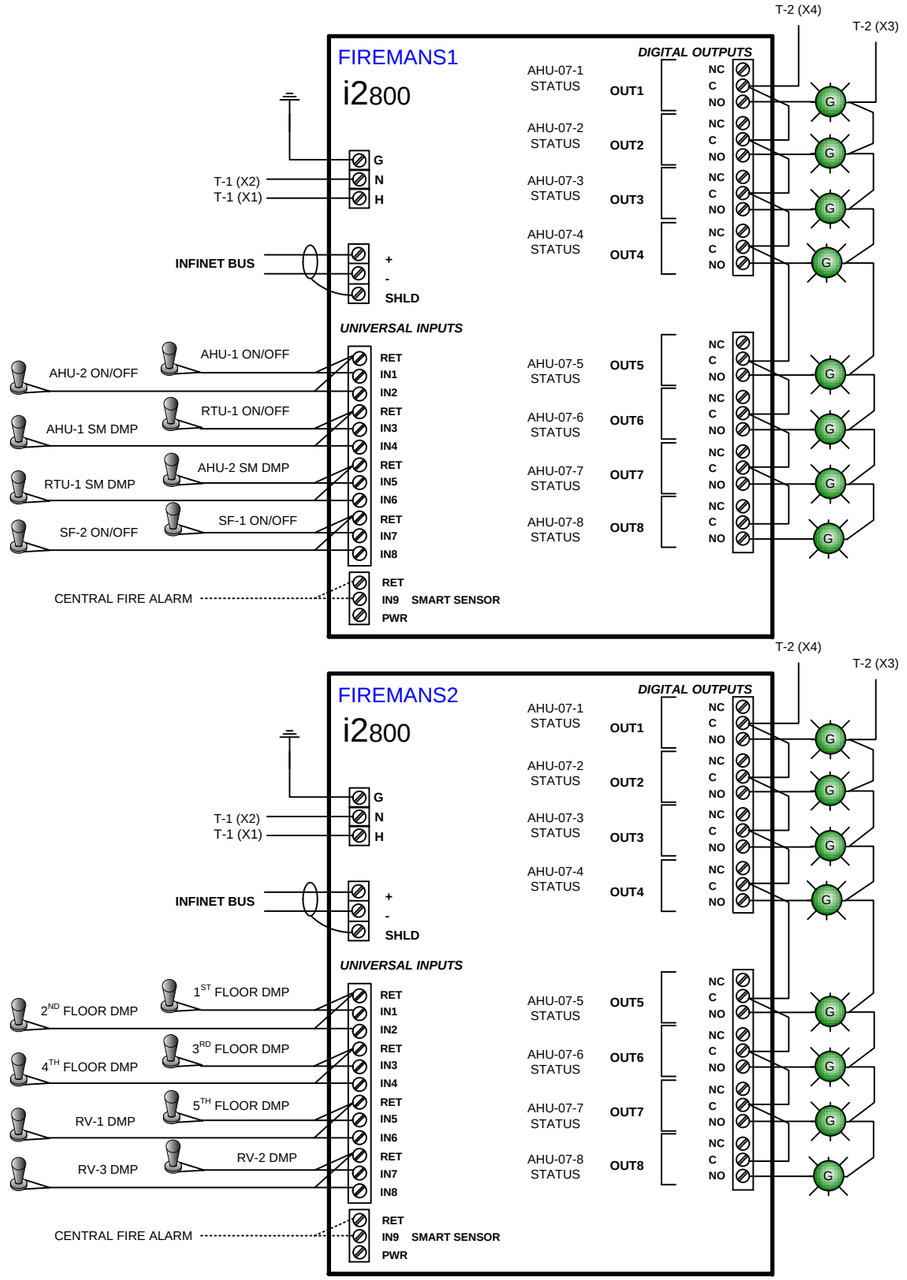
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014





FIREMAN'S PANEL

AIR HANDLING UNITS

AHU-1

ON / OFF / RUNNING

AHU-1 SMOKE DAMPERS

ON / OFF / RUNNING

AHU-2

ON / OFF / RUNNING

AHU-2 SMOKE DAMPERS

ON / OFF / RUNNING

RTU-1

ON / OFF / RUNNING

RTU-1 SMOKE DAMPERS

ON / OFF / RUNNING

STAIRWELL PRESSURIZATION FANS

SF-1

ON / OFF / RUNNING

SF-2

ON / OFF / RUNNING

EXHAUST FANS

1ST FLOOR

ON / OFF / RUNNING

2ND FLOOR

ON / OFF / RUNNING

3RD FLOOR

ON / OFF / RUNNING

4TH FLOOR

ON / OFF / RUNNING

5TH FLOOR

ON / OFF / RUNNING

ROOF VENTILATORS

RV-1

ON / OFF / RUNNING

RV-2

ON / OFF / RUNNING

RV-3

ON / OFF / RUNNING

BILL OF MATERIALS

Mfg	Part #	Qty.	Description	Typ	Qty	Tag	Point Description
SE	B3800	2	CONTROLLER - BACNET, 8 INPUTS / 8 DIGITAL OUTPUTS N/OR				
				1	2	B3800	CONTROLLERS
KELE	RET-4230	1	ENCLOSURE - 42H X 30W X 7D, NEMA 1				
				1	1	ENCL	ENCLOSURES
KELE	APW199D-G-24	16	PILOT LIGHT - ROUND FLUSH, GREEN, 24V				
				16	1	LT	INDICATOR LIGHT
KELE	AS6M-3Y2P	3	SWITCH - SELECTOR, 3 POSITION, MAINTAINED				
				3	1	H-O-A	SWITCH
KELE	ASW210	13	SELECTOR SWITCH - 2 POS MAINTAINED, 1NO, R OPER. POS.				
				13	1	SS	SWITCH
LECTRO	LE11900	2	TRANSFORMER - 75VA, 120/24VAC, UA				
				2	1	T-X	TRANSFORMERS
LECTRO	LE16550	2	TRANSFORMER - 50VA, 120/24VAC, UA				
				1	1	T-X	TRANSFORMERS

MASON & BARRY INC
101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls

FIREMAN'S PANEL
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

VALVE SCHEDULE PART 1

From Project Specifications							Sizing Data			Valve Type and Actuator Specifications													Ordering Data	
Quantity	System	Flow (GPM) or Steam (LBS)	Desired Pressure Drop (PSI)	Desired Cv Rating	Pipe Size (in.)	System Close-off Pressure (PSI)	Valve Size (in.)	Valve Cv	Actual Pressure drop (PSI)	Ball	Globe	Butterfly	2-Way	3-Way	24 VAC	120 VAC	On-Off	Tri-State	Modulating	Spring Rtn .	Fail NO or NC	Switches	Valve #	Actuator #
1	FBP-1-1	3.00	3.00	1.7	0.75	200.0	0.50	1.90	2.5	X			X		X				X				B211B	TR24-SR-T
1	FBP-2-1	3.25	3.00	1.88	0.75	200.0	0.50	1.90	2.93	X			X		X				X				B211B	TR24-SR-T
1	FBP-2-2	1.50	3.00	0.87	0.75	200.0	0.50	0.80	3.52	X			X		X				X				B209B	TR24-SR-T
1	FBP-2-3	4.00	3.00	2.31	0.75	200.0	0.50	1.90	4.43	X			X		X				X				B211B	TR24-SR-T
1	FBP-2-4	4.25	3.00	2.45	0.75	200.0	0.50	3.00	2.01	X			X		X				X				B212B	TR24-SR-T
1	FBP-2-5	2.75	3.00	1.59	0.75	200.0	0.50	1.90	2.09	X			X		X				X				B211B	TR24-SR-T
1	FBP-2-6	4.00	3.00	2.31	0.75	200.0	0.50	1.90	4.43	X			X		X				X				B211B	TR24-SR-T
1	FBP-2-7	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	FBP-2-8	1.75	3.00	1.01	0.75	200.0	0.50	1.20	2.13	X			X		X				X				B210B	TR24-SR-T
1	FBP-3-1	3.75	3.00	2.17	0.75	200.0	0.50	1.90	3.90	X			X		X				X				B211B	TR24-SR-T
1	FBP-3-2	4.50	3.00	2.60	0.75	200.0	0.50	3.00	2.25	X			X		X				X				B212B	TR24-SR-T
1	FBP-3-3	6.25	3.00	3.61	0.75	200.0	0.50	3.00	4.34	X			X		X				X				B212B	TR24-SR-T
1	FBP-3-4	1.50	3.00	0.87	0.75	200.0	0.50	0.80	3.52	X			X		X				X				B209B	TR24-SR-T
1	FBP-3-5	1.75	3.00	1.01	0.75	200.0	0.50	1.20	2.13	X			X		X				X				B210B	TR24-SR-T
1	FBP-3-6	6.25	3.00	3.61	0.75	200.0	0.50	3.00	4.34	X			X		X				X				B212B	TR24-SR-T
1	FBP-3-7	6.25	3.00	3.61	0.75	200.0	0.50	3.00	4.34	X			X		X				X				B212B	TR24-SR-T
1	FBP-3-8	6.75	3.00	3.90	0.75	200.0	0.50	4.70	2.06	X			X		X				X				B213B	TR24-SR-T
1	FBP-3-9	4.00	3.00	2.31	0.75	200.0	0.50	1.90	4.43	X			X		X				X				B211B	TR24-SR-T
1	FBP-4-1	2.00	3.00	1.15	0.75	200.0	0.50	1.20	2.78	X			X		X				X				B210B	TR24-SR-T
1	FBP-4-2	1.40	3.00	0.81	0.75	200.0	0.50	0.80	3.06	X			X		X				X				B209B	TR24-SR-T
1	FBP-4-3	1.90	3.00	1.10	0.75	200.0	0.50	1.20	2.51	X			X		X				X				B210B	TR24-SR-T
1	FBP-4-4	1.50	3.00	0.87	0.75	200.0	0.50	0.80	3.52	X			X		X				X				B209B	TR24-SR-T
1	FBP-4-5	1.80	3.00	1.04	0.75	200.0	0.50	1.20	2.25	X			X		X				X				B210B	TR24-SR-T
1	FBP-4-6	1.80	3.00	1.04	0.75	200.0	0.50	1.20	2.25	X			X		X				X				B210B	TR24-SR-T
1	FBP-4-7	2.30	3.00	1.33	0.75	200.0	0.50	1.20	3.67	X			X		X				X				B210B	TR24-SR-T
1	FBP-5-1	1.90	3.00	1.10	0.75	200.0	0.50	1.20	2.51	X			X		X				X				B210B	TR24-SR-T
1	FBP-5-2	1.30	3.00	0.75	0.75	200.0	0.50	0.80	2.64	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-3	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	FBP-5-4	0.90	3.00	0.52	0.75	200.0	0.50	0.46	3.83	X			X		X				X				B208B	TR24-SR-T
1	FBP-5-5	1.70	3.00	0.98	0.75	200.0	0.50	1.20	2.01	X			X		X				X				B210B	TR24-SR-T

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VALVE SCHEDULE PART 1
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

VALVE SCHEDULE PART 2

From Project Specifications						Sizing Data			Valve Type and Actuator Specifications													Ordering Data	
Quantity	System	Flow (GPM) or Steam (LBS)	Desired Pressure Drop (PSI)	Desired Cv Rating	Pipe Size (in.)	System Close-off Pressure (PSI)	Valve Size (in.)	Valve Cv	Actual Pressure drop (PSI)	Ball	Globe	Butterfly	2-Way	3-Way	24 VAC	120 VAC	On-Off	Tri-State	Modulating	Spring Rtn .	Fail NO or NC	Switches	Valve #	Actuator #
1	FBP-5-6	1.70	3.00	0.98	0.75	200.0	0.50	1.20	2.01	X			X		X				X				B210B	TR24-SR-T
1	FBP-5-7	1.30	3.00	0.75	0.75	200.0	0.50	0.80	2.64	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-8	0.80	3.00	0.46	0.75	200.0	0.50	0.46	3.02	X			X		X				X				B208B	TR24-SR-T
1	FBP-5-9	1.20	3.00	0.69	0.75	200.0	0.50	0.80	2.25	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-10	0.70	3.00	0.40	0.75	200.0	0.50	0.46	2.32	X			X		X				X				B208B	TR24-SR-T
1	FBP-5-11	1.10	3.00	0.64	0.75	200.0	0.50	0.80	1.89	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-12	1.30	3.00	0.75	0.75	200.0	0.50	0.80	2.64	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-13	1.60	3.00	0.92	0.75	200.0	0.50	0.80	4.00	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-14	1.10	3.00	0.64	0.75	200.0	0.50	0.80	1.89	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-15	0.50	3.00	0.29	0.75	200.0	0.50	0.30	2.78	X			X		X				X				B207B	TR24-SR-T
1	FBP-5-16	1.70	3.00	0.98	0.75	200.0	0.50	1.20	2.01	X			X		X				X				B210B	TR24-SR-T
1	FBP-5-17	1.20	3.00	0.69	0.75	200.0	0.50	0.80	2.25	X			X		X				X				B209B	TR24-SR-T
1	FBP-5-18	0.90	3.00	0.52	0.75	200.0	0.50	0.46	3.83	X			X		X				X				B208B	TR24-SR-T
1	FBP-5-19	1.70	3.00	0.98	0.75	200.0	0.50	1.20	2.01	X			X		X				X				B210B	TR24-SR-T
1	FBP-5-20	1.70	3.00	0.98	0.75	200.0	0.50	1.20	2.01	X			X		X				X				B210B	TR24-SR-T
1	TB-2-1	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-2-2	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-2-3	1.50	3.00	0.87	0.75	200.0	0.50	0.80	3.52	X			X		X				X				B209B	TR24-SR-T
1	TB-2-4	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-2-5	0.75	3.00	0.43	0.75	200.0	0.50	0.46	2.66	X			X		X				X				B208B	TR24-SR-T
1	TB-2-6	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-2-7	0.75	3.00	0.43	0.75	200.0	0.50	0.46	2.66	X			X		X				X				B208B	TR24-SR-T
1	TB-2-8	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-2-9	1.25	3.00	0.72	0.75	200.0	0.50	0.80	2.44	X			X		X				X				B209B	TR24-SR-T
1	TB-3-1	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-3-2	0.75	3.00	0.43	0.75	200.0	0.50	0.46	2.66	X			X		X				X				B208B	TR24-SR-T
1	TB-3-3	0.75	3.00	0.43	0.75	200.0	0.50	0.46	2.66	X			X		X				X				B208B	TR24-SR-T
1	TB-3-4	1.50	3.00	0.87	0.75	200.0	0.50	0.80	3.52	X			X		X				X				B209B	TR24-SR-T
1	TB-3-5	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-3-6	0.75	3.00	0.43	0.75	200.0	0.50	0.46	2.66	X			X		X				X				B208B	TR24-SR-T

101 Smiley Drive
St. Albans, WV 25177
A Certified Representative of Andover Controls
MASON & BARRY INC

VALVE SCHEDULE PART 2
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

VALVE SCHEDULE PART 3

From Project Specifications							Sizing Data			Valve Type and Actuator Specifications														Ordering Data	
Quantity	System	Flow (GPM) or Steam (LBS)	Desired Pressure Drop (PSI)	Desired Cv Rating	Pipe Size (in.)	System Close-off Pressure (PSI)	Valve Size (in.)	Valve Cv	Actual Pressure drop (PSI)	Ball	Globe	Butterfly	2-Way	3-Way	24 VAC	120 VAC	On-Off	Tri-State	Modulating	Spring Rtn .	Fail NO or NC	Switches	Valve #	Actuator #
1	TB-3-7	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-3-8	2.00	3.00	1.15	0.75	200.0	0.50	1.20	2.78	X			X		X				X				B210B	TR24-SR-T
1	TB-4-1	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-4-2	1.30	3.00	0.75	0.75	200.0	0.50	0.80	2.64	X			X		X				X				B209B	TR24-SR-T
1	TB-4-3	1.40	3.00	0.81	0.75	200.0	0.50	0.80	3.06	X			X		X				X				B209B	TR24-SR-T
1	TB-4-4	1.40	3.00	0.81	0.75	200.0	0.50	0.80	3.06	X			X		X				X				B209B	TR24-SR-T
1	TB-4-5	0.80	3.00	0.46	0.75	200.0	0.50	0.46	3.02	X			X		X				X				B208B	TR24-SR-T
1	TB-4-6	1.00	3.00	0.58	0.75	200.0	0.50	0.46	4.73	X			X		X				X				B208B	TR24-SR-T
1	TB-4-7	0.70	3.00	0.40	0.75	200.0	0.50	0.46	2.32	X			X		X				X				B208B	TR24-SR-T
1	TB-4-8	1.40	3.00	0.81	0.75	200.0	0.50	0.80	3.06	X			X		X				X				B209B	TR24-SR-T
1	TB-4-9	1.20	3.00	0.69	0.75	200.0	0.50	0.80	2.25	X			X		X				X				B209B	TR24-SR-T
1	TB-4-10	2.20	3.00	1.27	0.75	200.0	0.50	1.20	3.36	X			X		X				X				B210B	TR24-SR-T
1	TB-4-11	1.20	3.00	0.69	0.75	200.0	0.50	0.80	2.25	X			X		X				X				B209B	TR24-SR-T
8	CV	0.50	3.00	0.29	0.75	200.0	0.50	0.30	2.78	X			X		X		X						B207B	TR24-3-T
2	FCU-1, 3H	3.00	3.00	1.73	0.75	200.0	0.50	1.90	2.49	X			X		X				X				B211B	TR24-SR-T
6	FCU-(2-7)	2.60	3.00	1.50	0.75	200.0	0.50	1.20	4.69	X			X		X				X				B210B	TR24-SR-T
1	AHU-1 C	30.00	3.00	17.32	2.00	200.0	1.50	19.00	2.49	X			X		X				X	X	NO		B238	AFRB24-SR
1	AHU-1 H	40.00	3.00	23.09	2.00	200.0	1.50	19.00	4.43	X				X	X				X	X	NO		B338	AFRB24-SR
1	AHU-2 C	82.00	3.00	47.34	3.00	200.0	2.00	46.00	3.18	X				X	X				X	X	NO		B349	AFRB24-SR
1	AHU-2 H	27.00	3.00	15.59	2.00	200.0	1.50	19.00	2.02	X			X		X				X	X	NO		B238	AFRB24-SR
1	RTU-1 C	115.00	3.00	66.40	3.00	200.0	2.00	65.00	3.13	X			X		X				X	X	NO		B251	AFRB24-SR
1	RTU-1 H	27.00	3.00	15.59	2.00	200.0	1.50	19.00	2.02	X				X	X				X	X	NO		B338	AFRB24-SR
1	V-1	-	3.00	-	6.00	200.0	4.00	-	-			X		X		X			X				F7100HD	SY3-120MFT
1	V-2	-	3.00	-	6.00	200.0	4.00	-	-			X		X		X			X				F7100HD	SY3-120MFT
9	RCP	0.50	3.00	0.29	0.75	200.0	0.50	0.30	2.78	X					X		X						B207B	TR24-3-T
106																								

101 Smiley Drive
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MASON & BARRY INC

VALVE SCHEDULE PART 3
NEW STATE OFFICE BUILDING - FAIRMONT
FAIRMONT, WV

REVISIONS		
REV	BY	DATE
SUBMIT	NSD	05-01-2014
REVISE	NSD	07-18-2014

TOWER ENGINEERING

Submittal Cover Sheet

ESTC Project Name:	Fairmont Office Building	Date Received:	02-17-2014
ESTC Project No.:	2011227	Date Sent:	02-24-2014
Client:	Omni Architects		
Client Project No.:	20856	Contractor:	Stuart-McMunn Company

Manufacturer Or Supplier	Item or System	Recommended Action	Comments
Dunham-Bush	Ice Storage Tank	No Exceptions Taken	None

Comments:

Reviewed By: Cory Weiland

Cory Weiland
Tower Engineering

Note: Review or other action by the Engineer is only for the limited purpose of checking for conformance with the information and design concept expressed in the Contract Documents and is not for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor to the extent required by the Contract Documents. Review shall not constitute acceptance of safety precautions or, unless otherwise specifically stated by the Engineer, of construction means, methods, techniques, sequences or procedures. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component.

115 Evergreen Heights Drive, Suite 400, Pittsburgh, Pennsylvania 15229
Phone 412.931.8888 ■ Fax 412.939.2525 ■ tower@estower.com

Stuart-McMunn Company

Air Conditioning • Refrigeration • Heating • Plumbing • Medical Gas • Digital Controls
Serving West Virginia, Virginia and Ohio Since 1917 !

Thursday, February 13, 2014

PROJECT:	**NEW STATE OFFICE BUILDING**
ARCHITECTS:	**Omni Associates**
CONTRACTOR:	Stuart-McMunn Company 137 North Sixth Street Clarksburg WV 26301 Mechanical Contractor
MANUFACTURER:	**Dunham Bush**
SPECIFICATION SECTION:	**236450 Thermal Ice Storage Tanks** **Submitted per Request for Warranty Correction**

STUART-McMUNN COMPANY
SMCO JOB # 2013010
SMCO SUBMITTAL # 236450-1
WE HEREBY STATE THAT THIS DOCUMENT HAS BEEN REVIEWED FOR CONFORMANCE WITH THE DESIGN CONCEPT AND GENERAL COMPLIANCE WITH THE CONTRACT DOCUMENTS. THIS IN NO WAY RELEASES THE SUBCONTRACTOR/SUPPLIER FROM HIS RESPONSIBILITY TO ADHERE TO THE REQUIREMENTS OF THE CONTRACT DRAWINGS AND SPECIFICATIONS, INCLUDING ALL DIMENSIONS, QUANTITIES AND PERFORMANCE CRITERIA.
✓ APPROVED AS SUBMITTED
_____ APPROVED AS NOTED
_____ REJECTED - REVISE AND RESUBMIT
BY: Lan
DATE: 2/13/14

137 North Sixth Street • Clarksburg, WV 26301
Voice: 304.623.6666 • Fax: 304.623.4646 • email: leeanne@smco.us

Tobey-Karg Sales Agency

4640 Campbells Run Road
Pittsburgh, PA 15205
phone: 412-787-3899
fax: 412-787-8878

SUBMITTAL DATA

TO: **Stuart-McMunn Company**

PROJECT: **Fairmont State Office Building**

DATE: **February 6, 2014** **ORDER NO:**

Qty 3 **Thermal Ice Storage Tanks (Tag: T-1, 2, 3)**

Qty 3 **Dunham-Bush ICE-CEL TS205 Series Thermal Storage Modules**

Cylindrical tank design
Single piece design
Double wall fiberglass insulated tank
2" urethane foam insulation
R-14 thermally rated tank wall construction
Removable tank cover
Tank cover same construction as walls
2" PVC headers
¾" polyethylene tube heat exchanger
Thermally welded tube to headers for leak tight construction
15-year tank warranty (parts only)
5-year heat exchanger warranty (parts only)
Startup

Note:

1. Warranty Certificate to be provided once the product has shipped. See the attached specification for warranty details.

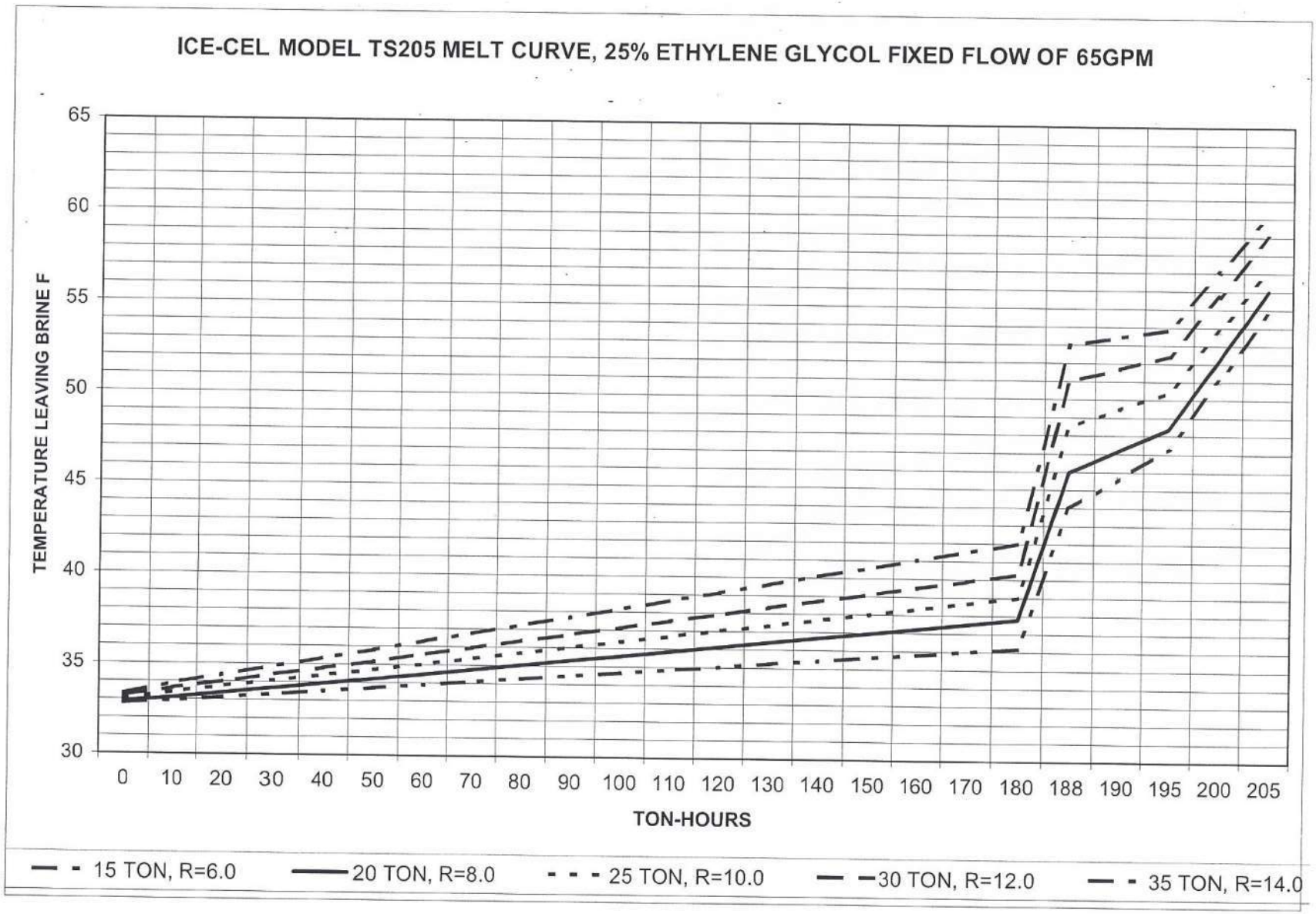
Drawings in this submittal package describe the equipment we propose to furnish for this project and are submitted for approval to manufacture.

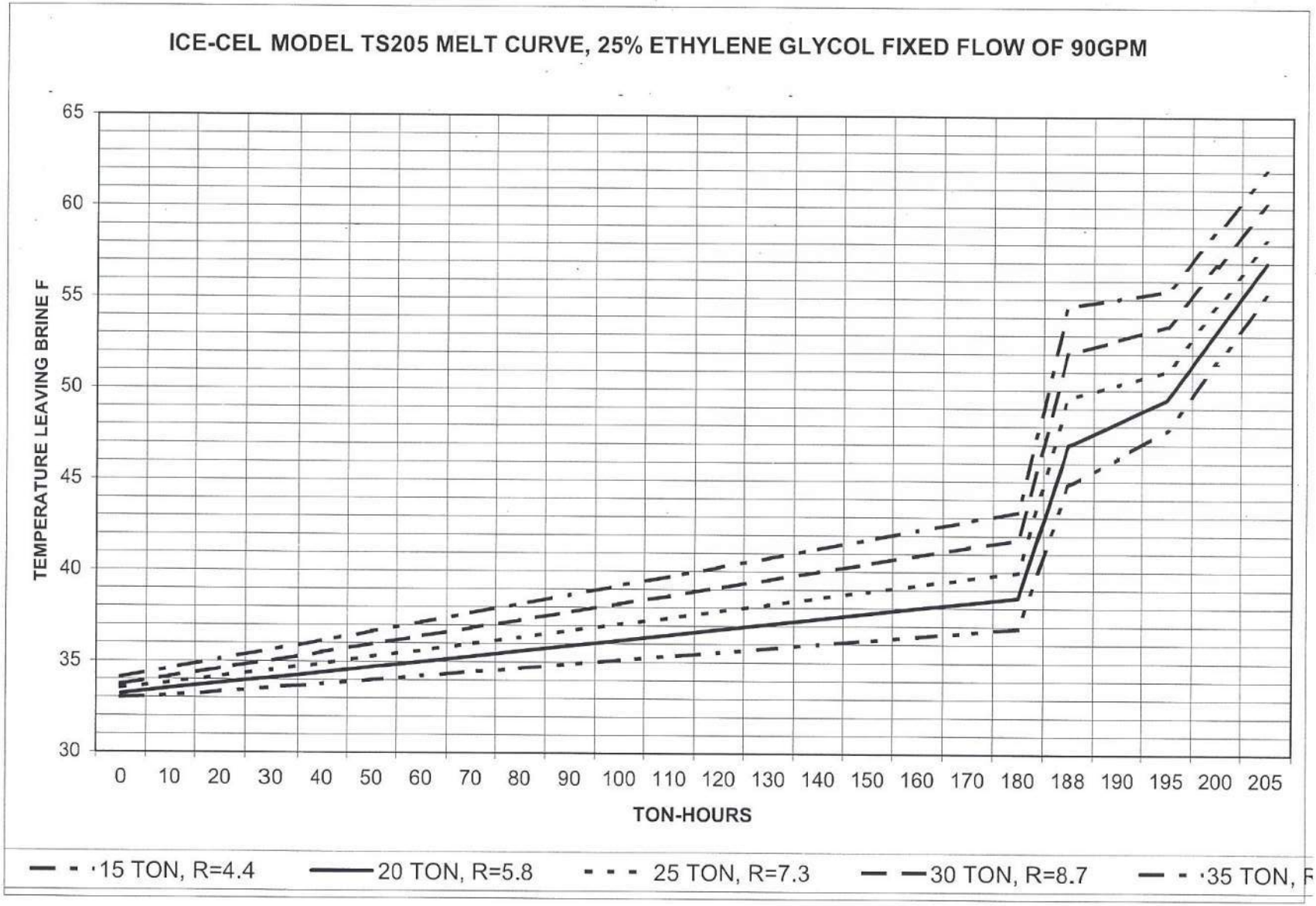
SUBMITTAL DATA-Ice-Cel Model TS205 Thermal Storage Module

Capacity (Ton-Hours)	
Total Storage Capacity	
(Based on heating tank water to 50°F	205
Latent Storage Capacity)	
(Based on melting ice to water at 32°F	180
Tank Type:	Double Wall Fiberglass
Insulation:	2" Urethane Foam (between double walls)
Single Pipe Construction:	
Rigging Hard Points	3
R-Value (cover, walls and bottom)	14.0
Heat Exchanger:	3/4" polyethylene tube
Supply and Return Headers:	Polyethylene
Stub-Outs:	2" PVC Pipe (male)
Mechanical Connections:	2 (accessible from the outside)
Maximum Operating Pressure:	150 psig.
Physical Specification:	
Diameter:	89"
Height:	101"
Volume of Glycol (gal.):	260
Volume of Water (gal.):	1,800
Weight, empty (lb):	1,870
Weight operating:	19,300

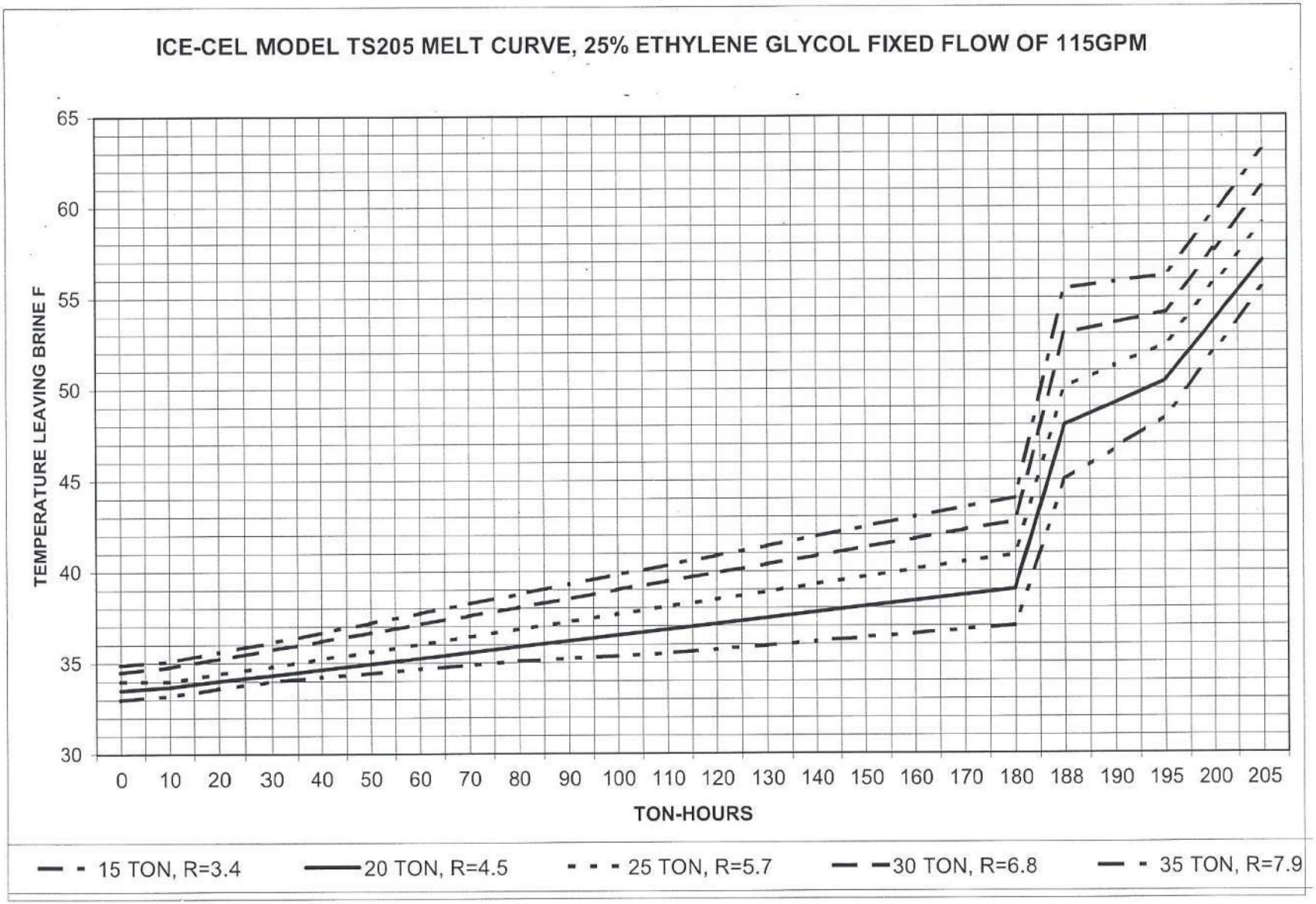
NOTES:

1. Removable tank cover is the same construction as the tank.
2. Tubes are thermally welded into headers to form one homogeneous heat exchanger with no fittings or joints to leak.
3. Ice-Cel design is protected by US Patent 5,109,920.
4. Parallel circuits with same direction of flow in adjoining tubes, thermal counter flow effect.

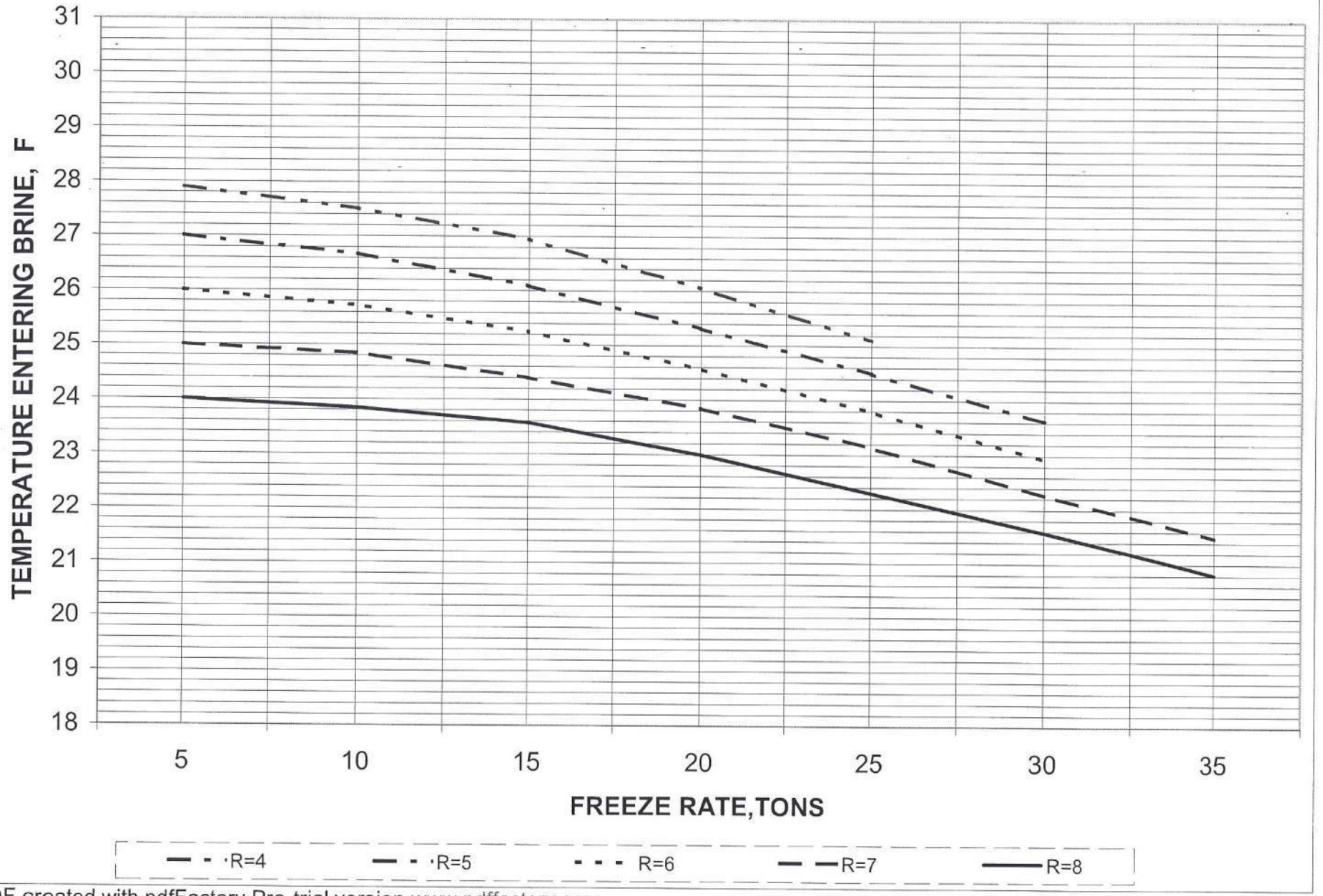




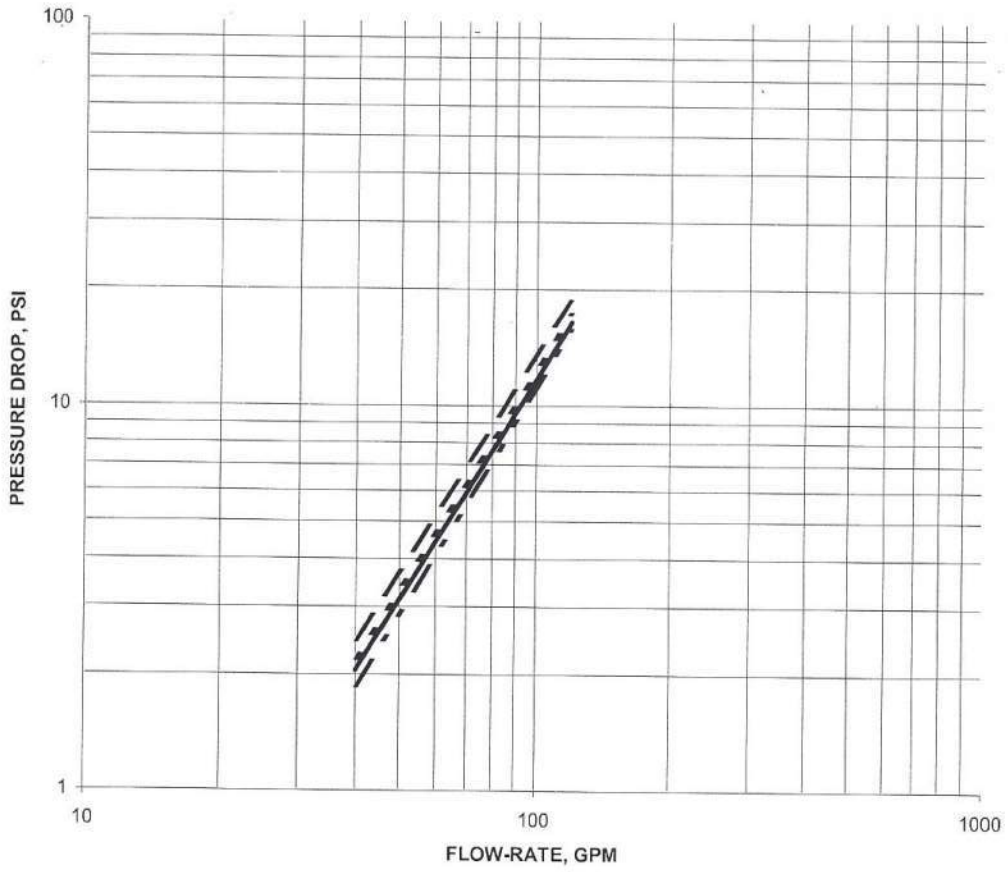
ICE-CEL MODEL TS205 MELT CURVE, 25% ETHYLENE GLYCOL FIXED FLOW OF 115GPM



ICE-CEL MODEL TS205 FREEZE CURVE,25% ETHYLENE GLYCOL



TS 205 PRESSURE DROP CURVE

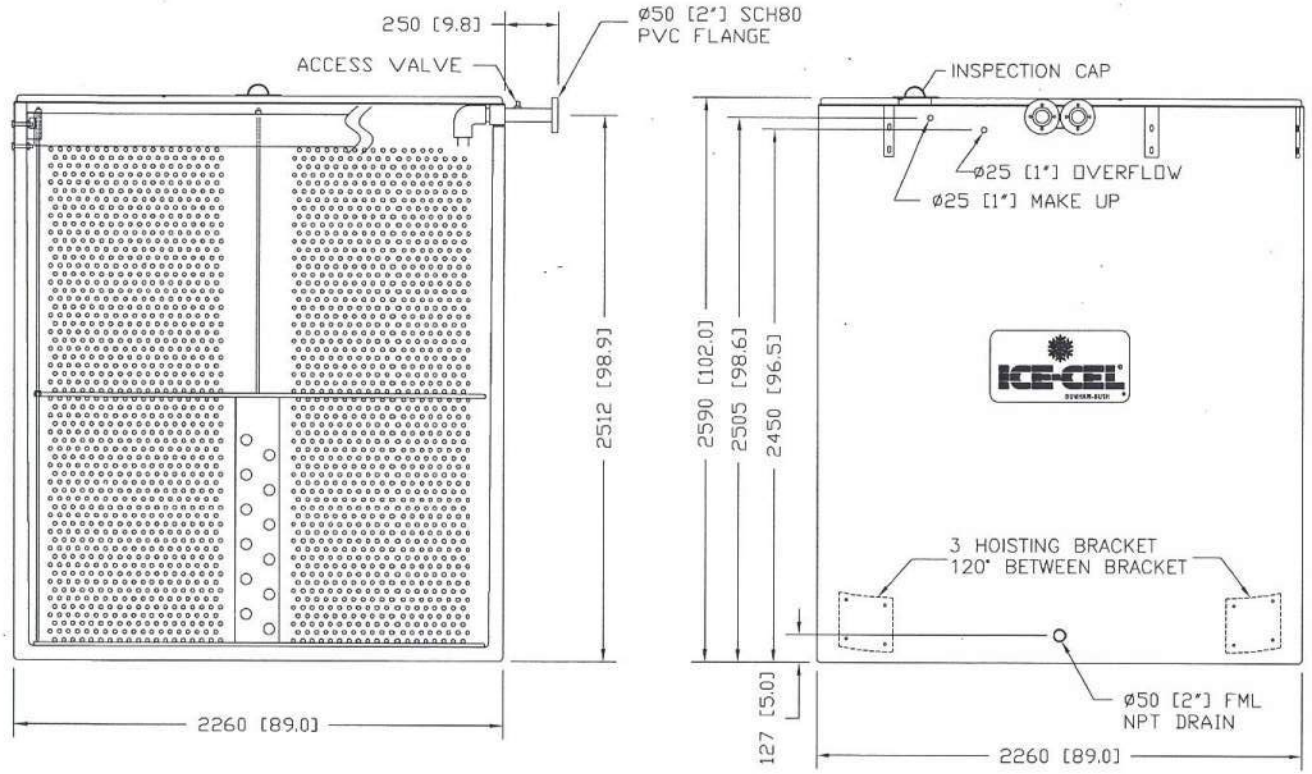


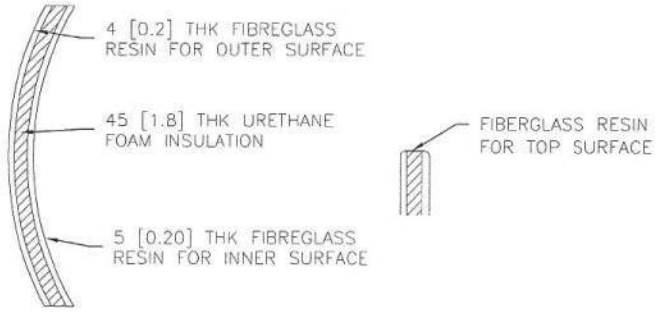
- - - 25% ETHYLENE GLYCOL, MELT

——— 25% ETHYLENE GLYCOL, FREEZE

- - - 25% PROPYLENE GLYCOL, MELT

— — 25% PROPYLENE GLYCOL, FREEZE





CERTIFIED DRAWING

ICE CEL TS205 PHYSICAL SPECIFICATION

DIAMETER MM [IN]	: 2260 [89.0]
HEIGHT MM [IN]	: 2590 [102.0]
VOL. OF GLYCOL SOLUTION L [GAL]	: 985 [260.2]
VOL. OF WATER L [GAL]	: 6814 [1800.1]
WEIGHT, EMPTY KG [LB]	: 848 [1870]
WEIGHT, TOTAL OPERATING KG [LB]	: 8832 [19471]

ALL DIMENSIONS ARE IN MM [IN]

DRAWN BY	CHARLES	DATE	01/11/11
CHECKED BY		DATE	
APPROVED BY		DATE	

REV	DESCRIPTION	DATE	DRN BY	CHK BY	APP'D BY

DUNHAM-BUSH INDUSTRIES SDN. BHD. (693824-X)

LOCATION.

QTY.

MODEL TS205

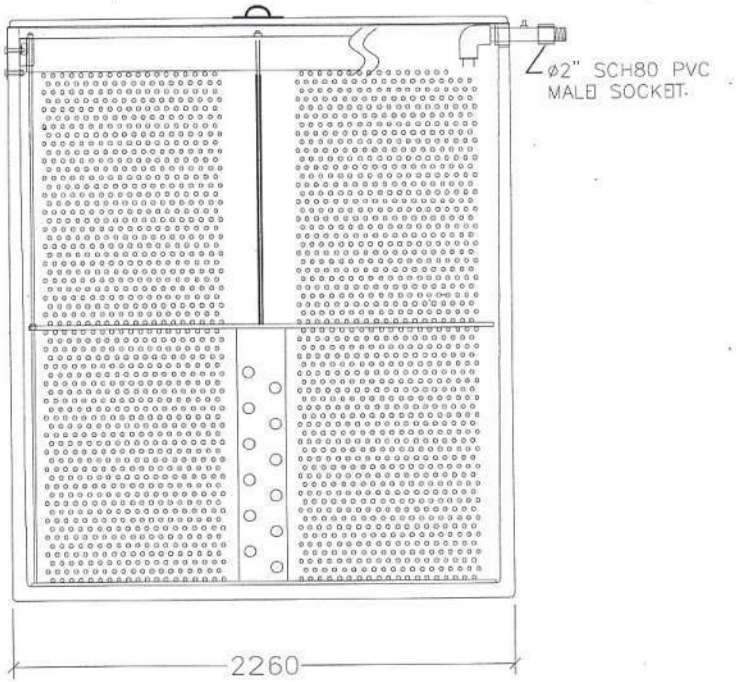
PROJECT STANDARD ICE CELL

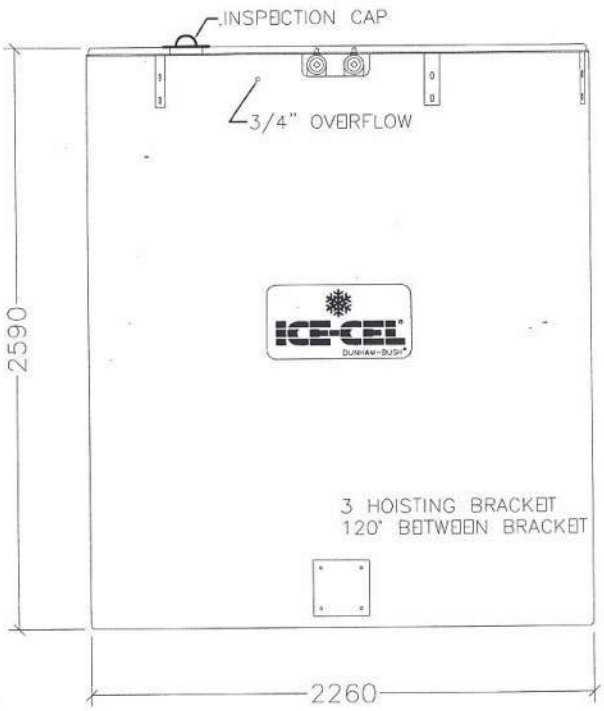
TITLE C/W DRN PIP/MAKE UP HOLE

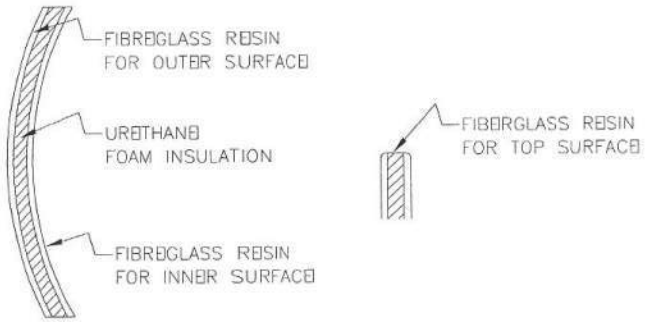
TS205 ICE CELL

DRAWING NO TS205_ICECELL A3

SCALE : N. T. S SHEET 1 OF 1







ICE CEL TS205 PHYSICAL SPECIFICATION

DIAMETER (MM)	2260	89"
HEIGHT (MM)	2590	102"
VOLUME OF GLYCOL SOLUTION (L)	985	260.2 gal
VOLUME OF WATER (L)	6814	1,800 gal
WEIGHT, EMPTY (KG)	848	1,870 lbs
WEIGHT, TOTAL OPERATING (KG)	8832	19,472 lbs

DUNHAM-BUSH

ALL DIMENSIONS ARE IN MILIMETER UNLESS OTHERWISE SPECIFIED

THRID ANGLE PROJECTION

A4

DRN BY: AZMI HUSIN | DATE: 13.3.2008

APPD BY: | DATE:

ICE-CEL | MODEL: TS205

TITLE: ICE-CEL SPECIFICATION

REV: 0 | DATE: | APPRD BY:

DRW NO: IC-205TD001-0

DUNHAM-BUSH
Products That Perform...By people Who Care

2006

INSTALLATION INSTRUCTIONS

ICE-CEL Model TS-205
Thermal Storage Module

1. **Location** : Ice-Cel modules can be located within a building's equipment room, outdoors or buried in the ground. For indoor or outdoor location, the module should be set on a slab of reinforced concrete capable of carrying the operating weight of 19,300 lbs (8;832 kg). The slab should be level within 1/16 in. per ft. (5mm per m) and its flatness should be within 1/8 in. (3 mm).

   For burying ice-cels, see separate instruction, "Buried Installation".

   For outdoor installation in cold climates, there is no risk involved in freezing the water in the module. Because of the excellent tank wall insulation, freezing due to cold ambient temperature proceeds very slowly with no damaging results on the module. The module is designed to resist the effects of solar radiation and should require little if any maintenance.

   Multiple modules should be located to allow access to interconnecting piping. No space is required between modules other than for piping access. See Fig. 1 for suggested layouts.

2. **Piping** : Each module is furnished with a pair of 2 in. PVC connection stubs located near the top of the tank. . They are connected to headers securely fastened within the tank. The external piping must be designed and adequately supported by pipe hangers to prevent twisting or bending stresses on the Ice-Cel connections. It is recommended that a transition to 3" PVC be made close to each module. Supply and return connections are interchangeable on each module. Piping to multiple modules should be arranged in reverse return fashion as shown in Fig. 1, in order to balance the pressure drop in each of the parallel circuits. All Ice-Cels should be piped in parallel. Pipe size should be selected as appropriate for design flow rate.

   Since the heat exchanger coils in all Ice-Cels are identical, there is no need for balancing valve for individual models. Care should be taken in assembling piping to keep it clean internally. If dirt and debris are allowed in the piping, a strainer must be installed upstream of pump and Ice-Cels to collect it.

   Provision in the brine piping must be made for air elimination. A vent valve should be installed at each high point. Each Ice-Cel has a vent at top of each header.

   Provision in the chilled brine piping system must also be made for expansion of the brine as temperature varies. 25% Ethylene and Propylene glycol brines expand about 1.5% from 22 °F to 90 °F (-5.6°C to 32.3°C). The total internal volume of the brine system should be calculated. An expansion tank should be selected with 3% of this volume to allow for expansion without excessive pressure buildup. This tank should be connected to the brine piping at its highest elevation.

   Leak test all brine piping before charging.

   An overflow fitting is provided in each Ice-Cel. Over time, the cold water in an Ice-Cel will condense water from the ambient air, overfilling the tank. If this slight overflow will be a nuisance, connect ¾ in. (20 mm) PVC piping from the overflow to a drain.

3. **Charging:** Fill the brine system, including Ice-Cel coils, with the proper brine solution *before* filling the Ice-Cel tanks with water. It is recommended that the brine solution be purchased from Dunham-Bush, as this brine is supplied pre-mixed at the prescribed concentration, using appropriate inhibitors and de-ionized water, for optimum long term performance. *Do Not* use automotive type antifreeze, since the inhibitors in it are not appropriate for air conditioning systems.

   Mixing glycol solutions on-site is inadvisable because it is difficult to determine precisely the system volume plus on-site mixing causes large amounts of air to become entrained in the solution. Premixed Glycol solutions are relatively free of entrained air.

   Be careful in charging the system to fill from the bottom up and vent air as you go. Glycol solutions tend to get very foamy and difficult to vent if you generate a lot of turbulence.

   After the brine system is filled, the Ice-cel modules can be filled with clean, cool tap water. Water from a domestic potable water supply is preferable. Fill each tank to a point 8 in. (203 mm) below the over flow connection. Finally, add algicide into the water in the module. This will prevent organic growth in the Ice-Cel.

4. **Commissioning :** Run the brine pump and check for proper flow rate. Check to see that brine pressure at the Ice-Cels does not exceed 150 psig (1034 kPa). Brine solutions are extremely attractive of entrained air and complete venting of the system is important for proper operation. Venting of the high points of the system must continue until no further air is found and be periodically checked over several weeks to insure all air is vented.

Add brine If necessary to fill up the system. The expansion tank should be about half full when the system is warm and nearly empty when operating in freeze mode.

Run the chiller with controls in the mode to freeze the Ice-Cels. Check the brine temperature leaving the chiller. As ice begins to form, leaving brine temperature should settle at design value, usually about 25°F (-3.89°C). Return brine to the chiller should be about 31°F (-0.56°C). Set the chiller cutout at about 3°F below the steady operating temperature (e.g. If operating temperature = 25°F, set the cutout at 22°F). The chiller should be controlled to run fully loaded until leaving brine temperature falls to the cutout level, then shut off and stay off. This indicates that the Ice-Cel(s) are fully frozen.

When fully frozen, the Ice-Cel will have a layer of water between the heat exchanger coil and the tank and a cylindrical core of water about 12in.(30.5 cm) diameter. This unfrozen water is normal.

Chiller controls must *not* be adjusted to run long periods of light load or to run with brine much below 22°F, during freeze mode, as this kind of operation could overfreeze the tank and damage it.

During melt mode, the Ice-Cel(s) can be used to serve the load alone or in tandem with the chiller. Brine temperature leaving the Ice-Cel can vary from 31°F to 38°F (0.5°C to 3.3 °C) early in the melt process, depending on load. As melting continues, leaving brine temperature rises. If it is desired to control the temperature of brine supplied to the load, a modulating bypass valve around the Ice-Cel(s) can be used. If the chiller is operating in series with the Ice-Cel(s), its capacity can be modulated to control brine supply temperature. Ice-Cels are very flexible in the melt mode and can serve a wide range of loads.

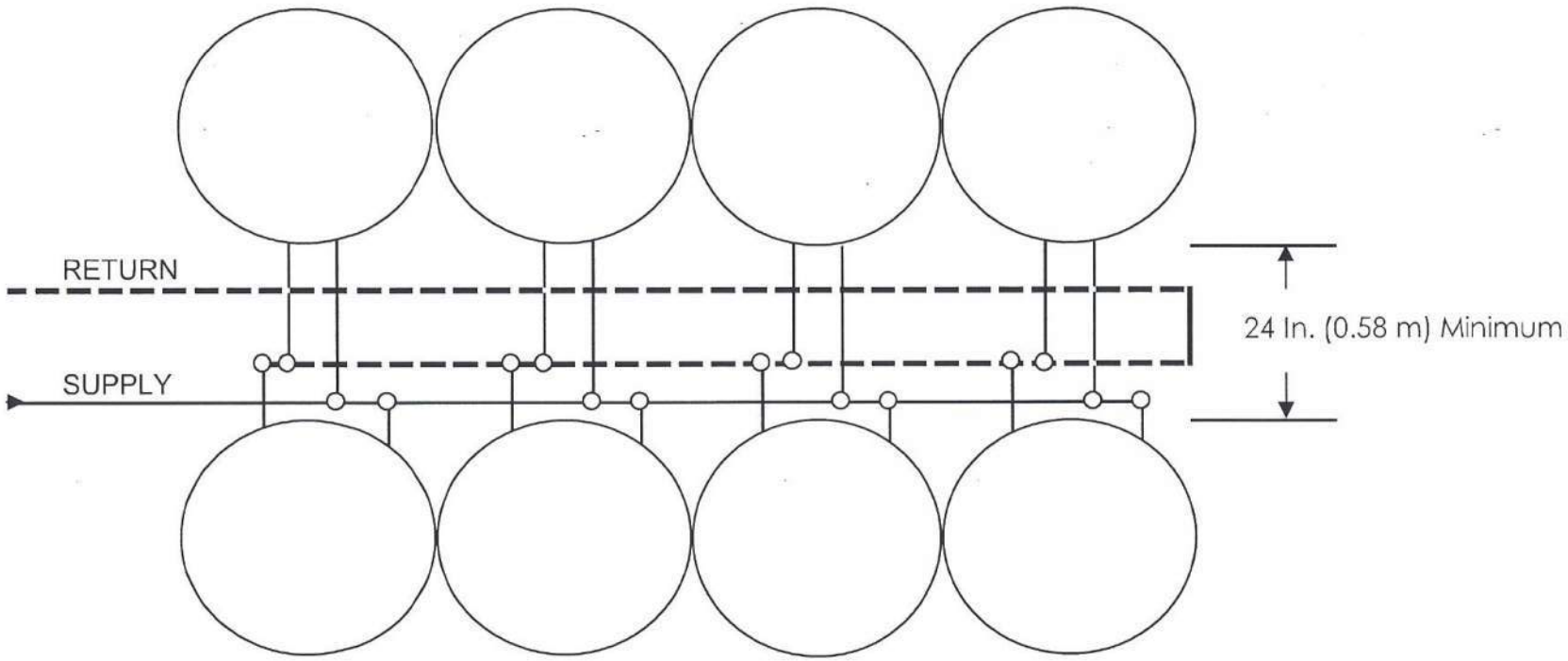
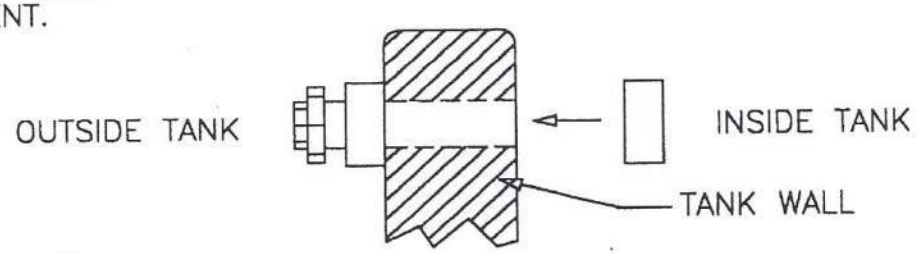


Figure No. 1

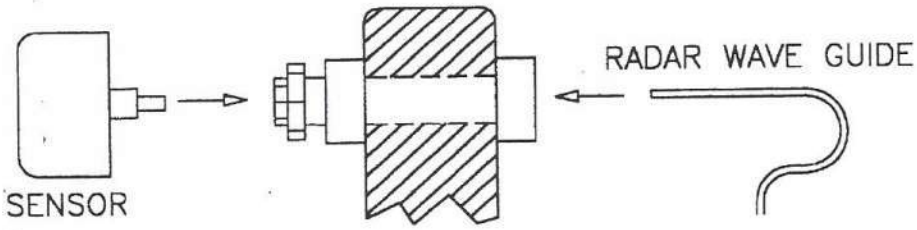
RADAR SENSOR INSTALLATION

1. USING A TWO INCH (2") HOLE SAW, DRILL A TWO INCH (2") DIAMETER HOLE IN THE SIDE OF THE ICE-CEL TANK (SEE ENCLOSED RADAR SENSOR HOLE PLACEMENT DRAWING FOR CORRECT DIMENSIONS).

2. USING PVC CLEANER AND PVC GLUE, JOIN THE PIPE AND COUPLING PIECE AS SHOWN. SECURE THE COUPLING AS SNUG AS POSSIBLE TO MINIMIZE SENSOR MOVEMENT.



3. SCREW THE SENSOR AND RADAR WAVE GUIDE TOGETHER AS SHOWN.



4. ROTATING THE PVC CONNECTION, SCREW THE SENSOR INTO THE THREADED BUSHING.

5. USING THE WIRING DIAGRAM ON PAGE 1 OF THIS DRAWING, WIRE THE SENSOR. THE SENSOR OUTPUTS A 4 TO 20 mA SIGNAL. A 24Vdc POWER SUPPLY IS RECOMMENDED WITH A MAXIMUM INPUT IMPEDANCE OF ALL EXTERNAL DEVICES NOT EXCEEDING 700 OHMS. USE 1/2" NPT CONDUIT AT THE THREADED HOLE.

6. APPLY SEALANT AROUND THE INSIDE AND OUTSIDE OF THE DRILLED TANK HOLE AND ALLOW TO DRY.

7. MAKE SURE THAT THE RADAR ROD IS NOT TOUCHING THE PVC PIPE OR COUPLING. IT SHOULD ONLY BE IN CONTACT WITH THE WATER INSIDE THE TANK. THE ROD CAN BE SLIGHTLY BENT IF NECESSARY.

8. FILL UP THE ICE-CEL TANK TO THE DRAIN HOLE.

9. PRESS THE SPAN BUTTON ON THE ICE SENSOR. THIS WILL BE THE 100% FROZEN POINT.

10. FREEZE THE TANK ONCE, LETTING THE WATER DRAIN THROUGH THE DRAIN HOLE.

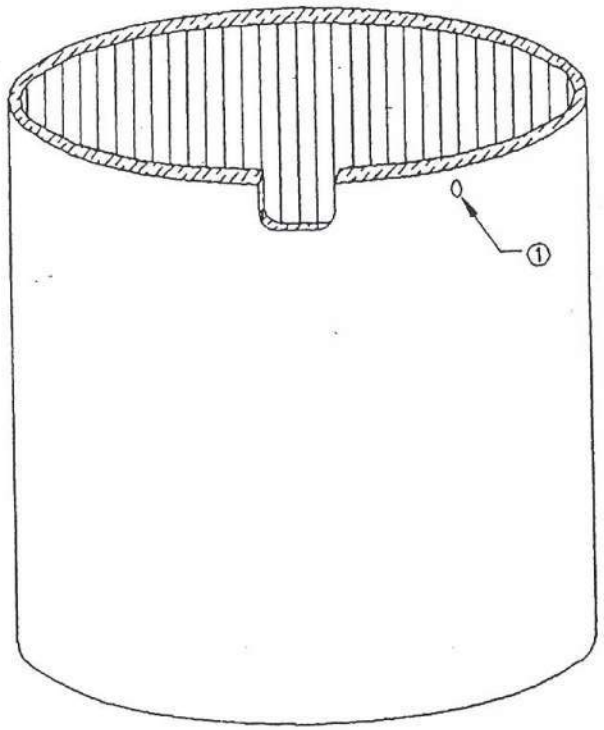
11. MELT THE TANK TO A NORMAL MELT LEVEL FOR YOUR SYSTEM. AFTERWARDS, PRESS THE ZERO BUTTON INDICATING A 0% FROZEN TANK. THE SENSOR CALIBRATES THE REST OF THE SPAN AUTOMATICALLY.

DUNHAM-BUSH, INC. COMMERCIAL PRODUCTS DIV. HARRISONBURG, VA. 22801		
SIMILAR TO	APP.	DATE
TITLE: ICE SENSOR WIRING DIAGRAM		
INITIAL USAGE: TS120, TS180, TS240		
DRAWN BY: NWH	DATE: 9-24-97	ICESENR
		SHEET 2 OF 2 SHEETS

A

B

C



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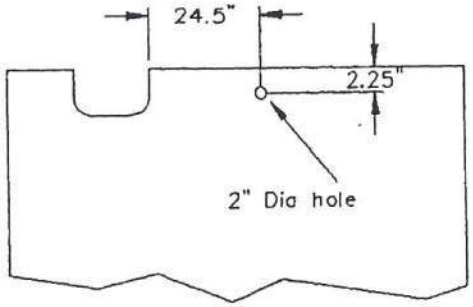


TOLERANCE UNLESS OTHERWISE SPECIFIED		
BASIC DIM.	FRACT.	DEC.
UP TO 6 IN.	±1/64	±.005
UP TO 24 IN.	±1/32	±.010
24 IN. AND UP	±1/32	±.015
ANGLES ±1°	SHEETMETAL ±1/32	

DUNHAM–BUSH, INC.
COMMERCIAL PRODUCTS DIV. HARRISONBURG, VA. 22801 USA

SIMILAR TO | APP. | DATE

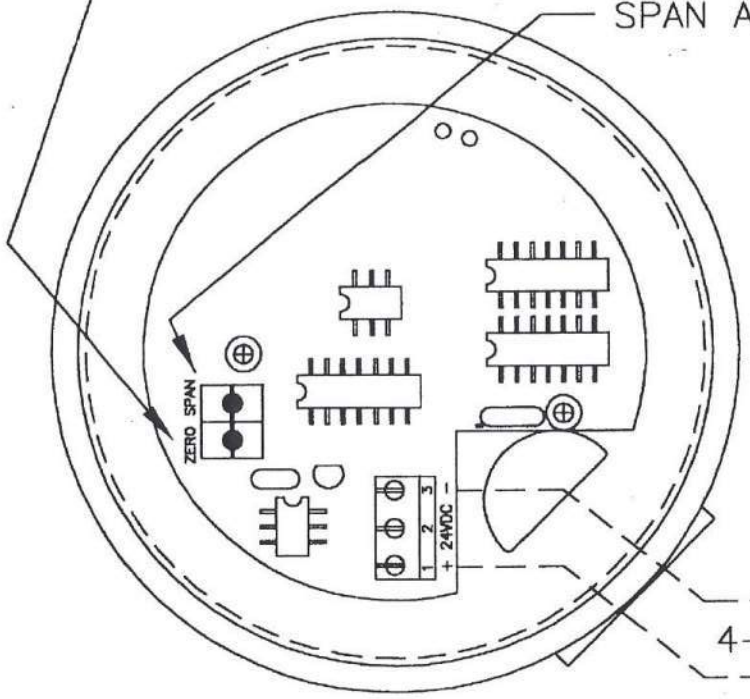
TITLE
Radar Sensor Hole Placement

INITIAL USAGE

DRAWN BY | DATE
K. Layman | 7/97

SHEET 1 OF 1 SHEETS

ECN	#	REVISION	DATE
NWH	1	FIXED POLARITY	4-13-99



TOP VIEW OF ICE SENSOR
(COVER REMOVED)

CUSTOMER SUPPLIED
METER AND POWER SUPPLY

120VAC DIGITAL
DISPLAY PANEL

24VDC SUPPLY — +

SIGNAL HI LO

BUILDING
AUTOMATION
SYSTEM
(BAS)

\+ SIGNAL —

4–20mA

NOTE:
TOTAL INPUT IMPEDANCE OF ALL
EXTERNAL DEVICES NOT TO EXCEED
700 OHMS AT 24VDC

DUNHAM–BUSH, INC.
COMMERCIAL PRODUCTS DIV. HARRISONBURG,VA. 22801 USA

SIMILAR TO	APP. DATE
TITLE: ICE SENSOR WIRING DIAGRAM	
INITIAL USAGE: TS120, TS180, TS240	
DRAWN BY: NWH	DATE: 6-24-97
ICESENR	SHEET 1 OF 2 SHEETS

ICESENR

DO NOT SCALE THIS DRAWING

DUNHAM-BUSH
COMMERCIAL PRODUCTS DIVISION
Products That Perform...By People Who Care

THERMAL STORAGE ICE CELS

GUIDE SPECIFICATIONS

PART 1: GENERAL

1.01 WORK INCLUDED

A. Provide complete ice thermal storage units suitable for outdoor installation. Contractor shall furnish and install ice thermal storage units as shown in schedule on the drawings. Units shall be installed in accordance with this specification.

1.02 DESIGN BASE

A. The construction drawings indicate a system bases on a selected manufactured of equipment and the design data available to the Engineer during construction document preparation. Size, configuration and space allocations are consistent with that manufacturer's recommendations and requirements.

B. Other listed or approved manufactures are encourages to provide equipment on this project; however, it shall be the Contractor and/or Supplier's responsibility to assure the equipment is consistent with the design base. No extra compensation will be approved for revisions required by the design base or the manufacturers' for any different services, space, clearances, etc.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. General Provisions: Section 15010
B. General Completion and Start-up: Section 15020
C. Equipment & Pipe Identification: Section 15021
D. Test: Section 15025 E. Chilled Water System: Section 15702

1.04 SUBMITTALS

A. Submit shop drawings on each piece of equipment specified in accordance with Specifications Section 51010, General Provisions.
B. Furnish three (3) sets of Operations and Maintenance Data.

1.05 START-UP

A. The contractor shall provide labor to accomplish the check, test and start-up procedure as recommended by the unit manufacturer.
B. The start-up serviceman shall provide and complete the manufacturer's check, test and start forms. One copy shall be sent to the Engineer and one copy to the manufacturer's factory.
C. (The unit manufacturer shall provide a factory trained serviceman to supervise the original start-up of the units for final operation.)

1.06 WARRANTY

A. The equipment supplier shall provide a guarantee on the entire ice thermal storage system for a period of one (1) year from the date of start-up or up to 18 mouths from date of shipment, whichever occurs first. The manufacturer also provides an additional 14 years on the tank and 4 years on the heat exchanger. Total warranty period of 15 years for the tank & 5 years for the heat exchanger.

B. Date of successful start-up shall be certified by a Mechanical contractor to the Engineer and Owner.

PART 2: PRODUCTS

2.01 ICE THERMAL STORAGE PRODUCTS

A. General

1. Furnish and install as shown on the plans ice thermals storage units. Units shall be Dunham-Bush Model T5205 or equal.
2. The units are to be completely factory assembled ice thermal storage units complete with removable cover, insulation, heat exchanger and pipe connections.
3. The units shall be built in accordance with all applicable national and local codes including ASTM specification D-4097-88.

B. The units shall be furnished as shown on the capacity schedules and drawings.

C. Construction: The ice thermal storage unit are to be completely factory assembled double wall thanks constructed on 1/8 inch fiberglass sufficient to protect the units from shipping and handling damage and capable of underground installation. The units should include two inches thickness or urethane foam insulation between the two layers of fiberglass. The walls should be an insulation resistance R-14 or more. Sidewalls and bottom of the tank shall be of the same insulated double-wall construction described above. A removable cover of the same construction shall be provided. The heat exchanger shall consist of two horizontal rows of serpentine coils of ¾ inch OD polyethylene tubing held in a rigid by radial plastic spacer bars. Each coil of tubing shall be connected to vertical inlet and outlet headers of the same polyethylene material. Tubes shall be thermally welded into the headers to form one homogeneous heat exchanger with no fittings or joins to leak. The heat exchanger shall be tested to 250 psig and rated for a maximum operating pressure of 150 psig. The headers shall have two inches male stub-outs of PVC pipe for easy connection to external piping. A ¾ inch FPT water overflow fitting shall be provided. All metal parts within the ice thermal storage unit shall be fabricated of corrosion-resistant stainless or zinc-coated steel.

D. The ice thermal storage units shall have units-in bolting pads of sufficient strength to allow attachment of rigging devices or casters for easy movement of the units during installation.

E. (The manufacturer shall fur finish a rigging kit with lifting brackets, spreader bar and chains for crane lifting and heavy duty industrial-type casters for ease of rolling the units during installation without damage)

F. (The manufacturer shall provide (sufficient quantity) (___gallons) of thoroughly premixed _30___% solution of (Dowtherm SR-1 ethylene glycol) and de-ionized water for the mechanical contractor to completely charge the building piping system. Field charging of concentrated (not premixed) glycol is not acceptable.)

PART 3: EXECUTION

3.01 INSTALLATION WORK BY MECHANICAL CONTRACTOR

A. Install ice thermal storage units on a flat surface, level within 1/16 inch and of sufficient strength to support the unit loading in operating conditions.
B. Assemble and install all components furnished loose by manufacturer as recommended by the manufacturer's literature.
C. Complete all glycol connections so the unit and glycol circuits are serviceable.
D. (Provide and install valves glycol piping upstream and downstream of the pipe stub-outs to provide means of isolating ice thermal storage units for maintenance and trim system)
E. Furnish and install taps for thermometers and pressure gauges in glycol piping adjacent to inlet and outlet of ice thermal storage unit.
F. Thoroughly clean the interior of all glycol solution piping.
G. Fill the glycol circuit with glycol solution as prescribed in Section 2.01.F above. Circulate and fully vent all air from the glycol circuit prior to refrigeration start-up.
H. Fill the ice thermal storage cells with water and add algaecide as recommended by manufacturer.

ORIGINAL
BAS SEQUENCE OF OPERATION

The following materials are provided to set forth the original sequence of operations as supplemented and clarified in the project documents. Meeting the requirements of this sequence, as modified by the project manual, is a project requirement. They are part of the project documents.

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All Division 23 Specification Sections also apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. ATC: Automatic Temperature Control.

C. BAS: Building Automation System.

D. AI: Analog Input.

E. AO: Analog Output.

F. DI: Digital Input.

G. DO: Digital Output.

H. VAV: Variable air volume.

I. VF: Variable Frequency.

J. AHU: Air Handling Unit.

K. RTU: Rooftop Unit.

L. CO_2: Carbon Dioxide

1.4 MISCELLANEOUS REQUIREMENTS

A. The control strategies described in this section shall be used in conjunction with the Input/Output Summary Tables attached herein for engineering the control systems and preparing the required control drawings.

B. The Input/Output Summary Tables and the sequence have been made to complement one another. The ATC Contractor shall interpret the sequences and the Input/Output Summary

Tables such that if a device is called for in one and not the other, it will be treated as if called for in both.

C. Control of all HVAC equipment shall be through the DDC system and by electric control as specified per individual sequence.

D. Whether indicated or not, all temperature setpoints included in the sequences of this Section shall be adjustable.

PART 2 - PRODUCTS

2.1 Refer to Division 23 Section "Automatic Temperature Control for HVAC" for control equipment and devices.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. The following general applications software shall be required on all appropriate equipment (i.e. rooftop units, exhaust fans, terminal unit equipment, etc.) for the purpose of optimizing energy consumption while maintaining occupant comfort:

B. Time of Day Scheduling (TOD): The system shall be capable of the following scheduling features:

1. Scheduling by building, area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes). A weekly repeating schedule, i.e. between 8:00 a.m. and 5:00 p.m., Monday through Friday shall constitute one schedule, not five.
2. Dated schedules shall be entered up to 9 (nine) years in advance.
3. Schedules shall be self-deleting when effective dates have passed.
4. Leap years shall be adjusted automatically without operator intervention.
5. For maximum speed in the communication of schedules, the operator shall have the ability to communicate schedules at the most efficient level with one scheduling command through the mouse interface. This ranges from system wide to individual zones, groups or pieces of equipment.
6. The system shall allow the operator to designate any combination of equipment to form a group that can be scheduled with a single operator command through the mouse interface at the workstation. Any designated group shall have the capability to be a member of another group.
7. The operator shall be able to make all schedule additions, modifications and deletions using the mouse and appropriate dialog boxes. In addition, the operator shall have the capability to edit all schedules off line and then download any or all schedule changes to the control modules with a single operator command through the mouse interface. In the event that a schedule in the control module is different from the workstation, the operator shall have the capability to upload any or all schedules from the control module to the workstation.
8. The operator shall be able to view a color-coded forecast of schedules for instant overview of facilities schedules. Schedule graphic forecast shall include colored coded indication of all types of schedules, i.e. normal, holiday and override.

C. Optimum Start/Stop (OSS)/Optimum Enable/Disable (OED):

1. Provide software to start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity in øF/hour of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable. Temperature compensated peak demand limiting shall remain in effect during morning start up to avoid setting a demand peak.

D. Day/Night Setback (DNS):

1. The system shall allow the space temperature to drift down [up] within a preset [adjustable] unoccupied temperature range. The heating [cooling] shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range.
2. The system shall be capable of closing all outside air and exhaust air dampers during the unoccupied period, except for 100% outside air units.
3. Unoccupied space temperature shall be monitored by the DDC temperature sensors located in the individual zones being controlled or within a representative room in the building if full DDC control is not being affected.
4. User shall be able to define, modify, or delete the following parameters.

    a. DNS setpoint temperature(s)
    b. Temperature band for night heating operation
    c. Period when the DNS is to be activated

E. Timed Local Override (TLO):

1. The system shall have TLO input points that permit the occupants to request an override of equipment that has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (momentary contact), wind-up timer, or ON/OFF switches as detailed in the I/O summary.
2. If a push button is used the system operator shall be able to define the duration of equipment ON time per input pulse and the total maximum ON time permitted. Override time already entered shall be canceled by the occupant at the input point. If a wind-up timer is used the equipment will stay in override mode until the timer expires. Year to date, month-to-date and current day override history shall be maintained for each TLO input point. History data shall be accessible by the operator at any time and shall be capable of being automatically stored on hard disk and/or printed on a daily basis.

F. Space Temperature Control (STC): There shall be two space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one of the two setpoints shall be operative at any time. The cooling setpoint is operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint. The heating setpoint is operative if the actual space temperature has more recently been equal to or less than the heating setpoint. There are two modes of operation for the setpoints, one for the occupied mode (example: heating = 72°F or 22°C, cooling = 76°F or 24.4°C) and one for the unoccupied mode (example: heating = 55°F or 12.7°C, cooling = 90°F or 32°C).

G. The occupied/unoccupied modes may be scheduled by time, date, or day of week.

1. If the actual space temperature is in the dead band between the heating setpoint and the cooling setpoint, the color displayed shall be green for the occupied mode, representing

ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing 'after-hours' conditions.

2. If the space temperature rises above the cooling setpoint, the color shall change to yellow.
3. When space temperature falls below the heating setpoint, the color shall change to light blue.
4. All setpoints and offsets shall be operator definable. When in the occupied mode, start-up mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.
5. When comfort conditions are warmer than ideal, indicated by the color yellow a request for additional cooling shall be sent over the network to other cooling equipment in the HVAC chain, such as a chiller. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
6. When comfort conditions are cooler than ideal; indicated by the color light blue, a request for additional heating shall be sent over the network to other heating equipment in the HVAC chain, such as a boiler. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
7. The cooling [and heating] setpoints may be increased [decreased] under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of setpoint increase [decrease] for each of the three levels. Each space temperature sensor in the building may be programmed independently.
8. An optimum start-up program transitions from the unoccupied setpoints to the occupied setpoints. The optimum start-up algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope (AI: Space Temperature).
9. A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers [and heating coil valve or heating stages in sequence] to achieve the setpoint target.

3.2 VAV RTU AND AHU FAN (DISCHARGE DUCT) STATIC PRESSURE SETPOINT OPTIMIZATION

A. The building automation system (BAS) shall continuously monitor the damper position of all VAV terminal units. The discharge duct static pressure shall be sensed directly at the discharge of each AHU and RTU. The sensor must be mounted in a non-turbulent location.

B. When any VAV damper is more than 95% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset upward by 0.1 in W.C. (adj.) at a frequency of 15 minutes (adj.) until one of the following occur:

1. No damper is more than 95% open.
2. The static pressure setpoint has reset upward to the system maximum duct static pressure setpoint.
3. The AHU and RTU variable-frequency drive is at the maximum speed setting.

C. When all VAV dampers are less than 85% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset downward by 0.1 in W.C.(adj.) at a frequency of 15 minutes (adj.) until one of the following occur:

1. At least one damper is more than 65% open or the static pressure setpoint has reset downward to the system minimum duct static pressure setpoint
2. The AHU and RTU variable-frequency drive is at the minimum speed setting.

D. The control bands, setpoint increment values, setpoint decrement values and adjustment frequencies shall be adjusted to maintain maximum static pressure optimization with stable system control and maximum comfort control.

E. The BAS shall have the capability of performing the following functions:

1. Allow the operator to exclude “problem” zones that should not be considered when determining the optimized setpoint.
2. Read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
3. Identify, and display to the user, the VAV box that serves the Critical Zone (that is, the zone with the most wide-open VAV damper). This information shall update dynamically as the location of the Critical Zone changes based on building load, and duct static pressure setpoint optimization control.

F. During the commissioning process, the ATC Subcontractor shall demonstrate the performance of fan pressure optimization.

3.3 VENTILATION OPTIMIZATION

A. The AHU and RTU outdoor-air damper shall be controlled to deliver required outdoor airflow at all load conditions during the occupied mode. The outdoor airflow setpoint for each AHU and RTU shall be as scheduled on the Drawings or shall be as indicated in its sequence of operations contained in this Section. The actual outdoor airflow shall be sensed at the outdoor air intake.

B. The building DDC system shall include a time-of-day schedule to indicate whether the AHU and RTU is in the occupied mode or the unoccupied mode. When the schedule indicates that the AHU and RTU is in the unoccupied mode, the required outdoor airflow for the system shall be zero. When the schedule indicates that the AHU and RTU is in the occupied mode, the required outdoor airflow for the AHU and RTU shall equal the design minimum outdoor airflow rate, unless one of the following is true:

1. The AHU and RTU serves one or more zones or spaces equipped with a carbon dioxide (CO_2) sensor.

    a. For those zones equipped with a CO_2 sensor, the required outdoor airflow for the zone shall be continuously calculated using the measured CO_2 concentration as an indicator of the current per-person ventilation rate.

2. Ambient conditions are such that the AHU and RTU is operating in the economizer mode.

C. If an AHU and RTU serves one or more zones or spaces equipped with a CO_2 sensor the DDC system shall modulate the outdoor air and return air dampers as follows:

1. If the CO_2 level in all spaces containing CO_2 sensors are below setpoint, then the outdoor air damper shall be placed in its low occupancy minimum outdoor position. The low occupancy minimum outdoor air position for each AHU and RTU is indicated in the AHU

and RTU Schedules on the Drawings or is indicated in its sequence of operations contained in this Section.

2. If the CO_2 level in any space rises above setpoint, and its terminal box primary air damper is in its maximum position, then the DDC system shall increase the unit's outdoor air quantity in 1% increments every 30 seconds until all space CO_2 levels are 50 ppm (adjustable) below their setpoint or the high occupancy minimum outdoor air position is reached.
3. If the CO_2 level in all spaces are below setpoint, the DDC system shall reduce the unit's outdoor air quantity in 1% increments every 30 seconds until any space CO_2 level rises to within 25 ppm (adjustable) of its setpoint or the unit's low occupancy outdoor air position is reached.

D. The CO_2 setpoint in each space shall be one of the following:

1. An Owner determined setpoint.
2. A DDC determined setpoint that is 500 ppm above the outdoor air CO_2 concentration level as measured and averaged by two CO_2 sensors.

E. If a space or zone containing a CO_2 sensor is served by a VAV terminal box or fan powered terminal box and its CO_2 level rises above setpoint, the DDC system shall increase the terminal box primary air damper position in increments of 25 cfm every 15 seconds until space CO_2 drops to a level of 50 ppm (adjustable) below its setpoint or the terminal box primary air damper reaches its maximum position. The DDC system shall not adjust/modulate the AHU and RTU outdoor air damper from its low occupancy minimum outdoor air position until the terminal box primary air damper reaches its maximum position and the space CO_2 level continues to remain above setpoint for a time period of 90 seconds (adjustable)

F. The DDC system shall not request a quantity of outdoor air that is above the AHU and RTU high occupancy minimum outdoor air position/quantity unless the current outdoor air temperature and humidity conditions permit economizer use and a system need for cooling exists.

3.4 PUMP PRESSURE SETPOINT OPTIMIZATION

A. This operating sequence shall apply to the building hot water pumps and the building chilled water pumps that are provided with variable frequency drives.

B. The building automation system shall continuously monitor the control valve position of all air handling units.

1. At system startup, the pump pressure setpoint shall be 100% of the maximum pressure setpoint.
2. When any control valve is more than 95% (adjustable) open, the pump pressure setpoint shall be reset upward by 10% (adjustable) of the current pump pressure setpoint at a frequency of every 2 minutes (adjustable) until one of the following occur:

   a. No control valve is more than 95% open (adjustable).
   b. The pump pressure setpoint has reset upward to the system maximum setting.
   c. The pump variable frequency drive(s) are at their maximum setting.

3. When all system control valves are less than 85% open (adjustable), the pump pressure setpoint shall be reset downward by 5% (adjustable) of the current pump pressure setpoint at a frequency of every 2 minutes (adjustable) until one of the following occur:

a. At least one control valve is more than 85% open (adjustable).
b. The pump's flow rate is equal to the chiller(s) or boiler(s) minimum flow rate.
c. The pump variable frequency drive(s) are at their minimum setting.

4. The control bands, setpoint increments, setpoint decrements, and adjustment frequencies shall be adjusted to maintain maximum pump pressure optimization with stable system control.

3.5 FIREFIGHTERS SMOKE CONTROL STATION AND INDICATOR PANEL (FSCS)

A. Provide a Firefighters Smoke Control Station & Indicator Panel (FSCS) to allow for firefighter monitoring and automatic or manual control of all HVAC smoke control devices (smoke supply & exhaust fans, stair pressurization supply fans, dampers, and smoke control devices). The wall mounted panel shall be a schematic representation, in plain English, that defines the location and status of all HVAC equipment smoke control devices.

B. The FSCS shall have the highest priority control over all smoke control systems & equipment. FSCS control shall override or bypass other building controls such as hand-off-auto and start/stop switches located on fan motor controllers, freeze detection devices, and duct smoke detectors.

C. The FSCS shall provide status indication & fault condition indication via pilot lights. Manual control of all smoke-control system components shall be provided at the FSCS. Status indicators and controls shall be arranged and labeled to convey the intended system objectives. Provision shall be included for testing the pilot lamps on the FSCS smoke-control panel(s) by means of one or more "LAMP TEST" momentary push buttons.

D. "On" status for supply or exhaust fans shall be sensed by a pressure difference across each fan. Positive status indication (fully open and fully closed) of for smoke damper position shall be via end switches at each damper.

E. All HVAC fans & dampers, controlled devices, and controls required for complete operation of the smoke control sequences shall be on emergency power.

F. The ATC contractor & HVAC Contractor shall demonstrate successful operation of all smoke control systems.

G. AHU-1, SF-1, SF-2, related system dampers, and related system smoke dampers are a part of the building smoke control system. For definition of system and component operation, refer to the control sequences for each device.

3.6 EGRESS CORRIDOR PRESSURIZATION:

A. AHU-1 and the associated system smoke dampers are a part of this system. For definition of system and component operation, refer to the control sequences for each device. All smoke dampers shall be UL 555 rated.

B. Monitor each duct smoke detector condition at each supply air fan discharge. If smoke is detected at any given supply fan, de-energize the fan and indicate a "smoke at supply fan discharge" alarm condition, for the device, at the FSCS. Allow for manual override of the smoke detector shutdown at the FSCS.

C. At the FSCS provide:

1. ON/OFF/AUTO control of each supply fan
2. OPEN/CLOSED control for each automatic control air damper which will override the sequence of control the damper.
3. OPEN/CLOSED control for each smoke damper.

D. When smoke is detected in a given corridor, via ceiling mounted smoke detectors, the corridor is indexed via the HVAC DDC system as a “smoke condition level (SCL)”. Any single building corridor floor level directly above and/or below an SCL, if not an SCL, is given the nomenclature “pressurization control level or PCL.” Coordinate with the Fire Alarm Contractor to obtain a signal from the smoke detector(s) on each floor level. The ATC Contractor shall run wiring to a location as dictated by the Fire Alarm Contractor. The Fire Alarm Contractor shall make all final connections to the Fire Alarm System.

E. SCL floors: The supply air smoke control dampers shall be closed at this floor, and the exhaust air smoke control air dampers shall be open.

F. PCL floors: The supply air smoke control dampers shall be open, and the exhaust air smoke control dampers shall be closed.

G. Vary the speed of each supply fan, via adjustable frequency drive to limit the supply duct static pressure within the shaft or duct main. Confirm that the installed location for each duct static pressure sensor is not isolated via smoke dampers, or provide additional duct static pressure sensors dedicated for smoke control mode only.

3.7 HOT WATER SYSTEM

A. The building hot water system shall be controlled via the building DDC system and the boiler master controller. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

1. The boiler manufacturer will furnish a boiler master controller to control the operation of the hot water plant in conjunction with the DDC system. The ATC Subcontractor shall coordinate his control requirements with the requirements of the boiler master controller described in Division 23 Section “Condensing Boilers.”

B. Three new condensing type boilers shall supply hot water to the areas in the building being renovated via three integral primary (boiler) pumps - one each per boiler - and two secondary (building) pumps.

C. The ATC Subcontractor shall provide all field labor to install all sensors shipped loose by the boiler manufacturer. In addition, the ATC Subcontractor shall provide all field labor, wiring and conduit to connect all sensors shipped loose to the boiler master controller.

D. The ATC Subcontractor shall provide controls necessary for the DDC system to perform the following:

1. The DDC system shall activate and de-activate the heating system as follows:

a. When the building is occupied, the DDC system shall send a signal to the boiler master controller to activate the heating system.

b. When the building is unoccupied and the outside air temperature drops below 60°F (adjustable), the DDC system shall send a signal to the boiler master controller to activate the heating system.
c. When the building is unoccupied and the outside air temperature rises above 65°F (adjustable), the DDC system shall send a signal to the boiler master controller to de-activate the heating system.
d. Provide an edit point at the DDC panel and/or at the DDC system operator's workstation to allow an authorized operator to manually override the DDC system to energize or de-energize the heating system. The override shall have an adjustable time period. The override point shall be accessed and addressed at the DDC system operator's workstation or remotely via web access. When this event occurs, a message shall be recorded at the DDC system operator's workstation.

2. When the DDC system sends a signal to the boiler master controller to activate the heating system, the DDC system shall start the lead building loop (secondary) hot water pump. A differential pressure sensor mounted in the branch piping between the building loop (secondary) hot water pumps and the hydraulically most remote outlet shall control the speed of the lead building loop hot water pump.

a. If the lead secondary (building) pump fails to start (or fails during operation) as proven by a current switch, an alarm shall be sent to the DDC system operator's workstation, informing the operator of the malfunction. The signal to the original lead secondary (building) pump shall be disabled through DDC. The DDC system shall then send a signal for the lag/standby secondary (building) pump to start.
b. The DDC system shall contain a run time program to automatically rotate the lead and lag/standby secondary (building) pumps when the accumulated run time exceeds predetermined number of hours. Ensure that the first lead secondary (building) pump is stopped before the new lead secondary (building) pump is started. Only one secondary (building) pump shall be energized at any one time.

3. When the DDC system indicates that the heating system shall be activated, the boiler master controller shall determine which boiler shall be activated. Refer to Division 23 Section "Condensing Boilers" for requirements.

E. A boiler master controller will be furnished by the boiler manufacturer for lead-lag control of boilers, for modulating and on-off burner control, for reset of hot water supply temperature in accordance with outdoor air temperature, for monitoring and alarming high boiler water pressure, and for on-off control of the integral primary (boiler) blend pumps. The boiler master controller shall include the following components, functions and capabilities:

1. Sensors for system hot water return temperature, hot water supply temperature at the outlet of each boiler, hot water supply temperature to the load (building), and outside air temperature.
2. When it receives a signal from the DDC system to activate the heating system, the boiler master controller shall energize the integral primary (boiler) pump associated with the lead boiler. Once it determines that flow is proven through the lead boiler, the boiler master controller shall energize the lead boiler and control its burner.

a. The boiler master controller shall also determine through its optimization program when each of the two lag boilers should be energized.
b. When a boiler is de-energized by the boiler master controller, its integral primary (boiler) pump shall continue to operate for a period of 30-minutes (adjustable) before it too is de-energized by the boiler master controller.

3. The boiler master controller shall extend the burner firing periods to increase seasonal efficiency by reducing burner on-off cycles and avoiding thermal losses with excessive pre-purge and post-purge cycles. The boiler master controller shall adjust boiler response to load changes by analyzing building return water temperature, outside air temperature, boiler hot water supply temperature and building supply water temperature.
4. The boiler master controller shall alternate the designation of the lead boiler and the two lag boilers after 250 hours (adjustable) of cumulative firing time of the lead boiler.
5. The boiler master controller shall have a display on the front panel that shall indicate the following conditions:

    a. Heating system enable.
    b. Boiler 1 enable.
    c. Boiler 2 enable.
    d. Boiler 3 enable.
    e. Boiler #1 down on failure condition.
    f. Boiler #2 down on failure condition.
    g. Boiler #3 down on failure condition.
    h. Primary (boiler) pump 1 failure.
    i. Primary (boiler) pump 2 failure.
    j. Primary (boiler) pump 3 failure.
    k. High boiler water pressure.

6. The boiler master controller shall generate a line voltage on-off switched signal and a 135 ohm or 4-20 ma modulating signal for each burner.
7. The boiler master controller shall energize one of the two lag/standby boilers if the lead boiler has a flame failure or other safety shutdown.
8. The boiler master controller shall control the operation and firing of the boilers to control the building loop hot water supply temperature (to load) as follows:

Hot Water Supply Temperature		Outside Air Temperature
140°F(adjustable)		15°F and below (adjustable)
135°F(adjustable)		30°F (adjustable)
130°F(adjustable)		40°F (adjustable)
125°F(adjustable)		50°F (adjustable)
120°F(adjustable)		60°F (adjustable)
110°F(adjustable)		70°F and above (adjustable)

9. The boiler master controller shall stage the three boilers on and off in an energy efficient manner.
10. A boiler pressure transducer shall monitor boiler water pressure to avoid relief valve weeping or opening caused by failure of pressure regulating valve on glycol feed unit make-up line or caused by incorrect pressurization of the bladder-type expansion tank. A common manual reset alarm light shall be provided.

F. The ATC Subcontractor's field technician shall coordinate with the Boiler manufacturer's factory certified technician during startup. The ATC Subcontractor's field technician shall be available to the Boiler manufacturer's factory certified technician during his necessary testing procedure as outlined in Division 23 Section "Condensing Boilers."

G. The ATC Subcontractor shall provide the interlock wiring at the boiler as required by the boiler manufacturer including but not limited to the low water cut-off, high limit, main gas valve proof of closure switch, safety gas valve, high and low gas switches, and to the boiler master controller.

H. The boiler manufacturer will furnish a boiler master controller that is BACNET compatible. The ATC Subcontractor shall connect the DDC system to the boiler master controller to monitor operation of the heating system and to adjust setpoints.

1. If the ATC system is not BACNET compatible, the ATC Subcontractor shall provide an interface device that will provide full compatibility between the ATC system and the boiler master controller.

I. The ATC Subcontractor shall provide breakglass switches where indicated. The switches shall be wired to de-energize the boilers and domestic hot water heaters when the switches are in an alarm condition.

J. DDC Points List for Heating System:

1.	AI	Outside Air Temperature
2.	AI	Building Loop Hot Water Supply Temperature (downstream of the secondary pumps)
3.	AI	Boiler Loop Hot Water Supply Temperature, (one at each boiler, 3 required)
4.	AI	Building Loop Hot Water Return Temperature (located in the common return
5.	AO	Variable Speed signal to Secondary (Building) Pump (2 Required)
6.	DI	Boiler Status (each boiler)
7.	DI	Hot Water Pump Status (each pump)
8.	DI	Boiler Water Flow Switch, Differential Pressure Type (each boiler)
9.	DI	Boiler Emergency Shutdown Alarm
10.	DI	Domestic Hot Water Boiler Status
11.	DI	Boiler Alarm (each boiler)
12.	DO	Boiler Start/Stop (each boiler)
13.	DO	Boiler High Stage Control (each boiler)
14.	DO	Boiler Low Stage Control (each boiler)
15.	DO	Hot Water Pump Start/Stop (each pump)

NOTE: ICE STORAGE SYSTEM WILL BE REMOVED BY THE PROJECT, ALL REFERENCES TO ICE STORAGE ARE TO CLARIFY THE REMOVAL, INCLUDING ANY ASSOCIATED BAS DEVICES

3.8 CHILLED WATER SYSTEM WITH ICE STORAGE

A. The chilled water system shall consist of one air cooled rotary screw chiller, two constant speed primary (chiller loop) chilled water pumps, two variable speed secondary (building loop) chilled water pumps, and three ice storage tanks.

B. The chiller will be furnished with microprocessor-based controls along with an interface device. The chiller's microprocessor-based controls will have a chiller optimization program that will control the operation of the chiller when the DDC system requests the chiller to operate. The ATC Subcontractor and the chiller manufacturer shall coordinate their controls to provide a fully functional system that shall operate according to the sequence described herein.

C. The building DDC system shall start the chilled water system according to any of the following conditions:

1. The DDC system time schedule determines that the building is in the occupied mode.
2. The DDC system time schedule determines that the ice making mode shall start.
3. The chilled water supply temperature has risen more than 5ºF (adjustable) above a setpoint of 38ºF (adjustable).

D. The chilled water system shall de-energize when the building is in the unoccupied mode, the chiller is not in the ice making mode, all AHUs and RTU chilled water valves are open less than

5% for more than 10 minutes, and the chiller has run a minimum of 30 minutes. Maintain chiller minimum and maximum on and off times (Refer to Off Mode as described in this article).

E. The compressor staging of the chiller shall be controlled via the chiller manufacturer's microprocessor-based controls..

F. Prior to a chiller becoming enabled, its primary (chiller loop) chilled water pump shall start. Once flow is proven via a differential pressure sensor the chiller shall start.

1. If the chiller's primary chilled water pump fails to start or operate as proven by a CT switch, after 30 seconds (adjustable) an alarm shall be sent to the central site informing the operator and the standby pump shall be indexed to start.
2. The DDC system shall contain a run time program to automatically rotate the lead and lag/standby secondary (building) pumps when the accumulated run time exceeds a predetermined number of hours. Ensure that the first lead secondary (building) pump is stopped before the new lead secondary (building) pump is started. Only one secondary (building) pump shall be energized at any one time.

G. The chiller sequencing software shall include the following:

1. Chiller plant system scheduling
2. Color graphic based chiller plant status screens
3. Color graphic based chiller status screens
4. System and chiller diagnostic messages
5. System and chiller reports
6. Ice hours remaining

a. The control system shall continually calculate the hours of ice remaining based upon the current load and historical data. The calculation shall be based upon ice tank level, current rate of consumption, current load and historical depletion rates.

H. Operation Modes: The system shall be capable of operating in six different modes:

1. Ice Tank Charging
2. Ice Tank Charging with Cooling
3. Chiller only cooling
4. Using Ice Tanks only for cooling
5. Simultaneous Chiller Cooling and Ice Tank Charging
6. Off:

a. In each mode the automation system shall control the chiller \ thermal storage system as indicated in the following table and descriptions

7. Mode Control Table:

Chiller Plant Cooling Function	Chiller / Ice Tank Pump	Distribution Pump	Ice Bank Control Valve V1	Distribution Control Valve V2
Ice Tank Charging	On	Off	Open to tanks	Bypass Primary loop
Ice Tank Charging with Cooling	On	On	Open to tanks	Modulating
Chiller only cooling	On	On	Bypass Tanks	Open to primary loop
Ice Tank only cooling	Off	On	Modulating	Open to primary loop
Simultaneous Chiller Cooling & Tank Charging	On	On	Modulating	Open to primary loop
Off	Off	Off	Off	Off

I. Occupied Mode: When the building DDC system indexes the chilled water system to the Occupied mode, the following shall occur:

1. The lead building loop (secondary) chilled water pump shall operate. A differential pressure sensor mounted in the branch piping located between the building loop (secondary) chilled water pumps and the hydraulically most remote outlet shall control the speed of the lead building loop (secondary) chilled water pump. The building automation system shall continuously monitor the chilled water control valve position of all air handling units. At system startup, the chilled water pump pressure setpoint shall be 80% of the maximum pressure setpoint.

    a. If the lead building loop (secondary) chilled water pump fails to start or operate as proven by a CT switch, after 30 seconds (adjustable) an alarm shall be sent to the central site informing the operator and the standby building loop chilled water pump shall be indexed to start.
    b. The base differential pressure setpoint will be determined during the water balancing of the system.
    c. The required base differential pressure setpoint will be conveyed in writing to the controls contractor.
    d. When any chilled water valve is more than 95% open, the chilled water pump pressure setpoint shall be reset upward by 10% of the current chilled water pump pressure setpoint at a frequency of every 2 minutes until no valve is more than 95% open, or the pump pressure setpoint has reset upward to the system maximum setting, or the pump variable frequency drive(s) are at their maximum setting.
    e. When all chilled water valves are less than 85% open, the chilled water pump pressure setpoint shall be reset downward by 5% of the current chilled water pump pressure setpoint at a frequency of every 2 minutes until at least one valve is more than 85%, open or the pump's flow rate is equal to the chiller'(s) minimum flow rate, or the pump variable frequency drive(s) are at their minimum setting.
    f. The control bands, setpoint increments, setpoint decrements, and adjustment frequencies shall be adjusted to maintain maximum pump pressure optimization with stable system control.

2. The building DDC system in conjunction with the chiller controls shall determine the optimum means of chiller operation and ice melting.

    a. When it is determined the best means of providing cooling to the building is to only operate the chillers, 3-way valve V-1 shall be placed in its normally closed position (preventing flow from circulating through the ice storage tanks), 3-way valve V-2 shall be placed in its normally open position (permitting flow to circulate between the building loop and the chiller loop), and the chiller and its primary chilled water pump shall be energized and controlled to maintain the chilled water supply temperature setpoint of 38ºF (adjustable).
    b. When it is determined the best means of providing cooling to the building is to only melt ice, the chiller shall be de-energized, 3-way valve V-1 shall modulated to maintain to maintain the chilled water supply temperature setpoint of 38ºF (adjustable), and 3-way valve V-2 shall be placed in its normally open position (permitting flow to circulate between the building loop and the chiller loop).
    c. When it is determined the best means of providing cooling to the building is to operate the chillers and melt ice, 3-way valve V-1 shall be modulated, 3-way valve V-2 shall be placed in its normally open position (permitting flow to circulate between the building loop and the chiller loop), and the chiller and its primary chilled water pumps shall be energized and controlled to maintain the chilled water supply temperature setpoint of 38ºF (adjustable).

J. Unoccupied Mode: When the building DDC system indexes the chilled water system to the Unoccupied mode, the following shall occur:

1. Non-Ice Making Mode: The building DDC system in conjunction with the chiller controls shall control the chilled water system as follows:

    a. If cooling or dehumidification is required in the building as determined by the DDC system during the unoccupied mode, the following shall occur:

        1) The lead building loop (secondary) chilled water pump shall operate. A differential pressure sensor mounted in the branch piping located between the building loop (secondary) chilled water pumps and the hydraulically most remote outlet shall control the speed of the lead building loop (secondary) chilled water pump. The building automation system shall continuously monitor the chilled water control valve position of all air handling units. At system startup, the chilled water pump pressure setpoint shall be 80% of the maximum pressure setpoint.

            a) If the lead building loop (secondary) chilled water pump fails to start or operate as proven by a CT switch, after 30 seconds (adjustable) an alarm shall be sent to the central site after 30 seconds (adjustable) informing the operator and the standby building loop chilled water pump shall be indexed to start.
            b) The base differential pressure setpoint will be determined during the water balancing of the system.
            c) The required base differential pressure setpoint will be conveyed in writing to the controls contractor.
            d) When any chilled water valve is more than 95% open, the chilled water pump pressure setpoint shall be reset upward by 10% of the current chilled water pump pressure setpoint at a frequency of every 2 minutes until no valve is more than 95% open, or the pump pressure setpoint has reset upward to the system maximum setting, or the pump variable frequency drive(s) are at their maximum setting.

e) When all chilled water valves are less than 85% open, the chilled water pump pressure setpoint shall be reset downward by 5% of the current chilled water pump pressure setpoint at a frequency of every 2 minutes until at least one valve is more than 85%, open or the pump's flow rate is equal to the chiller'(s) minimum flow rate, or the pump variable frequency drive(s) are at their minimum setting.

f) The control bands, setpoint increments, setpoint decrements, and adjustment frequencies shall be adjusted to maintain maximum pump pressure optimization with stable system control.

2) If ice is still available, the chiller shall be shut off, and 3-way valve V-2 shall be placed in its normally open position (permitting flow to circulate between the building loop and the chiller loop), and 3-way valve V-1 shall modulated to melt ice in order to maintain chilled water supply temperature setpoint of 45ºF (adjustable).

3) If ice is not available, 3-way valve V-1 shall be placed in its normally closed position (preventing flow from circulating through the ice storage tanks), 3-way valve V-2 shall be placed in its normally open position (permitting flow to circulate between the building loop and the chiller loop), and the chiller(s) shall be started and shall operate to maintain building chilled water supply temperature setpoint of 45ºF (adjustable).

b. If cooling or dehumidification is not required in the building as determined by the DDC system during the unoccupied mode, the following shall occur:

1) The chiller shall be de-energized.
2) The lead chiller loop (primary) pump shall be de-energized.
3) The lead building loop (secondary) pump shall be de-energized.

2. Ice Making Mode: The building DDC system in conjunction with the chiller controls shall control the chilled water system as follows:

a. The chiller and its primary chilled water pump shall be energized and controlled to maintain the chilled water loop supply temperature setpoint of 25ºF (adjustable).
b. If building chilled water supply temperature is below setpoint of 45ºF (adjustable), 3-way valve V-2 shall be placed in its normally closed position (preventing flow to circulate between the building loop and the chiller loop), and 3-way valve V-1 shall be in its normally open position in order to make ice and charge the ice storage tanks.
c. If building chilled water supply temperature is above setpoint of 45ºF (adjustable), 3-way valve V-2 shall modulate (permitting flow to circulate between the building loop and the chiller loop) in order to maintain the building chilled water supply temperature setpoint of 45ºF (adjustable), and 3-way valve V-1 shall be in its normally open position in order to make ice and charge the ice storage tanks.
d. The remaining hours of ice inventory will be continually calculated and updated on a graphics screen. An alarm shall be triggered when the ice inventory gets to a critical level. This calculation shall be made based upon ice tank levels, current chilled water demand and historical depletion data.
e. Each ice storage tank shall be provided with a sensor that shall have the capability of determining the quantity of ice remaining in the tank.

3. Ice making shall begin daily at 11:00 PM (adjustable) if the capacity of ice stored in any single ice storage tank is below 85% (adjustable), Ice making shall end daily whenever all ice storage tanks reach full capacity or at 6:00 AM the following morning (adjustable).

K. In addition to the secondary (building-loop) pumps, each primary (chiller-loop) pump shall be provided with a variable frequency (VF) drive. Unlike the secondary (building-loop) pumps, the primary (chiller-loop) pump shall not vary once its speed is determined through the water balancing operation. The primary (chiller-loop) pumps shall operate at constant speed and the VF drives shall be used for balancing purposes only. The ATC Subcontractor and the HVAC Contractor shall provide assistance to the Balancing Subcontractor in adjusting the VF drives.

L. The ATC contractor shall provide all wiring and conduit for factory provided controls shipped loose for field installation. Coordinate requirements with the chiller manufacturer or his supplier.

M. DDC Points for the Chilled Water System: In addition to the points indicated below, refer to Division 23 Section “Scroll Water Chillers” for additional points that shall be incorporated into the building DDC system.

1. AI Chiller Supply Temperature
2. AI Chiller Return Temperature
3. AI Building Loop Chilled Water Supply Temperature
4. AI Building Loop Chilled Water Return Temperature
5. AI Chiller Loop Chilled Water Supply Temperature
6. AI Chiller Loop Chilled Water Return Temperature
7. AI Chilled Water System Differential Pressure
8. AI Chiller Amps
9. AI Chiller Loop Chilled Water Supply Flow
10. AI Ice Tank Level (typical of 3)
11. DI Chiller Loop Chilled Water Pump Status (each pump)
12. DI Building Loop Chilled Water Pump Status (each pump)
13. AO Building Loop Chilled Water Pump Speed (each pump)
14. DI Chiller Fault Alarm From Chiller Mfg. Panel
15. AO Chiller CHWS Reset Signal
16. AO Ice Tank 3 way control valve (V-1)
17. AO Distribution 3 way control valve (V-2)
18. DO Chiller Enable
19. DO Chiller Loop Chilled Water Pump Start/Stop (each pump)
20. DO Building Loop Chilled Water Pump Start/Stop (each pump)

N. Software / calculated points available for display on graphics

1. Chiller Design Flow
2. Chiller Design Capacity
3. Chilled Water Flow Status
4. Current Limit Setpoint
5. Compressor Current Draw
6. Compressor Power
7. Chiller Enable/Disable
8. Chiller Status
9. Chiller Available
10. Chiller Failure 1
11. Chiller Mode (Ice Making)
12. Minimum Condenser Pressure Differential
13. Chiller Operating Mode
14. Communication Status
15. Hours of Ice Inventory Remaining

O. Coordinate the control system requirements with the requirements described in Division 23 Section “Scroll Water Chillers.”

3.9 VARIABLE AIR VOLUME AIR HANDLING UNITS AHU-2 AND RTU-1

A. The variable air volume (VAV) air handling unit (AHU) and the VAV rooftop unit (RTU) shall be controlled via DDC type controls. The Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. The VAV AHU and the VAV RTU each consist of an outside-air damper, a return air damper, a hot water heating coil, a chilled water cooling coil, a supply fan with variable frequency (VF) drive, and an exhaust/relief fan with VF drive. The VAV AHU and the VAV RTU shall be controlled by a DDC controller furnished by the Subcontractor. Actuators shall be electronic.

1. Each unit shall be provided with an airflow station mounted in the outdoor airstream to measure the exact amount of outdoor air the unit introduces into the system. The HVAC Trade shall determine whether the ATC subcontractor or the VAV AHU and VAV RTU manufacturer shall provide the airflow station.

C. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the VAV AHU and VAV RTU for the warm-up mode prior to the areas they serve being occupied. The start/stop optimization program and time schedule program shall also determine when to de-energize the VAV AHU and VAV RTU.

D. When the VAV AHU and/or VAV RTU is indexed to the warm-up or cool-down mode, the DDC system shall control it according to the following sequence:

1. During the warm-up mode:

a. The supply fan(s) shall be de-energized.
b. The outside air damper shall be closed and its return air damper shall be open.
c. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
d. The chilled water cooling coil control valve shall be closed to the coil.
e. The hot water heating coil control valve shall be closed to the coil.
f. All warm-up mode heating shall be accomplished by the fan powered terminal boxes and VAV terminal boxes and their associated reheat coils according to the sequences described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” and “Variable Air Volume Terminal Boxes with Hot Water Reheat Coils” articles in this Section.

2. During the cool-down mode:

a. The supply fan(s) shall be energized and shall run continuously while in the morning cool down mode.

1) A static pressure sensor, mounted 2/3 the distance from the VAV AHU or VAV RTU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled “VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization” in this Section for additional requirements.

b. The outside air damper shall be closed and its return air damper shall be open.
c. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.

d. The chilled water cooling coil control valve shall be placed in its full open position to permit full flow to the coil and then shall be modulated to avoid overshoot and to maintain a space air temperature setpoint of 75°F (adjustable).
e. The hot water heating coil control valve shall be closed to the coil.
f. The fan powered terminal boxes and VAV terminal boxes shall be controlled according to the sequences described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” and “Variable Air Volume Terminal Boxes with Hot Water Reheat Coils” articles in this Section.

E. When the VAV AHU and/or VAV RTU is indexed to the Occupied operating mode, the DDC system shall control it according to the following sequence:

1. Supply Fan: The supply fan shall be energized and shall run continuously.

a. A static pressure sensor, mounted 2/3 the distance from the VAV AHU or VAV RTU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled “VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization” in this Section for additional requirements.

2. Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer): When the VAV AHU and/or VAV RTU is initially energized, the normally closed outdoor air damper shall remain in its full closed position and the normally open return air damper shall remain in its full-open position for a period of 60 seconds. After 60 seconds has elapsed, the outdoor air damper and return air damper shall be controlled as follows:

a. Normal Mode: The outdoor air damper shall initially be placed in its low occupancy minimum outdoor air position of 3220 cfm for AHU-2 and 2850 cfm for RTU-1 as determined by an airflow station mounted in the unit’s outdoor airstream. The DDC system shall then control the position of the outdoor air damper via the various space CO2 sensors located in high occupancy spaces served by the system according to the “Ventilation Optimization” article in this Section. The high occupancy minimum outdoor air damper position shall be as indicated in the schedule on the Drawings.
b. Economizer Mode: When free cooling is available and space temperature is above setpoint, the outside air damper and the return air damper shall be modulated to maintain the unit’s discharge air temperature setpoint. The DDC system shall compare the enthalpy of the outside air to the enthalpy of the return/exhaust air to determine whether free cooling is available.

1) The exhaust/relief air fan shall be energized and its associated motorized damper shall be open. The exhaust/relief fan’s VF drive shall then be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.

3. Cooling Mode:

a. The DDC system shall first determine whether free cooling is available. If free cooling is available, then the unit’s outdoor air damper, return air damper, and exhaust fan and associated motorized damper and shall be controlled as previously described in the subparagraph entitled “Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer)” in this article.

b. If free cooling is not available, the DDC system shall:

1) (AHU-2 Only): Modulate the 3-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil and open to the bypass.
2) (RTU-1 Only): Modulate the 2-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil.

c. If the primary air damper in all VAV terminal boxes and all fan powered terminal boxes are at their minimum position, the discharge air temperature shall be reset upwards by 0.10°F every 30-seconds (adjustable) until one of the primary air dampers opens beyond its minimum position or until discharge air temperature reaches 60°F (adjustable).

4. Heating Mode:

a. (AHU-2 Only): The DDC system shall modulate the 2-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil.
b. (RTU-1 Only): The DDC system shall modulate the 3-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil and open to the bypass.

5. Dehumidification: Provide space humidity sensor(s) and space temperature sensor(s) in the location(s) shown on the plans. The DDC system shall calculate actual space dewpoint temperature based upon actual space temperature and actual space humidity. When space dewpoint temperature rises above a setpoint of 55°F (adjustable), the unit shall be placed in its dehumidification mode. When space dewpoint temperature drops below 54°F (adjustable), the unit shall be returned to its normal control mode. When placed in its dehumidification mode, the following shall occur:

a. (AHU-2 Only): The 3-way chilled water cooling coil control valve shall:be full open to the cooling coil and full closed to the bypass to provide maximum cooling.
b. (RTU-1 Only): The 2-way chilled water cooling coil control valve shall:be full open to the cooling coil to provide maximum cooling.
c. Each fan powered terminal box hot water reheat coil and each VAV terminal box reheat coil shall be controlled to maintain space temperature according to the sequences described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” and “Variable Air Volume Terminal Boxes with Hot Water Reheat Coils” articles in this Section.

F. When the VAV AHU and/or VAV RTU is indexed to the Unoccupied mode, the DDC system shall control it according to the following sequence:

1. The supply fan(s) shall be de-energized.
2. The outside air damper shall be closed and its return air damper shall be open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.

5. The hot water heating coil control valve shall be closed to the coil.
6. Dehumidification: When space dewpoint temperature rises above a setpoint of 55°F (adjustable), the unit supply fan shall be energized, the unit's heating coil control valve shall remain closed, and the unit's cooling system shall be controlled to provide full cooling as described below. The unit's exhaust fan shall remain de-energized, the return air damper shall remain open and the outdoor air damper shall remain closed. When space dewpoint temperature drops below 54°F (adjustable), the unit's supply and exhaust fans shall be de-energized, the unit's heating coil control valve shall remain closed, and the unit's chilled water coil shall be closed.

    a. The chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.
    b. Each fan powered terminal box hot water reheat coil and each VAV terminal box reheat coil shall be controlled to maintain space temperature according to the sequences described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" and "Variable Air Volume Terminal Boxes with Hot Water Reheat Coils" articles in this Section.

G. Night Setback Mode: If space temperature drops below the night setback temperature setpoint of 60°F (adjustable) when the VAV AHU and/or VAV RTU is in the Unoccupied Mode, the following shall occur:

1. The supply fan(s) shall remain de-energized.
2. The outside air damper shall remain closed and its return air damper shall remain open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.

    a. All night setback heating will be handled by the fan powered terminal boxes. Refer to the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" article in this Section for requirements.

H. Smoke Control: A duct mounted smoke detector, located in both the supply air and return air ducts, shall stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when products of combustion are detected in either the supply or return airstreams.

1. Whenever air handling unit AHU-1 is placed in the smoke control mode, air handling unit AHU-2 and rooftop air handling unit RTU-1 shall be de-energized.

I. Provide a freezestat mounted in the unit's outdoor airstream in a location downstream of the electric duct coil to stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when outdoor air temperature drops below 38°F (adjustable).

J. Provide a water level sensor mounted in the unit's drain pan to stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass when the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan.

K. DDC Input/Output Points for VAV Air Handling Units AHU-2 and RTU-1:

1.	AI	Mixed Air Temperature
2.	AI	Discharge Air Temperature (at unit outlet)
3.	AI	Space Air Temperature
4.	AI	Space/Return Air Humidity
5.	AI	Outdoor Air Temperature
6.	AI	Outdoor Air Humidity
7.	AI	Space Differential Pressure
8.	AI	Discharge Temperature Setpoint Adjust
9.	AI	Space CO2 Level
10.	AI	Outside Airflow Rate
11.	AI	Supply Fan Variable Frequency Drive Status
12.	AI	Exhaust/Relief Fan Variable Frequency Drive Status
13.	DI	Supply Fan Status
14.	DI	Exhaust Fan Status
15.	DI	Manual Over-ride
16.	DI	Freezestat
17.	DI	Smoke Detector Alarm
18.	DI	Drain Pan Water Level Alarm
19.	DI	Low/High Outdoor Airflow Rate Alarm
20.	AO	Outdoor Air Damper Position
21.	AO	Return Air Damper Position
22.	AO	Hot Water Heating Coil Valve Position
23.	AO	Supply Fan Variable Frequency Drive Speed
24.	AO	Exhaust Fan Variable Frequency Drive Speed
25.	AO	Chilled Water Cooling Coil Valve Position
26.	DO	Relief Air Damper Open/Close
27.	DO	Supply Fan Start/Stop

L. Coordinate the control system requirements described in this Section with the requirements described in Division 23 Sections “Indoor, Central-Station Air-Handling Units” and “Outdoor, Central-Station Air-Handling Units.”

3.10 VARIABLE AIR VOLUME AIR HANDLING UNITS AHU-1

A. The variable air volume (VAV) air handling unit (AHU) shall be controlled via DDC type controls. The Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Air handling unit AHU-1 is utilized to pressurize corridor floor levels under a smoke control mode. The smoke-control mode shall have the highest priority over all other operating control modes. The smoke control mode shall be automatically activated in response to signals received from corridor smoke detectors. Manual activation and deactivation of the smoke control system fans and smoke dampers shall be provided at Firefighters Smoke Control Panel. All smoke dampers and combination fire/smoke dampers shall be UL 555 rated. The smoke-control mode shall be initiated within 10 seconds after an automatic or manual activation command is received at the smoke-control system. Smoke-control systems shall activate individual components (e.g., dampers, fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts, and other equipment.

C. The VAV AHU consists of an outside-air damper, a return air damper, a hot water heating coil, a chilled water cooling coil, a supply fan with variable frequency (VF) drive, and an exhaust/relief

fan with VF drive. The VAV AHU shall be controlled by a DDC controller furnished by the Subcontractor. Actuators shall be electronic.

1. The VAV AHU shall be provided with an airflow station mounted in the outdoor airstream to measure the exact amount of outdoor air the unit introduces into the system. The HVAC Trade shall determine whether the ATC subcontractor or the VAV AHU manufacturer shall provide the airflow station.

D. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the VAV AHU for the warm-up mode prior to the areas they serve being occupied. The start/stop optimization program and time schedule program shall also determine when to de-energize the VAV AHU.

E. When the VAV AHU is indexed to the warm-up or cool-down mode, the DDC system shall control it according to the following sequence:

1. During the warm-up mode:

   a. The supply fan(s) shall be de-energized.
   b. The outside air damper shall be closed and its return air damper shall be open.
   c. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
   d. The chilled water cooling coil control valve shall be closed to the coil.
   e. The hot water heating coil control valve shall be closed to the coil.
   f. All warm-up mode heating shall be accomplished by the fan powered terminal boxes and their associated reheat coils according to the sequence described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” article in this Section.

2. During the cool-down mode:

   a. The supply fan(s) shall be energized and shall run continuously while in the morning cool down mode.

      1) A static pressure sensor, mounted 2/3 the distance from the VAV AHU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled “VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization” in this Section for additional requirements.

   b. The outside air damper shall be closed and its return air damper shall be open.
   c. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
   d. The chilled water cooling coil control valve shall be placed in its full open position to permit full flow to the coil and then shall be modulated to avoid overshoot and to maintain a space air temperature setpoint of 75°F (adjustable).
   e. The hot water heating coil control valve shall be closed to the coil.
   f. The fan powered terminal boxes shall be controlled according to the sequence described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” article in this Section.

F. When the VAV AHU is indexed to the Occupied operating mode, the DDC system shall control it according to the following sequence:

1. Supply Fan: The supply fan shall be energized and shall run continuously.

    a. A static pressure sensor, mounted 2/3 the distance from the VAV AHU to the most remote terminal, shall modulate the speed of the fan through its variable frequency drive to maintain the duct static pressure setpoint. The ATC Subcontractor shall determine the proper setpoint for the static pressure sensor during air system balancing operations and control system functional performance testing operations. Refer to the article entitled “VAV RTU and AHU Fan (Discharge Duct) Static Pressure Setpoint Optimization” in this Section for additional requirements.

2. Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer): When the VAV AHU is initially energized, the normally closed outdoor air damper shall remain in its full closed position and the normally open return air damper shall remain in its full-open position for a period of 60 seconds. After 60 seconds has elapsed, the outdoor air damper and return air damper shall be controlled as follows:

    a. Normal Mode: The outdoor air damper shall initially be placed in its low occupancy minimum outdoor air position of 730 cfm for AHU-1 as determined by an airflow station mounted in the unit’s outdoor airstream. The DDC system shall then control the position of the outdoor air damper via the various space CO2 sensors located in high occupancy spaces served by the system according to the “Ventilation Optimization” article in this Section. The high occupancy minimum outdoor air damper position shall be as indicated in the schedule on the Drawings.
    b. Economizer Mode: When free cooling is available and space temperature is above setpoint, the outside air damper and the return air damper shall be modulated to maintain the unit’s discharge air temperature setpoint. The DDC system shall compare the enthalpy of the outside air to the enthalpy of the return/exhaust air to determine whether free cooling is available.

        1) The exhaust/relief air fan shall be energized and its associated motorized damper shall be open. The exhaust/relief fan’s VF drive shall then be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.

    c. The return air (mixed air) damper located internal to the unit shall be smoke rated in order to isolate the outdoor airstream from the exhaust airstream during the smoke control mode.

3. Unit Exhaust Fan: The DDC system shall control the operation of the unit’s exhaust fan as follows:

    a. An adjustable outdoor air damper end switch shall start and stop the unit’s exhaust fan. When the outdoor air damper end switch starts the exhaust fan it shall open the exhaust air damper; similarly, when the outdoor air damper end switch stops the exhaust fan it shall also close the exhaust air damper. The ATC Subcontractor shall determine through trial and error the optimum position of the end switch in which to start and stop the exhaust fan.
    b. A space differential pressure sensor shall modulate the exhaust fan’s variable frequency drive to maintain space pressure setpoint as follows:

        1) The exhaust/relief air fan shall be modulated to maintain a differential pressure of 0.03-inches w.g. (adjustable) measured between the space and the outdoors.

4. Cooling Mode:

a. The DDC system shall first determine whether free cooling is available. If free cooling is available, then the unit's outdoor air damper, return air damper, and exhaust fan and associated motorized damper and shall be controlled as previously described in the subparagraph entitled "Outdoor Air and Return Air Dampers (Comparative Enthalpy Economizer)" in this article.
b. If free cooling is not available, the DDC system shall modulate the 2-way chilled water cooling coil control valve open and closed to the cooling coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the heating mode, the chilled water cooling coil control valve shall be closed to the coil.
c. If the primary air damper in all fan powered terminal boxes are at their minimum position, the discharge air temperature shall be reset upwards by 0.10°F every 30-seconds (adjustable) until one of the primary air dampers opens beyond its minimum position or until discharge air temperature reaches 60°F (adjustable).

5. Heating Mode:

a. The DDC system shall modulate the 3-way hot water heating coil control valve open and closed to the heating coil to maintain a discharge air temperature setpoint of 55°F (adjustable). If the unit is operating in the cooling mode, the hot water heating coil control valve shall be closed to the coil and open to the bypass.

6. Dehumidification: Provide space humidity sensor(s) and space temperature sensor(s) in the location(s) shown on the plans. The DDC system shall calculate actual space dewpoint temperature based upon actual space temperature and actual space humidity. When space dewpoint temperature rises above a setpoint of 55°F (adjustable), the unit shall be placed in its dehumidification mode. When space dewpoint temperature drops below 54°F (adjustable), the unit shall be returned to its normal control mode. When placed in its dehumidification mode, the following shall occur:

a. The 2-way chilled water cooling coil control valve shall:be full open to the cooling coil to provide maximum cooling.
b. Each fan powered terminal box hot water reheat coil shall be controlled to maintain space temperature according to the sequence described in the "Fan Powered Terminal Boxes with Hot Water Reheat Coils" article in this Section.

G. When the VAV AHU is indexed to the Unoccupied mode, the DDC system shall control it according to the following sequence:

1. The supply fan(s) shall be de-energized.
2. The outside air damper shall be closed and its return air damper shall be open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.
6. Dehumidification: When space dewpoint temperature rises above a setpoint of 55°F (adjustable), the unit supply fan shall be energized, the unit's heating coil control valve shall remain closed, and the unit's cooling system shall be controlled to provide full cooling as described below. The unit's exhaust fan shall remain de-energized, the return air damper shall remain open and the outdoor air damper shall remain closed. When space dewpoint temperature drops below 54°F (adjustable), the unit's supply and exhaust fans shall be de-energized, the unit's heating coil control valve shall remain closed, and the unit's chilled water coil shall be closed.

a. The chilled water cooling coil control valve shall be full open to the cooling coil to provide maximum cooling.
b. Each fan powered terminal box hot water reheat coil shall be controlled to maintain space temperature according to the sequence described in the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” article in this Section.

H. Night Setback Mode: If space temperature drops below the night setback temperature setpoint of 60°F (adjustable) when the VAV AHU is in the Unoccupied Mode, the following shall occur:

1. The supply fan(s) shall remain de-energized.
2. The outside air damper shall remain closed and its return air damper shall remain open.
3. The exhaust/relief fan shall be de-energized and its associated motorized damper shall be closed.
4. The chilled water cooling coil control valve shall be closed to the coil.
5. The hot water heating coil control valve shall be closed to the coil.

a. All night setback heating will be handled by the fan powered terminal boxes. Refer to the “Fan Powered Terminal Boxes with Hot Water Reheat Coils” article in this Section for requirements.

I. When the air handling unit is indexed to the Smoke Control mode, the DDC system shall control it according to the following sequence:

1. The unit’s supply fan(s) shall be energized.
2. The unit’s internal exhaust fan shall be energized.
3. The unit’s outside air damper shall be open, the unit’s exhaust air damper shall be closed, and the unit’s return air damper shall be closed.
4. The chilled water valve shall be closed.
5. The hot water heating coil control valve shall be modulated open and closed to the coil to maintain discharge air temperature of 38ºF (adjustable).
6. The position of all unit dampers shall be proved via end switches, and indicated at the FSCS. Manual open/closed/automatic control for each damper shall be provide at the FSCS
7. The status of each system fan shall be proved via differential pressure, and indicated at the FSCS. Manual on/off/automatic control for each fan shall be provided at the FSCS.

J. Smoke Control: Under normal mode (whenever the unit is not in the smoke control mode), a duct mounted smoke detector, located in both the return air and supply air ducts, shall stop the supply fan, close the outside air damper, open the return air damper, close the chilled water cooling coil control valve, and close the hot water heating coil control valve to the coil in order to provide full flow to the bypass whenever products of combustion are detected in either the supply or return airstreams.

K. Provide a low temperature sensor mounted in the unit discharge to perform the following:

1. Normal Mode: When discharge air temperature drops below 38°F (adjustable), the supply fan shall stop, the exhaust fan shall stop, the outside air and exhaust air dampers shall close, the return air damper shall open, the chilled water control valve shall close, and the hot water coil control valve shall fully close to the coil and fully open to the bypass.
2. Smoke Control Mode: When the air handling unit is place in the Smoke Control Mode, the DDC system shall over-ride and lock out the low temperature sensor and the unit shall continue to operate regardless of the discharge air temperature.

L. Provide a water level sensor mounted in the unit's drain pan to perform the following:

1. Normal Mode: When the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan, the supply fan shall stop, the exhaust fan shall stop, the outside air and exhaust air dampers shall close, the return air damper shall open, the chilled water control valve shall close, and the hot water coil control valve shall fully close to the coil and fully open to the bypass.
2. Smoke Control Mode: When the air handling unit is place in the Smoke Control Mode, the DDC system shall over-ride and lock out the water level sensor and the unit shall continue to operate regardless of the water level in the unit's drain pan.

M. DDC Input/Output Points for VAV Air Handling Units AHU-1:

1. AI Mixed Air Temperature
2. AI Discharge Air Temperature (at unit outlet)
3. AI Space Air Temperature
4. AI Space/Return Air Humidity
5. AI Outdoor Air Temperature
6. AI Outdoor Air Humidity
7. AI Space Differential Pressure
8. AI Discharge Temperature Setpoint Adjust
9. AI Space CO2 Level
10. AI Outside Airflow Rate
11. AI Supply Fan Variable Frequency Drive Status
12. AI Exhaust/Relief Fan Variable Frequency Drive Status
13. DI Supply Fan Status
14. DI Exhaust/Relief Fan Status
15. DI Manual Over-ride
16. DI Low Temperature Alarm
17. DI Smoke Detector Alarm
18. DI Drain Pan Water Level Alarm
19. DI Low/High Outdoor Airflow Rate Alarm
20. AO Outdoor Air Damper Position
21. AO Return Air Damper Position
22. AO Hot Water Heating Coil Valve Position
23. AO Supply Fan Variable Frequency Drive Speed
24. AO Exhaust Fan Variable Frequency Drive Speed
25. AO Chilled Water Cooling Coil Valve Position
26. DO Exhaust/Relief Air Damper Open/Close
27. DO Supply Fan Start/Stop
28. DO Exhaust/Relief Fan Start/Stop

N. Coordinate the control system requirements described in this Section with the requirements described in Division 23 Sections "Indoor, Central-Station Air-Handling Units."

3.11 STAIR PRESSURIZATION

A. Each stair pressurization system shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Damper Control: Each fan shall be provided with a motorized damper.

1. The ATC Subcontractor shall coordinate the furnishing of the motorized dampers with the HVAC Trade and the supply fan supplier.

    a. The ATC Subcontractor shall install all motorized dampers in the throat of the supply fan's roof curb.
    b. The ATC Subcontractor shall provide power to each motorized damper and the damper shall be controlled so that it is open when the fan is operating and it is closed when the fan is not operating.
    c. Each damper shall be the low temperature, thermally broken type. Refer to Division 23 Sections "Automatic Temperature Control for HVAC" for damper requirements.

C. Stair Pressurization Control:

1. Whenever a fire in the building occurs as indicated by the building fire alarm system, the DDC system shall start stair pressurization fans SF-1 and SF-2. Coordinate with the building fire alarm subcontractor to obtain the fire alarm signal.
2. Each stair pressurization fan shall be controlled as follows:

    a. A space pressure sensor shall modulate the fan's variable frequency drive to maintain the pressure in the stairwell between 0.06-inches w.g. and 0.18-inches w.g.
    b. As space pressure in the stair approaches the maximum allowable pressure of 0.18-inches w.g., an automatic air damper shall modulate open to prevent space pressure from rising above 0.18-inches w.g.
    c. Should pressure in the stair drop below 0.06-inches w.g. or rise above 0.18-inches w.g. an alarm shall be registered with the operator workstation.

D. DDC Input/Output Points for Stair Pressurization:

1. AI Space Pressure (each)
2. AO Supply Fan VF Drive Speed (each)
3. AO Automatic Air Damper Position
4. DI Space Pressure Minimum Alarm (each)
5. DI Space Pressure Maximum Alarm (each)
6. DI Supply Fan Status (each)
7. DI Supply Fan Failure Alarm
8. DO Supply Fan Start/Stop (each)

3.12 EXHAUST FANS

A. Fan Status: Each fan shall be provided with a current sensor to monitor the operation of the fan.

B. Damper Control: Each fan shall be provided with a motorized damper.

1. All centrifugal roof exhaust fans shall be provided with a motorized damper. The ATC Subcontractor shall coordinate the furnishing of the motorized dampers with the HVAC Trade and the exhaust fan supplier.

    a. The ATC Subcontractor shall install all motorized dampers in the throat of the roof curb.

b. The ATC Subcontractor shall provide power to each motorized damper and the damper shall be controlled so that it is open when the fan is operating and it is closed when the fan is not operating.
c. Each damper shall be the low temperature, thermally broken type. Refer to Division 23 Sections “Automatic Temperature Control for HVAC” for damper requirements.

C. Continuous Control: Exhaust fan EF-3 shall be wired to operate continuously.

D. DDC Scheduled Control: Exhaust fans EF-1 and EF-2 shall be energized and de-energized according to a DDC Time Schedule. Exhaust fans EF-1 and EF-2 shall operate during the Occupied Mode and shall not operate during Unoccupied mode.

E. DDC Points List for Exhaust Fans:

1. AI Space Temperature (each fan designated for temperature control)
2. DI Exhaust Fan Status (each fan)
3. DO Exhaust Fan Start/Stop (each fan, except those wired for continuous operation)

3.13 COMPUTER ROOM AIR CONDITIONING UNIT AND REMOTE AIR COOLED CONDENSER

A. Each computer room air conditioning unit shall be shipped from the factory with microprocessor-based controls furnished and installed by the computer room air conditioning unit manufacturer.

B. The computer room air conditioning unit manufacturer shall provide an interface device for each unit furnished so that the building DDC system can fully communicate with the computer room air conditioning unit manufacturer’s microprocessor-based controls. Each unit will be furnished with a factory installed control system that will be fully BACNet compatible. The ATC Subcontractor shall interface with each computer room air conditioning unit to provide remote monitoring and control from the building DDC system.

1. If the ATC system is not fully BACNET compatible, the ATC Subcontractor shall provide an interface device that will provide full compatibility between the ATC system and each computer room air conditioning unit.

C. The ATC subcontractor shall install all sensors and other controls that are shipped loose from the factory for field installation. The ATC Subcontractor shall provide all interconnecting wiring and conduit required for the installation of sensors and controls shipped loose. In addition, the ATC subcontractor shall provide all interconnecting wiring between each computer room air conditioning unit and its remote air cooled condenser.

D. Provide a water level sensor mounted in each unit’s drain pan to stop the unit fan(s) when the water in the pan rises to within ½-inch (adjustable) of the top of the drain pan.

E. DDC Input/Output Points for Computer Room Air Conditioning Unit and Remote Air Cooled Condenser:

1. AI Space Air Temperature
2. AI Space Relative Humidity
3. DI Supply Fan Status
4. DI Low Space Temperature Alarm
5. DI High Space Temperature Alarm
6. DI Low Space Humidity Alarm

7. DI High Space Humidity Alarm
8. DI Humidifier Status
9. DI Loss of Airflow Alarm
10. DI Loss of Power Alarm
11. DI Change Filters Alarm
12. DI Drain Pan Water Level

F. Coordinate the control system requirements with the requirements described in Division 23 Section “Computer Room Air Conditioners.”

3.14 VARIABLE AIR VOLUME (VAV) TERMINAL BOXES WITH HOT WATER REHEAT COILS

A. Each VAV terminal box shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Each VAV terminal box shall have a primary air damper and a hot water reheat coil. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

C. The ATC Subcontractor shall furnish DDC controls to the VAV terminal box manufacturer for factory mounting and wiring by the terminal box manufacturer.

D. VAV Terminal Box Cool-Down Mode:

1. In the Cool-down Mode the rooftop unit or air handling unit shall energize, the VAV terminal box primary air damper shall open to its maximum position, and the normally open hot water reheat coil control valve shall remain closed.
2. As space temperature approaches its cooling setpoint of 74ºF (adjustable), the VAV terminal box primary air damper shall be modulated to its minimum occupied position.
3. If space temperature drops below the heating setpoint of 72ºF (adjustable), the VAV terminal box’s 2-way modulating hot water reheat coil control valve shall be modulated to maintain a minimum space temperature of 72ºF (adjustable).

E. VAV Terminal Box Warm-up Mode:

1. In the Warm-up Mode the rooftop unit or air handling unit shall energize and the VAV terminal box primary air damper shall open to its minimum position.
2. If space temperature is below the heating setpoint of 72ºF (adjustable), the VAV terminal box’s hot water reheat coil control valve shall open. As space temperature approaches the heating setpoint, the hot water control valve shall be modulated to maintain a minimum space temperature of 72ºF (adjustable).

F. VAV Terminal Box Occupied Mode:

1. In the Occupied mode, the VAV terminal box primary air damper shall open to its minimum position. A space temperature sensor shall modulate the primary air damper between its minimum occupied position and its maximum occupied position to maintain cooling temperature setpoint of 74ºF (adjustable).
2. When space temperature drops below the cooling temperature setpoint of 74ºF (adjustable) toward the heating setpoint of 72ºF (adjustable), the VAV terminal box primary air damper shall be modulated to its minimum occupied position. If space temperature drops below the heating setpoint of 72ºF (adjustable), then the VAV terminal

box's hot water reheat coil control valve shall be modulated to maintain a minimum space temperature of 72ºF (adjustable).

3. The VAV terminal boxes that serve rooms having CO2 sensors shall have dual minimum airflow setpoints. When the space or zone CO2 concentration is above setpoint, the VAV terminal box shall increase the lower minimum airflow to the higher minimum airflow setpoint in 25 cfm increments every 15 seconds seconds until CO2 concentration in the space drops to a level of 50 ppm below setpoint or the terminal box primary air damper reaches its higher minimum airflow position. When the CO2 concentration in the space drops to a level of 50 ppm below setpoint, the VAV terminal box shall decrease its primary air damper position in 25 cfm increments every 30 seconds until space CO2 concentration rises to within 25 ppm of setpoint or the primary air damper's lower minimum airflow position is reached.

G. VAV Terminal Box Unoccupied/Night Setback Mode:

1. In the Unoccupied/Night Setback mode, the VAV terminal box primary air damper shall be closed and its hot water reheat coil control valve shall be closed.
2. If system indoor humidity rises above the system dewpoint temperature setpoint of 55°F (adjustable), the rooftop unit or air handling unit supply fan shall energize, the VAV terminal box primary air damper shall open, and the VAV terminal box hot water reheat coil control valve shall modulate open and closed to the coil to maintain space/zone temperature at setpoint. Once the system humidity drops below the system dewpoint temperature setpoint of 54°F (adjustable), the rooftop unit or air handling unit supply fan shall de-energize, the VAV terminal box primary air damper shall close, and the VAV terminal box hot water reheat coil control valve shall close.
3. The override button on any of the room sensors shall override the unoccupied/night setback mode and shall place the VAV terminal boxes and its associated rooftop unit or air handling unit into the Occupied mode for a timed period of 2-hours (adjustable). Once the timed period is complete, the system shall revert back to the unoccupied/night setback mode.

H. Coordinate the control system requirements with the requirements as described in Division 23 Section "Air Terminal Units."

I. DDC Input/Output Points for VAV Terminal Boxes with Hot Water Reheat Coils:

1. AI Space/Zone Temperature
2. AI Discharge Air Temperature (downstream of the VAV terminal box)
3. AI Space/Zone Temperature Setpoint Adjustment
4. AI Space/Zone Airflow Rate
5. AI Space/Zone CO2 level
6. AO Terminal Box Damper
7. AO Hot Water Reheat Coil Control Valve
8. DI Local Occupied/Unoccupied Override

3.15 FAN POWERED TERMINAL BOXES WITH HOT WATER REHEAT COILS

A. Each fan powered terminal box shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Each fan powered terminal box shall have a supply fan, a primary air damper and a hot water reheat coil. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

C. The ATC Subcontractor shall furnish DDC controls to the terminal box manufacturer for factory mounting and wiring by the terminal box manufacturer.

D. Fan Powered Terminal Box Cool-Down Mode:

1. In the Cool-down Mode the rooftop unit or air handling unit shall energize, the fan powered terminal box supply fan shall energize, the terminal box primary air damper shall open to its maximum position, and the normally open hot water reheat coil control valve shall remain closed.
2. As space temperature approaches its cooling setpoint of 74ºF (adjustable), the fan powered terminal box primary air damper shall be modulated to its minimum occupied position.
3. If space temperature drops below the heating setpoint of 72ºF (adjustable), the fan powered terminal box's 2-way modulating hot water reheat coil control valve shall be modulated open and closed to the coil to maintain a minimum space temperature of 72ºF (adjustable).

E. Fan Powered Terminal Box Warm-up Mode:

1. In the Warm-up Mode the rooftop unit or air handling unit shall remain de-energized.
2. If space temperature is below the heating setpoint of 72ºF (adjustable), the fan powered terminal box's supply fan shall be energized and its hot water reheat coil control valve shall open. As space temperature approaches the heating setpoint, the hot water control valve shall be modulated to maintain a minimum space temperature of 72ºF (adjustable).
3. If space temperature is above the heating setpoint of 72ºF (adjustable), the fan powered terminal box's supply fan shall remain de-energized and its hot water reheat coil control valve shall remain closed to the coil.

F. Fan Powered Terminal Box Occupied Mode:

1. In the Occupied mode, a space temperature sensor shall modulate the primary air damper between its minimum occupied position and its maximum occupied position to maintain cooling temperature setpoint of 74ºF (adjustable).
2. Whenever space temperature is above the heating setpoint, the fan powered terminal box supply fan shall be de-energized.
3. When space temperature drops below the cooling temperature setpoint of 74ºF (adjustable) toward the heating setpoint of 72ºF (adjustable), the fan powered terminal box primary air damper shall be modulated to its minimum occupied position. If space temperature drops below the heating setpoint of 72ºF (adjustable), then the following shall occur:

    a. The fan powered terminal box's supply fan shall first be energized to recirculate space/zone air and mix it with primary air in order to raise the fan powered terminal box discharge air temperature.
    b. If space temperature continues to drop then the fan powered terminal box's hot water reheat coil control valve shall be modulated open and closed to its reheat coil to maintain space temperature at a setpoint of 72ºF (adjustable).
    c. When space temperature rises above 72.5ºF (adjustable), the reheat coil control valve shall close to the coil. As space temperature continues to rise and rises above 73ºF (adjustable), the fan powered terminal box supply fan shall de-energize.

4. The fan powered terminal boxes that serve rooms having CO_2 sensors shall have dual minimum primary airflow setpoints. When the space or zone CO_2 concentration is above setpoint, the fan powered terminal box shall increase its primary air damper position from its lower minimum airflow toward its higher minimum airflow setpoint in 25 cfm increments every 15 seconds until CO_2 concentration in the space drops to a level of 50 ppm below setpoint or the terminal box primary air damper reaches its higher minimum airflow position. When the CO_2 concentration in the space drops to a level of 50 ppm below setpoint, the VAV terminal box shall decrease its primary air damper position in 25 cfm increments every 30 seconds until space CO_2 concentration rises to within 25 ppm of setpoint or the primary air damper's lower minimum airflow position is reached.

G. Fan Powered Terminal Box Unoccupied/Night Setback Mode:

1. In the Unoccupied/Night Setback mode, the fan powered terminal box supply fan shall be de-energized, its primary air damper shall be closed, and its hot water reheat coil control valve shall be closed.
2. When room temperature drops below the night setback heating setpoint of 65ºF (adjustable), the terminal box supply fan shall energize, the terminal box primary air damper shall remain closed, and the terminal box hot water reheat coil control valve shall open. Once the space temperature rises 2°F (adjustable) above the night setback temperature setpoint, the terminal box supply fan shall de-energize, the terminal box primary air damper shall remain closed, and the terminal box hot water reheat coil control valve shall close.
3. If system indoor humidity rises above the system dewpoint temperature setpoint of 55°F (adjustable), the rooftop unit or air handling unit supply fan shall energize, the fan powered terminal box primary air damper shall open, the fan powered terminal box reheat coil control valve shall remain closed, and the fan powered terminal box supply fan shall energize to recirculate space/zone air and mix it with primary air in order to raise the fan powered terminal box discharge air temperature and maintain space temperature at a cooling setpoint of 74°F.

    a. If operation of the fan powered terminal box supply fan alone cannot maintain space temperature at setpoint, then hot water reheat coil control valve shall modulate open and closed to the coil to maintain space/zone temperature at setpoint.
    b. Once the system humidity drops below the system dewpoint temperature setpoint of 54°F (adjustable), the rooftop unit or air handling unit supply fan shall de-energize, the fan powered terminal box supply fan shall de-energize, the fan powered terminal box primary air damper shall close, and the fan powered terminal box hot water reheat coil control valve shall close.

4. The override button on any of the room sensors shall override the night setback mode and shall place the fan powered terminal boxes and its associated rooftop unit or air handling unit into the Occupied mode for a timed period of 2-hours (adjustable). Once the timed period is complete, the system shall revert back to the night setback mode.

H. Coordinate the control system requirements with the requirements as described in Division 23 Section "Air Terminal Units."

I. DDC Input/Output Points for Fan Powered Terminal Boxes with Hot Water Reheat Coils:

1. AI Space/Zone Temperature
2. AI Discharge Air Temperature (downstream of the fan powered terminal box)
3. AI Space/Zone Temperature Setpoint Adjustment
4. AI Space/Zone Airflow Rate

5. AI Space/Zone CO2 level
6. AO Terminal Box Damper
7. AO Hot Water Reheat Coil Control Valve
8. DI Local Occupied/Unoccupied Override
9. DI Fan Status
10. DO Fan Start/Stop

3.16 FAN COIL UNITS

A. Each fan coil unit shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Each fan coil unit shall have a supply fan, and a chilled water coil.

C. Each fan coil unit shall be controlled as follows:

1. The DDC system shall determine through the start/stop optimization program and the time schedule program when to energize the fan coil unit prior to the area being occupied. The start/stop optimization program and the time schedule program shall also determine when to de-energize the fan coil unit.
2. When the fan coil unit is indexed to the Occupied operating mode, the DDC system shall control it according to the following sequence:

a. Supply Fan: The DDC system shall control the supply fan as follows:

1) The supply fan shall started and stopped via the space temperature sensor based on a call for cooling.

b. Chilled Water Coil: The 2-way normally closed chilled water control valve shall be modulated open and closed to the coil to maintain a space air temperature occupied cooling setpoint of 82°F (adjustable).

3. When the fan coil unit is indexed to the Unoccupied operating mode, the DDC system shall control it according to the following sequence:

a. Supply Fan: The fan shall be de-energized.
b. Chilled Water Coil: The unit's 2-way chilled water control valve shall be closed to the coil.
c. If space temperature rises above an unoccupied cooling setpoint of 90°F (adjustable), the supply fan shall energize and the 2-way normally closed chilled water control valve shall be placed in its full open position to allow full flow through the unit's chilled water coil. Once space temperature drops below 85°F (adjustable), the supply fan shall de-energize and the chilled water coil control valve shall close.

D. Coordinate the control system requirements with the requirements as described in Division 23 Section "Fan Coil Units."

E. DDC Input/Output Points for Fan Coil Units:

1. AI Space/Zone Temperature
2. AI Discharge Air Temperature (downstream of the fan coil unit)
3. AO Chilled Water Coil Control Valve
4. DI Fan Status

5. DO Fan Start/Stop

3.17 HOT WATER CABINET UNIT HEATERS

A. Each hot water cabinet unit heater shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. A wall-mounted temperature sensor, through the building DDC system, shall cycle the cabinet unit heater's fan to maintain a space temperature heating setpoint of 65°F (adjustable). An aquastat shall prevent the cabinet unit heater's fan from operating when hot water supply temperature drops below setpoint of 100°F (adjustable).

C. Coordinate the control system requirements with the requirements as described in Division 23 Section "Unit Heaters."

D. DDC Input/Output Points for Hot Water Cabinet Unit Heaters:

1. AI Space Air Temperature
2. DO Fan Start/Stop

3.18 HOT WATER UNIT HEATERS

A. Each hot water unit heater shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. A wall-mounted temperature sensor, through the building DDC system, shall cycle the unit heater's fan to maintain a space temperature heating setpoint of 65°F (adjustable). An aquastat shall prevent the unit heater's fan from operating when hot water supply temperature drops below setpoint of 100°F (adjustable).

C. Coordinate the control system requirements with the requirements as described in Division 23 Section "Unit Heaters."

D. DDC Input/Output Points for Hot Water Unit Heaters:

1. AI Space Air Temperature
2. DO Fan Start/Stop

3.19 HOT WATER CONVECTORS

A. Each hot water convector shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. A wall-mounted temperature sensor, through the building DDC system, shall modulate a 2-way hot water control valve to maintain a space temperature heating setpoint of 70°F (adjustable).

C. Coordinate the control system requirements with the requirements as described in Division 23 Section "Convectors".

D. DDC Input/Output Points for Hot Water Convectors:

1. AI Space Air Temperature
2. AO Hot Water Valve Open/Close

3.20 HOT WATER RADIANT CEILING PANELS

A. Each hot water radiant ceiling panel shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. A wall-mounted temperature sensor, through the building DDC system, shall modulate a 2-way (normally open) hot water valve to maintain a space temperature heating setpoint of 72°F (adjustable).

C. Coordinate the control system requirements with the requirements as described in Division 23 Section “Valance Heating Units”.

D. DDC Input/Output Points for Hot Water Radiant Ceiling Panels:

1. AI Space Air Temperature
2. AO Hot Water Valve Position
3. AO Setpoint Adjust

3.21 AUTOMATIC AIR DAMPERS

A. Automatic Air Dampers (Outdoor air Intake): Two automatic air dampers shall be provided to segregate the outdoor air intake louver, located in the exterior wall of the First Floor outdoor air intake plenum, into two airstreams.

1. One automatic air damper shall be associated with air handling unit AHU-1. The automatic air damper shall be fully open when AHU-1 is operating and shall be fully closed when AHU-1 is not operating.
2. The other automatic air damper shall be associated with air handling unit AHU-2. The automatic air damper shall be fully open when AHU-2 is operating and shall be fully closed when AHU-2 is not operating.

B. Automatic Air Dampers (Relief): Two automatic air dampers shall be provided to segregate the relief air louver, located in the exterior wall of the First Floor relief air plenum, into two airstreams.

1. One automatic air damper shall be associated with air handling unit AHU-1. The automatic air damper shall be fully open when AHU-1 is operating and shall be fully closed when AHU-1 is not operating.
2. The other automatic air damper shall be associated with air handling unit AHU-2. The automatic air damper shall be fully open when AHU-2 is operating and shall be fully closed when AHU-2 is not operating.

C. DDC Input/Output Points for Automatic Air Dampers:

1. AI Building Differential Pressure
2. AO Automatic Air Damper Position

3.22 SMOKE DAMPERS AND COMBINATION FIRE/SMOKE DAMPERS

A. Each smoke damper shall be controlled via the building DDC system. The ATC Subcontractor shall provide DDC control components to accomplish the sequence described below.

B. Smoke dampers and combination fire/smoke dampers that are part of the building smoke control system shall be controlled automatically as a part of the smoke control sequences, and manually (automatic/open/closed) at the FSCS. Provide end switches at each smoke damper to prove fully open / fully closed position. Provide indication of position, via pilot lights at the FSCS.

C. Duct Mounted Smoke Dampers and Combination Fire/Smoke Dampers: For each smoke damper and combination fire/smoke damper, provide the following:

1. Mount duct smoke detectors furnished by the Electrical Trade.
2. Provide 120-volt power to smoke damper or combination fire/smoke damper.
3. Provide control wiring between the associated duct smoke detector and the combination fire/smoke damper actuator or smoke damper actuator in order to close the damper when smoke is sensed.

D. Elevator Smoke Damper: Provide 120-volt power to smoke damper. Provide wiring between the elevator hoistway detector's auxiliary contacts, the elevator lobby detector's auxiliary contacts and the smoke damper actuator in order to open the smoke damper when the one of the following occurs:

1. Smoke is sensed in the elevator hoistway or in the elevator lobby.
2. Upon loss of power.
3. Upon activation of a manual override control.

E. DDC Input/Output Points for Smoke Dampers

1. DI Smoke Detector Alarm
2. DO Damper Open/Close

3.23 CARBON MONOXIDE SENSORS

A. The ATC Subcontractor shall provide the proper number of carbon monoxide sensors to monitor the First Floor boiler room for the presence of carbon monoxide. If carbon monoxide level in the boiler room exceeds the setpoint, then an alarm shall be registered at the central operator's workstation. In addition, an audible and visual alarm, provided by the ATC Subcontractor, shall sound within the boiler room.

3.24 MISCELLANEOUS COMMON POINTS

A. The ATC Subcontractor shall provide the following sensors that shall be common to all sequences:

1. A minimum of two (2) outdoor air temperature sensors shall be provided. These sensors shall be mounted on the north facing side of the building and shall be provided with sun shields (if necessary). The temperature measurements from the two sensors shall be averaged. If a difference of more than 1°F is measured between the two sensors, an alarm shall be registered at the operator's workstation.

2. A minimum of two (2) outdoor air humidity sensors shall be provided. The humidity measurements from the two sensors shall be averaged. If a difference of more than 2% RH is measured between the two sensors, an alarm shall be registered at the operator's workstation.
3. A minimum of two (2) outdoor air CO2 sensors shall be provided. The CO2 measurements from the two sensors shall be averaged. If a difference of more than 30 ppm is measured between the two sensors, an alarm shall be registered at the operator's workstation.

B. DDC Input/Output Points for Miscellaneous Points

1. AI Outdoor Air Temperature (2 each)
2. AI Outdoor Air Relative Humidity (2 each)
3. AI Outdoor CO2 (2 each)

END OF SECTION 230993

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