

26 - 9/16/26



STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS AND VETERANS SERVICES

BUSINESS ADMINISTRATION
STATE MILITARY RESERVATION
4 PEMBROKE ROAD
CONCORD, NEW HAMPSHIRE 03301-5652

David J. Mikolaities, Major General
The Adjutant General

Nicole Desilets-Bixler
Deputy Adjutant General

Phone: 603-225-1360
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August 3, 2026

Her Excellency Governor Kelly A. Ayotte
and the Honorable Executive Council
State House
Concord, New Hampshire 03301

REQUESTED ACTION

1. Authorize the Department of Military Affairs and Veterans Services to enter into a contract with JBC Construction LLC (VC#298573), Londonderry, New Hampshire, in the amount of \$767,250.00 for the New Hampshire Army National Guard (NHARNG) Training Site MEP Upgrade Project in Center Strafford, New Hampshire upon Governor and Executive Council approval through May 31, 2027. **100% Federal Funds.**

2. Further, authorize a contingency in the amount of \$60,000.00 for unanticipated expenses bringing the contract total to \$827,250.00 effective upon Governor and Council approval through May 31, 2027. **100% Federal Funds.**

Funds are available in the following account for Fiscal Year 2027, with the authority to adjust encumbrances between fiscal years within the price limitation through the Budget Office, if needed and justified.

02-12-12-120010-22450000, Army Guard Facilities:

103-500736-Contract for Operational Services

FY 2027
\$827,250.00

EXPLANATION

This project consists of replacing a rooftop HVAC unit, adding site lighting and replacing the Building Management System (BMS) for the training site. The existing rooftop HVAC system is beyond its useful life and will be replaced with a new system to keep the dining facility operational to support the training of NHARNG soldiers. LED site lighting will be added to provide adequate light for parking areas and enhance training functionality year-round by adding lights to the track and adjacent training areas. The existing BMS has failed, and the systems currently do not communicate and are no longer supported by the manufacturers. Replacing the failed system with an up-to-date BMS will allow the training site to control the heating and cooling of the buildings on site efficiently. This will both save energy and provide the site with the ability to manage the buildings to meet the needs of the soldiers being trained.

The Department of Military Affairs and Veteran Services solicited for these construction services by placing a Request for Bid (RFB) on the State of New Hampshire Bureau of Purchase and Property website on June 22, 2026. Three (3) vendors submitted qualified bids. JBC Construction LLC was the lowest cost and were awarded this contract contingent upon Governor and Council approval.

Funds to support the required Army National Guard Facilities Renovation are provided under the existing Master Cooperative Agreement. Under the Agreement, the State of New Hampshire - Department of Military Affairs and Veterans Services provides these services and the Federal Government reimburses the State for the costs related to the services at the rate of 100%. In the event Federal Funds are not available for this contract, General Funds will not be used.

The Department of Military Affairs and Veterans services have determined the vendor is in good standing with the Secretary of State's Office, has secured the required levels of insurance, and has provided evidence of authority to execute and be bound by the contract.

This contract has been approved for form, substance, and execution by the New Hampshire Department of Justice.

Respectfully submitted,



David J. Mikolaities
Major General, NH National Guard
The Adjutant General

RFB-DMAVS-2027-01

Name of RFB: NHARNG Center Strafford Training Site – MEP Upgrades

Number of Responses to RFB: Three (3)

Contractor	Bid Amount	ALT #1	ALT #2	Rank
JBC Construction LLC	\$767,250.00	-\$142,000.00	-\$2,500.00	A
KJ Fisher & Sons LLC	\$1,022,734.00	-\$184,800.00	-\$7,820.00	B
Northern Electrical Incorporated	\$1,125,770.00	-\$137,650.00	-\$32,300.00	C

Contract Awarded to: JBC Construction LLC

**STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS AND VETERANS SERVICES
BID FORM**

BID POSTING

Date: 06/22/2026
Time: 3:00 PM EST
Subject: RFB-DMAVS-2027-01

BID CLOSING

Date: 07/17/2026
Time: 12:00 PM EST

CONTRACT PRICE

Numerical Bid \$ 767,250.00

Verbal Bid Seven Hundred Sixty-Seven Thousand Two Hundred Fifty Dollars and No Cents

Allotment for Owner Initiated Repairs \$ 60,000.00
And Changes Sixty Thousand Dollars

Deduct Alternate #1: Exclude entire rooftop mounted PV, Battery Storage and all associated equipment and wiring at Building 12. See drawing E-101 and associated specifications.

Deduct Alternate #2: Exclude EV Charging Station and Conductors at VCOT area. Stub conduit for future connection. See drawing E-102 and associated specifications.

TOTAL BID AMOUNT

Numerical Bid Alternate #1 DEDUCT ALTERNATE \$ -142,000.00

Verbal Bid Deduct One Hundred Forty-Two Thousand Dollars and No Cents

Numerical Bid Alternate #2 DEDUCT ALTERNATE \$ -2,500.00

Verbal Bid Deduct Two Thousand Five Hundred Dollars and No Cents

VENDOR CONTACT INFORMATION:

Please provide contact information below for a person knowledgeable of and who can answer questions regarding this bid response.

<u>Dan Callahan</u>	<u>603-965-5262</u>	
Contact Person	Local Telephone Number	Toll Free Telephone Number

<u>Dan_callahan@comcast.net</u>	<u>www.JBC-ConstructionNH.com</u>
E-mail Address	Company Website

Vendor Company Name: JBC Construction LLC

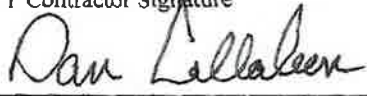
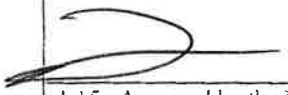
Vendor Address: P.O. Box 107 Londonderry, N.H. 30353

Notice: This agreement and all of its attachments shall become public upon submission to Governor and Executive Council for approval. Any information that is private, confidential or proprietary must be clearly identified to the agency and agreed to in writing prior to signing the contract.

AGREEMENT

The State of New Hampshire and the Contractor hereby mutually agree as follows:

GENERAL PROVISIONS**1. IDENTIFICATION.**

1.1 State Agency Name Department of Military Affairs and Veteran Services		1.2 State Agency Address 1 Minuteman Way, Bldg. 1, Concord, NH 03301	
1.3 Contractor Name JBC Construction (VC#:298573)		1.4 Contractor Address P.O. Box 107 Londonderry NH, 03053	
1.5 Contractor Phone Number (603)965-5262	1.6 Account Unit and Class 10-12-12-22450000-103-500736	1.7 Completion Date 11/30/2027	1.8 Price Limitation Not to Exceed \$827,250.00
1.9 Contracting Officer for State Agency Quinton Hawkins		1.10 State Agency Telephone Number (603) 225-1361	
1.11 Contractor Signature  Date: 7/27/26		1.12 Name and Title of Contractor Signatory DAN CALLAHAN - MEMBER	
1.13 State Agency Signature  Date: 07/30/26		1.14 Name and Title of State Agency Signatory Administrator of Business Operations Quinton Hawkins	
1.15 Approval by the N.H. Department of Administration, Division of Personnel (if applicable) By: _____ Director, On: _____			
1.16 Approval by the Attorney General (Form, Substance and Execution) (if applicable) By:  On: 8/26/26			
1.17 Approval by the Governor and Executive Council (if applicable) G&C Item number: _____ G&C Meeting Date: _____			

2. SERVICES TO BE PERFORMED. The State of New Hampshire, acting through the agency identified in block 1.1 ("State"), engages contractor identified in block 1.3 ("Contractor") to perform, and the Contractor shall perform, the work or sale of goods, or both, identified and more particularly described in the attached EXHIBIT B which is incorporated herein by reference ("Services").

3. EFFECTIVE DATE/COMPLETION OF SERVICES.

3.1 Notwithstanding any provision of this Agreement to the contrary, and subject to the approval of the Governor and Executive Council of the State of New Hampshire, if applicable, this Agreement, and all obligations of the parties hereunder, shall become effective on the date the Governor and Executive Council approve this Agreement, unless no such approval is required, in which case the Agreement shall become effective on the date the Agreement is signed by the State Agency as shown in block 1.13 ("Effective Date").

3.2 If the Contractor commences the Services prior to the Effective Date, all Services performed by the Contractor prior to the Effective Date shall be performed at the sole risk of the Contractor, and in the event that this Agreement does not become effective, the State shall have no liability to the Contractor, including without limitation, any obligation to pay the Contractor for any costs incurred or Services performed.

3.3 Contractor must complete all Services by the Completion Date specified in block 1.7.

4. CONDITIONAL NATURE OF AGREEMENT.

Notwithstanding any provision of this Agreement to the contrary, all obligations of the State hereunder, including, without limitation, the continuance of payments hereunder, are contingent upon the availability and continued appropriation of funds. In no event shall the State be liable for any payments hereunder in excess of such available appropriated funds. In the event of a reduction or termination of appropriated funds by any state or federal legislative or executive action that reduces, eliminates or otherwise modifies the appropriation or availability of funding for this Agreement and the Scope for Services provided in EXHIBIT B, in whole or in part, the State shall have the right to withhold payment until such funds become available, if ever, and shall have the right to reduce or terminate the Services under this Agreement immediately upon giving the Contractor notice of such reduction or termination. The State shall not be required to transfer funds from any other account or source to the Account identified in block 1.6 in the event funds in that Account are reduced or unavailable.

5. CONTRACT PRICE/PRICE LIMITATION/ PAYMENT.

5.1 The contract price, method of payment, and terms of payment are identified and more particularly described in EXHIBIT C which is incorporated herein by reference.

5.2 Notwithstanding any provision in this Agreement to the contrary, and notwithstanding unexpected circumstances, in no event shall the total of all payments authorized, or actually made hereunder, exceed the Price Limitation set forth in block 1.8. The payment by the State of the contract price shall be the only and the complete reimbursement to the Contractor for all expenses, of whatever nature incurred by the Contractor in the performance

hereof, and shall be the only and the complete compensation to the Contractor for the Services.

5.3 The State reserves the right to offset from any amounts otherwise payable to the Contractor under this Agreement those liquidated amounts required or permitted by N.H. RSA 80:7 through RSA 80:7-c or any other provision of law.

5.4 The State's liability under this Agreement shall be limited to monetary damages not to exceed the total fees paid. The Contractor agrees that it has an adequate remedy at law for any breach of this Agreement by the State and hereby waives any right to specific performance or other equitable remedies against the State.

6. COMPLIANCE BY CONTRACTOR WITH LAWS AND REGULATIONS/EQUAL EMPLOYMENT OPPORTUNITY.

6.1 In connection with the performance of the Services, the Contractor shall comply with all applicable statutes, laws, regulations, and orders of federal, state, county or municipal authorities which impose any obligation or duty upon the Contractor, including, but not limited to, civil rights and equal employment opportunity laws and the Governor's order on Respect and Civility in the Workplace, Executive order 2020-01. In addition, if this Agreement is funded in any part by monies of the United States, the Contractor shall comply with all federal executive orders, rules, regulations and statutes, and with any rules, regulations and guidelines as the State or the United States issue to implement these regulations. The Contractor shall also comply with all applicable intellectual property laws.

6.2 During the term of this Agreement, the Contractor shall not discriminate against employees or applicants for employment because of age, sex, sexual orientation, race, color, marital status, physical or mental disability, religious creed, national origin, gender identity, or gender expression, and will take affirmative action to prevent such discrimination, unless exempt by state or federal law. The Contractor shall ensure any subcontractors comply with these nondiscrimination requirements.

6.3 No payments or transfers of value by Contractor or its representatives in connection with this Agreement have or shall be made which have the purpose or effect of public or commercial bribery, or acceptance of or acquiescence in extortion, kickbacks, or other unlawful or improper means of obtaining business.

6.4. The Contractor agrees to permit the State or United States access to any of the Contractor's books, records and accounts for the purpose of ascertaining compliance with this Agreement and all rules, regulations and orders pertaining to the covenants, terms and conditions of this Agreement.

7. PERSONNEL.

7.1 The Contractor shall at its own expense provide all personnel necessary to perform the Services. The Contractor warrants that all personnel engaged in the Services shall be qualified to perform the Services, and shall be properly licensed and otherwise authorized to do so under all applicable laws.

7.2 The Contracting Officer specified in block 1.9, or any successor, shall be the State's point of contact pertaining to this Agreement.

8. EVENT OF DEFAULT/REMEDIES.

8.1 Any one or more of the following acts or omissions of the Contractor shall constitute an event of default hereunder ("Event of Default"):

- 8.1.1 failure to perform the Services satisfactorily or on schedule;
- 8.1.2 failure to submit any report required hereunder; and/or
- 8.1.3 failure to perform any other covenant, term or condition of this Agreement.

8.2 Upon the occurrence of any Event of Default, the State may take any one, or more, or all, of the following actions:

8.2.1 give the Contractor a written notice specifying the Event of Default and requiring it to be remedied within, in the absence of a greater or lesser specification of time, thirty (30) calendar days from the date of the notice; and if the Event of Default is not timely cured, terminate this Agreement, effective two (2) calendar days after giving the Contractor notice of termination;

8.2.2 give the Contractor a written notice specifying the Event of Default and suspending all payments to be made under this Agreement and ordering that the portion of the contract price which would otherwise accrue to the Contractor during the period from the date of such notice until such time as the State determines that the Contractor has cured the Event of Default shall never be paid to the Contractor;

8.2.3 give the Contractor a written notice specifying the Event of Default and set off against any other obligations the State may owe to the Contractor any damages the State suffers by reason of any Event of Default; and/or

8.2.4 give the Contractor a written notice specifying the Event of Default, treat the Agreement as breached, terminate the Agreement and pursue any of its remedies at law or in equity, or both.

9. TERMINATION.

9.1 Notwithstanding paragraph 8, the State may, at its sole discretion, terminate the Agreement for any reason, in whole or in part, by thirty (30) calendar days written notice to the Contractor that the State is exercising its option to terminate the Agreement.

9.2 In the event of an early termination of this Agreement for any reason other than the completion of the Services, the Contractor shall, at the State's discretion, deliver to the Contracting Officer, not later than fifteen (15) calendar days after the date of termination, a report ("Termination Report") describing in detail all Services performed, and the contract price earned, to and including the date of termination. In addition, at the State's discretion, the Contractor shall, within fifteen (15) calendar days of notice of early termination, develop and submit to the State a transition plan for Services under the Agreement.

10. PROPERTY OWNERSHIP/DISCLOSURE.

10.1 As used in this Agreement, the word "Property" shall mean all data, information and things developed or obtained during the performance of, or acquired or developed by reason of, this Agreement, including, but not limited to, all studies, reports, files, formulae, surveys, maps, charts, sound recordings, video recordings, pictorial reproductions, drawings, analyses, graphic representations, computer programs, computer printouts, notes, letters, memoranda, papers, and documents, all whether finished or unfinished.

10.2 All data and any Property which has been received from the State, or purchased with funds provided for that purpose under this Agreement, shall be the property of the State, and shall be returned to the State upon demand or upon termination of this Agreement for any reason.

10.3 Disclosure of data, information and other records shall be governed by N.H. RSA chapter 91-A and/or other applicable law. Disclosure requires prior written approval of the State.

11. CONTRACTOR'S RELATION TO THE STATE. In the performance of this Agreement the Contractor is in all respects an independent contractor, and is neither an agent nor an employee of the State. Neither the Contractor nor any of its officers, employees, agents or members shall have authority to bind the State or receive any benefits, workers' compensation or other emoluments provided by the State to its employees.

12. ASSIGNMENT/DELEGATION/SUBCONTRACTS.

12.1 Contractor shall provide the State written notice at least fifteen (15) calendar days before any proposed assignment, delegation, or other transfer of any interest in this Agreement. No such assignment, delegation, or other transfer shall be effective without the written consent of the State.

12.2 For purposes of paragraph 12, a Change of Control shall constitute assignment. "Change of Control" means (a) merger, consolidation, or a transaction or series of related transactions in which a third party, together with its affiliates, becomes the direct or indirect owner of fifty percent (50%) or more of the voting shares or similar equity interests, or combined voting power of the Contractor, or (b) the sale of all or substantially all of the assets of the Contractor.

12.3 None of the Services shall be subcontracted by the Contractor without prior written notice and consent of the State.

12.4 The State is entitled to copies of all subcontracts and assignment agreements and shall not be bound by any provisions contained in a subcontract or an assignment agreement to which it is not a party.

13. INDEMNIFICATION. The Contractor shall indemnify, defend, and hold harmless the State, its officers, and employees from and against all actions, claims, damages, demands, judgments, fines, liabilities, losses, and other expenses, including, without limitation, reasonable attorneys' fees, arising out of or relating to this Agreement directly or indirectly arising from death, personal injury, property damage, intellectual property infringement, or other claims asserted against the State, its officers, or employees caused by the acts or omissions of negligence, reckless or willful misconduct, or fraud by the Contractor, its employees, agents, or subcontractors. The State shall not be liable for any costs incurred by the Contractor arising under this paragraph 13. Notwithstanding the foregoing, nothing herein contained shall be deemed to constitute a waiver of the State's sovereign immunity, which immunity is hereby reserved to the State. This covenant in paragraph 13 shall survive the termination of this Agreement.

14. INSURANCE.

14.1 The Contractor shall, at its sole expense, obtain and continuously maintain in force, and shall require any subcontractor or assignee to obtain and maintain in force, the following insurance:

14.1.1 commercial general liability insurance against all claims of bodily injury, death or property damage, in amounts of not less than \$1,000,000 per occurrence and \$2,000,000 aggregate or excess; and

14.1.2 special cause of loss coverage form covering all Property subject to subparagraph 10.2 herein, in an amount not less than 80% of the whole replacement value of the Property.

14.2 The policies described in subparagraph 14.1 herein shall be on policy forms and endorsements approved for use in the State of New Hampshire by the N.H. Department of Insurance, and issued by insurers licensed in the State of New Hampshire.

14.3 The Contractor shall furnish to the Contracting Officer identified in block 1.9, or any successor, a certificate(s) of insurance for all insurance required under this Agreement. At the request of the Contracting Officer, or any successor, the Contractor shall provide certificate(s) of insurance for all renewal(s) of insurance required under this Agreement. The certificate(s) of insurance and any renewals thereof shall be attached and are incorporated herein by reference.

15. WORKERS' COMPENSATION.

15.1 By signing this agreement, the Contractor agrees, certifies and warrants that the Contractor is in compliance with or exempt from, the requirements of N.H. RSA chapter 281-A ("*Workers' Compensation*").

15.2 To the extent the Contractor is subject to the requirements of N.H. RSA chapter 281-A, Contractor shall maintain, and require any subcontractor or assignee to secure and maintain, payment of Workers' Compensation in connection with activities which the person proposes to undertake pursuant to this Agreement. The Contractor shall furnish the Contracting Officer identified in block 1.9, or any successor, proof of Workers' Compensation in the manner described in N.H. RSA chapter 281-A and any applicable renewal(s) thereof, which shall be attached and are incorporated herein by reference. The State shall not be responsible for payment of any Workers' Compensation premiums or for any other claim or benefit for Contractor, or any subcontractor or employee of Contractor, which might arise under applicable State of New Hampshire Workers' Compensation laws in connection with the performance of the Services under this Agreement.

16. WAIVER OF BREACH. A State's failure to enforce its rights with respect to any single or continuing breach of this Agreement shall not act as a waiver of the right of the State to later enforce any such rights or to enforce any other or any subsequent breach.

17. NOTICE. Any notice by a party hereto to the other party shall be deemed to have been duly delivered or given at the time of mailing by certified mail, postage prepaid, in a United States Post Office addressed to the parties at the addresses given in blocks 1.2 and 1.4, herein.

18. AMENDMENT. This Agreement may be amended, waived or discharged only by an instrument in writing signed by the parties hereto and only after approval of such amendment, waiver or discharge by the Governor and Executive Council of the State of New Hampshire unless no such approval is required under the circumstances pursuant to State law, rule or policy.

19. CHOICE OF LAW AND FORUM.

19.1 This Agreement shall be governed, interpreted and construed in accordance with the laws of the State of New Hampshire except where the Federal supremacy clause requires otherwise. The wording used in this Agreement is the wording chosen by the parties to express their mutual intent, and no rule of construction shall be applied against or in favor of any party.

19.2 Any actions arising out of this Agreement, including the breach or alleged breach thereof, may not be submitted to binding arbitration, but must, instead, be brought and maintained in the Merrimack County Superior Court of New Hampshire which shall have exclusive jurisdiction thereof.

20. CONFLICTING TERMS. In the event of a conflict between the terms of this P-37 form (as modified in EXHIBIT A) and any other portion of this Agreement including any attachments thereto, the terms of the P-37 (as modified in EXHIBIT A) shall control.

21. THIRD PARTIES. This Agreement is being entered into for the sole benefit of the parties hereto, and nothing herein, express or implied, is intended to or will confer any legal or equitable right, benefit, or remedy of any nature upon any other person.

22. HEADINGS. The headings throughout the Agreement are for reference purposes only, and the words contained therein shall in no way be held to explain, modify, amplify or aid in the interpretation, construction or meaning of the provisions of this Agreement.

23. SPECIAL PROVISIONS. Additional or modifying provisions set forth in the attached EXHIBIT A are incorporated herein by reference.

24. FURTHER ASSURANCES. The Contractor, along with its agents and affiliates, shall, at its own cost and expense, execute any additional documents and take such further actions as may be reasonably required to carry out the provisions of this Agreement and give effect to the transactions contemplated hereby.

25. SEVERABILITY. In the event any of the provisions of this Agreement are held by a court of competent jurisdiction to be contrary to any state or federal law, the remaining provisions of this Agreement will remain in full force and effect.

26. ENTIRE AGREEMENT. This Agreement, which may be executed in a number of counterparts, each of which shall be deemed an original, constitutes the entire agreement and understanding between the parties, and supersedes all prior agreements and understandings with respect to the subject matter hereof.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS & VETERANS SERVICES
NEW HAMPSHIRE ARMY NATIONAL GUARD

Center Strafford MEP Upgrades
RFB-DMAVS-2027-01

EXHIBIT A
SPECIAL PROVISIONS



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SECTION 1 – SPECIAL PROVISIONS

1. OVERVIEW

The following special provisions modify, change, delete or add to the General Provisions of the form P-37 agreement. Where any part of the General Provisions is modified or voided by these Special Provisions, the unaltered provisions for that part shall remain in effect.

- A. The term “Contracting Officer” as used in this agreement shall mean the State’s Contracting Officer as is specified at item #1.9 of the General Provisions of this agreement or his/her authorized representative. No individual shall be an authorized representative of the Contracting Officer unless he or she is so appointed in writing by the Contracting Officer, in which case such written appointment shall be provided to the Contractor.
- B. The Contractor shall be responsible for correcting, at his own cost and expense, defective work, or damaged property when defects and damage are caused by the Contractor’s employees, equipment, or supplies, or sub-contractors employed as a part of this agreement. The Contracting Officer may withhold all or part of payments due to the Contractor until defective work or damaged property caused by the Contractor, his employees, equipment, or supplies, or sub-contractors employed as a part of this agreement is placed in satisfactory condition.
- C. **General Provisions** are amended as follows:
 - a. **Provision 14. INSURANCE:** *Add* the following sub-sub-part:
“14.1.3 Insurance against all claims arising from the Contractor’s use of automobiles in the conduct of this agreement, in amounts of not less than \$250,000.00 per person bodily injury liability, \$500,000.00 per occurrence bodily injury liability and \$50,000.00 property damage liability.”
- D. *Add* the following as Special Provisions to the extent not inconsistent with the express terms of this Agreement:

2. CONTRACT SECURITY

The Contractor shall within ten (10) days after the receipt of the Notice of Award furnish the Owner with a performance bond and a payment bond in penal sums equal to the amount of the Contract price conditioned upon the performance by the Contractor of all undertakings, covenants, terms, conditions and agreements of the Contract Documents, and upon the prompt payment by the Contractor to all persons supplying labor and materials in the prosecution of the Work provided by the Contract Documents. Such Bonds shall be executed by the Contractor and a corporate bonding company licensed to transact business in the State in which the Work is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these Bonds shall be borne by the Contractor.

3. ACCESS TO RECORDS

The contractor shall grant access to any books, documents, papers, and records that are directly pertinent to this contract, to enable and support audits, examinations, excerpts, and transcriptions to the following entities and their duly authorized representatives:

- A. The State of New Hampshire
- B. The Federal Awarding Agency to include the Inspector General
- C. The Comptroller General of the United States

4. RECORDS RETENTION

Between the Effective Date and three (3) years after the Completion Date, as often as the State, DMAVS, or Federal Government shall demand, the Contractor shall make available for audit purposes, all records that pertain to this Agreement. Upon demand the contractor shall provide copies of such documents which may include but are not limited to invoices, payrolls, records of personnel, and other information relating to all matters covered in this agreement.

5. NONDISCRIMINATION

The contractor covenants and agrees that no person shall be subject to discrimination or denied benefits in connection with the contractor's performance under this agreement. Accordingly, and to the extent applicable, the contractor covenants and agrees to comply with the following national policies prohibiting discrimination:

- A. On the basis of race, color or national origin, in Title VI of the Civil Rights Act of 1964 (42 U.S.C. Section 2000d et seq.), as implemented by DoD regulations at 32 CFR part 195.
- B. On the basis of race, color or national origin, in Executive Order 11246 as implemented by Department of Labor regulations at 41 CFR part 60.
- C. On the basis of sex or blindness, in Title IX of the Education Amendments of 1972 (20 U.S.C. 1681, et seq.), as implemented by DoD regulations at 32 CFR part 196.
- D. On the basis of age, in The Age Discrimination Act of 1975 (42 U.S.C. Section 6101 et seq.), as implemented by Department of Health and Human Services regulations at 45 CFR part 90.
- E. On the basis of handicap, in Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794), as implemented by Department of Justice regulations at 28 CFR part 41 and DoD regulations at 32 CFR part 56.

6. WAGE RATE REQUIREMENTS *(Construction, Alteration, or Repair Contracts)*

For any contract in excess of \$2,000.00 for the construction, alteration, or repair (including painting and decorating) of public buildings or public works, the contractor covenants and agrees to comply with the Davis-Bacon and Related Acts. The contractor further covenants and agrees to ensure compliance with the Davis-Bacon and Related Acts for any subcontract award under this contract. Under Davis-Bacon and Related Acts, contractors and subcontractors must pay their laborers and mechanics employed under the contract no less than the locally prevailing wages and fringe benefits for corresponding work on similar projects in the area.

7. LOBBYING *(Non-Profit Organization Contracts)*

For any contract exceeding \$100,000.00, the contractor covenants and agrees to submit to the Department of Military Affairs and Veterans Services the certification and any disclosure forms regarding lobbying that are required under 31 U.S.C. 1352, as implemented by the DoD (NGB) at 32 CFR part 28.

- A. Nonprofit organizations described in section 501(c)(4) of title 26, United States Code (the Internal Revenue Code of 1968) may not engage in lobbying activities as defined in the Lobbying Disclosure Act of 1995 (2 U.S.C., chapter 26). If DMAVS determines that the nonprofit has engaged in lobbying activities, all payments under this and other contracts with the Department shall cease and the contract(s) shall be terminated unilaterally for material failure to comply with the provisions as outlined in this agreement.

8. DRUG FREE WORKPLACE

The Contractor covenants and agrees to comply with the requirements regarding drug-free workplace in of 32 CFR Part 26, which implements section 5151-5160 of the Drug-Free Workplace act of 1988 (Public Law 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.).

9. ENVIRONMENTAL PROTECTION

The Contractor covenants and agrees that its performance under this Agreement shall comply with:

- A. The requirements of Section 114 of the Clean Air Act (42 U.S.C. Section 7414);
- B. Section 308 of the Federal Water Pollution Control Act (33 U.S.C. Section 1318), that relates generally to inspection, monitoring, entry reports, and information, and with all regulations and guidelines issued there under;
- C. The Resources Conservation and Recovery Act (RCRA);
- D. The Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA);
- E. The National Environmental Policy Act (NEPA);
- F. The Solid Waste Disposal Act
- G. The applicable provisions of the Clean Air Act (42 U.S.C. 7401, et seq.) and Clean Water Act (33 U.S.C. 1251, et seq.), as implemented by Executive Order 11738 and Environmental Protection Agency (EPA) rules at 40 CFR part 31;
- H. To identify any impact this award may have on the quality of the human environment and provide help as needed to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C. 4321, et seq.) and any applicable federal, state, or local environmental regulation.

In accordance with the EPA rules, the parties further agree that the Contractor shall also identify to the Department any impact this award may have on:

- A. The quality of the human environment and provide help the agency may need to comply with the National Environmental Policy Act (NEPA, at 42 U.S.C 4321, et seq.) and to prepare Environment Impact Statements or other required environmental documentation.

- a. In such cases, the recipient agrees to take no action that will have an adverse environmental impact (e.g., physical disturbance of a site such as breaking of ground) until the agency provides written notification of compliance with the environmental impact analysis process.
- B. Flood-prone areas and provide help the agency may need to comply with the National Flood Insurance Act of 1968 and Flood Disaster Protection Act of 1973 (42 U.S.C. 4001, et seq.), which require flood insurance, when available, for federally assisted construction or acquisition in flood-prone areas.
- C. Coastal zones and provide help the agency may need to comply with the Coastal Zone Management Act of 1972 (16 U.S.C. 1451, et seq.), concerning protection of U.S. coastal resources.
- D. Coastal barriers and provide help the agency may need to comply with the Coastal Barriers Resource Act (16 U.S.C. 3501 et seq.), concerning preservation of barrier resources.
- E. Any existing or proposed component of the National Wild and Scenic Rivers System and provide help the agency may need to comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1271 et seq.).
- F. Underground sources of drinking water in areas that have an aquifer that is the sole or principal drinking water source and provide help the agency may need to comply with the Safe Drinking Water Act (42 U.S.C 300H-3).

10. PURCHASE OF RECOVERED MATERIALS BY STATES OR POLITICAL SUBDIVISIONS OF STATES *(Construction, Alteration, or Repair Contracts)*

If, for the execution of this contract, the Contractor purchases items designated in Environmental Protection Agency (EPA) regulations in 40 CFR part 247, Subpart B, the contractor covenants and agrees to comply with applicable requirements within those EPA regulations, which implement section 6002 of the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6962).

11. FLY AMERICA REQUIREMENTS

The contractor covenants and agrees to comply with the International Air Transportation Fair Competitive Practices Act of 1974 (49 U.S.C. 40118, also known as the "Fly America" act), as implemented at 41 CFR 301-10.131 through 301-10.143 which provides that U.S. Government-financed international air travel of passengers and transportation of personal effects or property must use a U.S. Flag air carrier or be performed under a cost-sharing arrangement with a U.S. carrier if such service is available.

- A. The contractor shall include the requirements of the Fly America Act in all subcontracts that might involve international air transportation.

12. USE OF UNITED STATES FLAG CARRIERS *(Construction, Alteration, or Repair Contracts)*

The contractor covenants and agrees to comply with the Department of Transportation regulations at 46 CFR 381.7(b) requiring at least 50 percent of equipment, materials, or commodities purchased or otherwise obtained with federal funds under cooperative agreement awards, and transported by ocean vessel, be transported on privately owned U.S. flag commercial vessels, if available.

13. DEBARMENT AND SUSPENSION

Non-federal entities and contractors are subject to the non-procurement debarment and suspension regulations implementing Executive Orders 12549 and 12698, 2 CFR part 180. These regulations restrict awards, sub awards, and contracts with certain parties that are debarred, suspended, or otherwise excluded for or ineligible for participation in Federal assistance programs or activities. The State complies with the DOD implementation of 2 CFR part 180 (at 2 CFR Part 1125) by checking the Excluded Parties List System (EPLS) at www.sam.gov to verify contractor eligibility to receive contracts and subcontracts resulting from the Federal Agreement which funds this contract. The state shall not solicit offers from, nor award contracts to contractors listed in EPLS. This verification shall be documented in the State and subrecipient contract files and shall be subject to audit by the grantor and Federal/State audit agencies.

14. INFRASTRUCTURE INVESTMENT AND JOBS ACT ("IIJA")

The DMAVS covenants and agrees that it will not expend any funds appropriated by Congress unless all of the iron, steel, manufactured products, and construction materials used in projects undertaken for the Department are produced in the United States. Grants and Cooperative Agreements Policy Letter, 22-06, Initial Implementation Guidance on Application of Buy America Preference in Federal Financial Assistance Programs for Infrastructure. The Contractor covenants and agrees to utilize American made iron, steel, manufactured products, and construction materials for the completion of the work under this agreement. The Contractor further agrees to notify the Contracting Officer in the event that American materials are not available.

15. UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES

The DMAVS covenants and agrees that it will comply with CFR 49 part 24, which implements the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. Section 4601 et seq.) and provides for fair and equitable treatment of persons displaced by federally assisted programs or persons whose property is acquired as a result of such programs.

16. COPELAND "ANTI-KICKBACK" ACT *(Construction, Alteration, or Repair Contracts)*

The contractor covenants and agrees that it will comply with the Copeland "Anti-Kickback" Act (18 U.S.C. Section 874) as supplemented in Department of Labor regulations (29 CFR Part 3). As

applied to this agreement, the Copeland "Anti-Kickback" Act makes it unlawful to induce, by force, intimidation, threat of procuring dismissal from employment, or otherwise, any person employed in the construction or repair of public buildings or public works, financed in whole or in part by the United States, to give up any part of the compensation to which that person is entitled under a contract of employment.

17. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

For contracts in an amount greater than \$100,000.00 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act that involve the employment of mechanics or laborers and is not a type of contract excepted under 40 U.S.C. 3701, the contractor covenants and agrees that it will comply with the clauses specified in the Department of Labor (DoL) regulations at 29 CFR 5.5(b) to require use of wage standards that comply with the Contract Work Hours and Safety Standards Act (40 CFR, Subtitle II, Part A, Chapter 37), as implemented by the DoL at 29 CFR part 5, "Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction". As applied to this contract, the Contract Work Hours and Safety Standards Act specifies that no laborer or mechanic doing any part of the work contemplated by this agreement shall be required or permitted to work more than 40 hours in any workweek unless paid for all additional hours at not less than 1.5 times the basic rate of pay.

18. NATIONAL DEFENSE AUTHORIZATION ACT (NDAA)

(for Fiscal Year (FY) 2019 (Public Law 115-232))

The contractor covenants and agrees that it will not use "covered telecommunications equipment or services," as that term is defined in Section 889 of the NDAA for FY 2019, as a substantial or essential component of any system or as critical technology as part of any system involved in the contractor's performance of this contract. The contractor further covenants and agrees that it will not subcontract any part of its performance under this contract to any entity that uses such covered telecommunications equipment or services as a substantial or essential component of any system or as critical technology as part of any system.

19. PROHIBITION ON CERTAIN INTERNAL CONFIDENTIALITY AGREEMENTS

The contractor agrees and covenants that it will not require its employees, contractors, or subrecipients seeking to report fraud, waste, or abuse to sign or comply with internal confidentiality agreements or statements prohibiting or otherwise restricting them from lawfully reporting that waste, fraud, or abuse to a designated investigative or law enforcement representative of a federal department or agency authorized to receive such information.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS & VETERANS SERVICES NEW
HAMPSHIRE ARMY NATIONAL GUARD

Center Strafford MEP Upgrades
RFB-DMAVS-2027-01

EXHIBIT B
SCOPE OF SERVICES



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SECTION 1 – SCOPE OF SERVICES

1. GENERAL CONDITIONS

A. This Agreement consists of the following documents: Form P-37, Exhibits A, B, C, D, and Appendix 1 & 2 which are all incorporated herein.

B. The Exhibit B: Scope of Services shall include all the information and requirements about the project that are derived herein as well as the Project Manual (Appendix 1), the authorized construction drawings, documents, and clarification sketches (Appendix 2) as well as any addenda.

C. This project consists of new Building Management Systems (BMS) for the entire campus, Roof Top Unit (RTU) HVAC replacement at Building # 5 Dining Facility (DFAC), and site lighting. The project will include the Disciplines(s) of: Site Construction, Demolition of existing systems, Thermal and Moisture Protection, Equipment, Mechanical and Electrical.

a. **Deduct Alternate #1:** Exclude entire rooftop mounted PV, Battery Storage and all associated equipment and wiring at Building 12. See drawing E-101 and associated specifications.

b. **Deduct Alternate #2:** Exclude EV Charging Station and Conductors at VCOT area. Stub conduit for future connection. See drawing E-102 and associated specifications.

D. The Contractor will provide all labor, parts, materials, tools, equipment, supplies, transportation, vehicles, Personal Protective Equipment, and any other incidentals necessary to travel to the New Hampshire Army Training Site in Center Strafford, NH, to perform the contract services specified herein.

E. For any unanticipated work required, a written proposal will be submitted to the agency primary contact for approval prior to work commencing.

2. CONTRACT TERM

This Agreement shall be effective upon Governor and Executive Council approval through November 30, 2027.

3. PRIMARY AND SECONDARY CONTACTS

The Contractor will report to and work in conjunction with a DMAVS/NHARNG Primary and Secondary Contact as designated by the Department. The initial Contacts will be:

Primary:

Ken Coombs
Architect/Project Manager
(603) 227-1466
kenneth.e.coombs5.nfg@army.mil

Secondary:

Ben Stevens
Design & Construction Branch Chief
(603) 724-1086
benjamin.m.stevens3.mil@army.mil

The Department reserves the right to appoint an alternate Primary and Secondary Contact to assist in managing this contract.

SECTION 2 – PROJECT CONDITIONS

1. CONTRACT DOCUMENTS

- A. The Contract Documents consist of the Contract Agreement, General Conditions, and Supplementary General Conditions, Drawings and Specifications, including all Addenda issued prior to execution of the Contract; Bonds where required; insurance certificates; and subsequently thereto, Change Orders issued in accordance with the General Conditions.
- B. The Contract Documents shall be signed by the Department and the Contractor in as many original counterparts as may be mutually agreed. No Contract shall be considered as in effect until it has been fully executed by all of the parties thereto and the award concurred in by Governor and Council. If there is federal funding, it must also have the concurrence of the applicable Federal Agency having jurisdiction.
- C. This Contract is executed in a number of counterparts, each of which is an original and constitutes the entire agreement between the parties. This Contract shall be construed according to the laws of the State of New Hampshire. No portion of this Contract shall be understood to waive the sovereign immunity of the State. This Contract shall not be amended, except as specified herein, except with the approval of the Governor and Council.
- D. The Contract Documents are complementary and anything called for by one of the Contract Documents and not called for by the others shall be of like effect as if required by all.
- E. Should the Contract Documents disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and or materials, unless specifically otherwise directed by written Addendum to the Contract.
- F. The Contractors and all subcontractors shall refer to all of the Contract Documents, including those not specifically showing the work of their specialized trades, and shall perform all work reasonably inferable from them as being necessary to produce the intended results.
- G. All indications or notations which apply to one of a number of similar situations, materials or processes shall be deemed to apply to all such situations, materials or processes wherever they appear in the work, except where a contrary result is clearly indicated by the Contract Documents.
- H. Where codes, standards, requirements, and publications of public and private bodies are referred to in the Contract Documents, such references shall be understood to be to the latest revision prior to the date of receiving Bids, except where otherwise indicated.
- I. Where no explicit quality or standards for materials or workmanship is established for work, such work is to be of good quality for the intended use and consistent with the quality of the surrounding work and of the construction of the Project in general.
- J. All manufactured articles, materials, and equipment shall be applied, installed, connected, erected, tested, cleaned, and conditioned in accordance with the manufacturer's written or printed directions and instructions, unless specifically indicated otherwise in the Contract Documents.

- K. The Drawings are generally made to scale, but all working dimensions shall be taken from the figured dimensions or by actual measurements at the job. In case by scaling. Study and compare all the Drawings and verify all figures before laying out or constructing work. The Contractor shall be responsible for errors in his work that might have been avoided thereby. Whether or not an error is believed to exist, deviation from the Drawings and the dimensions given thereon shall be made only after approval in writing from the Department.
- L. The Mechanical, Fire Protection (sprinkler) and Electrical Drawings, when provided, are diagrammatic only, and are not intended to show the exact physical locations or configurations of work. Such work shall be installed to clear all obstructions, permit proper clearances by coordinating his work with other trades, and present an orderly appearance where exposed.

2. ACCESS TO THE WORK

- A. The Contractor shall provide for access to the work for inspection by the Department and government officials having jurisdiction. The Consultant, Engineer, and officials of Local, State, and Federal Agencies in the case of such programs as they administer and their authorized representatives shall have access at all times to the work for inspection wherever it is in preparation or progress, and the Contractor shall provide proper facilities for such access and inspection.

3. CONTRACT ADMINISTRATION

- A. The Department shall determine the amount, quality, and acceptability and fitness of all parts of the work, shall interpret the Contract Documents, and any Change Orders, and shall decide all other issues in connection with the work. The Department shall have the authority to approve or order changes in the work that alter the terms or conditions of the Contract. The Department shall confirm in writing any oral order, direction, requirements or determination.
- B. When a Federal Agency participates in the cost of the work covered by this Contract, the work shall be under the observation and inspection of the Department, but subject to the inspection and approval of the proper officials of the Federal Agency.

4. ACCIDENT PROTECTION

- A. It is a condition of this Contract, and shall be made a condition of each subcontract entered into pursuant to the Contract, that the Contractor and any Subcontractors shall not require any laborer or mechanic employed in the performance of the Contract to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous to his health or safety as determined by construction safety and health standards of the Occupational Safety and Health Administration, United States Department of Labor, which standards include, by reference, the established Federal Safety and Health Regulations for Construction. These standards and regulations

comprise Part 1910 and Part 1926 respectively of Title 29 of the Code of Federal Regulations and are set forth in the Federal Register. In the event any revisions in the Code of Federal Regulations are published, such revisions will be deemed to supersede the appropriate Part 1910 and Part 1926, and be effective as of the date set forth in the revised regulation.

5. HAZARDOUS MATERIALS

- A. The Contractor shall also be aware of laws and regulations relating to hazardous materials that may be encountered during construction operations, either within project limits or at material sites off the project. The health and safety of employees, the general public, and the potential of damage to the overall environment is possible if hazardous materials are not recognized, reported, and the appropriate action taken to dispose of, remove from the site, or otherwise contain the possible contaminants.
- B. If any abnormal condition is encountered or exposed that indicates the presence of a hazardous material or toxic waste, construction operations shall be immediately suspended in the area and the Department notified. No further work shall be conducted in the area of the contaminated material until the site has been investigated and the Department has given approval to continue the work in the area. The Contractor shall fully cooperate with the Department and perform any remedial work as directed. Work shall continue in other areas of the Project unless otherwise directed.
- C. Exposure to hazardous materials may result from contact with, but not necessarily limited to, such items as drums, barrels, and other containers, waste such as cars, batteries, and building construction debris. Containers leaking unknown chemicals or liquids, abandoned cars leaking petroleum products, batteries leaking acid, construction debris which may include asbestos, or any other source of suspected hazardous material found within excavation areas or stockpiled on land within construction limits shall be referred to the Department of Environmental Services and the Department so that a proper identification of the materials may be made and disposal procedures initiated as required.
- D. Disposition of the hazardous material or toxic waste shall be made under the requirements and regulations of the Department of Environmental Services. Work required disposing of these materials and any remedial work shall be performed under a Supplemental Agreement or Contract item, if included in the Contract.

6. SUBCONTRACTS

- A. Nothing contained in the Specifications or Drawings shall be construed as creating any contractual relationship between any Subcontractor and the Department. The Divisions or Sections of the Specifications are not intended to control the Contractor in dividing the work among Subcontractors or to limit the work performed by any trade.
- B. The Contractor shall be as fully responsible to the Department for the acts and omissions of Subcontractors and of persons employed by them, as he is for the acts and

omissions of persons directly employed by him.

- C. The Contractor shall, without additional expense to the State, utilize the services of specialty Subcontractors, as required.
- D. The Department will not normally undertake to settle any differences between the Contractor and his Subcontractors or between Subcontractors.
- E. The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind Subcontractors to the Contractor by the terms of the General Conditions and other Contract Documents insofar as applicable to the work of Subcontractors and to give the Contractor the same power as regards terminating any subcontract that the Department may exercise over the Contractor under any provisions of the Contract Documents.
- F. Within fifteen (15) days after the award of the Contract, the Contractor shall submit a complete list of all of the Subcontractors setting forth in detail the work they will be responsible for. If a subcontractor is added during the construction process the Contractor will revise the list and resubmit to the Department.

7. RESPONSIBILITY OF CONTRACTOR TO ACT IN EMERGENCY

- A. In case of any emergency that threatens loss or injury of property, and/or safety of life, the Contractor shall act, without previous instructions from the Department, as the situation may warrant. He shall notify the Department thereof immediately thereafter. Any compensation claimed by the Contractor together with substantiating documents in regard to expense, shall be submitted to the Department and the amount of compensation shall be determined by agreement.

8. SEPARATE CONTRACTS

- A. The Department may award other Contracts in connection with the Project, the work under which will proceed simultaneously with the execution of this Contract. The Contractor shall coordinate operations with those of other Contractors.

9. MUTUAL RESPONSIBILITY OF CONTRACTORS

- A. If the Contractor or any of his/her Subcontractors or employee's causes loss or damage to any separate Contractor or Subcontractor on the work, the Contractor or Subcontractor agrees to settle with such separate Contractor or Subcontractor by agreement, if he/she will so settle. If such separate Contractor or Subcontractor sues the State because of any loss so sustained, the Department shall notify the Contractor and/or their subcontractors, who shall indemnify and hold harmless the Department against any expenses or judgment arising there from.

10. PAYMENTS TO CONTRACTOR

- A. The Department will manifest payments to the Contractor each calendar month on the basis of duly certified and approved estimate of the work performed during the

preceding period. In preparing estimates, the material delivered on the site and any preparatory work done may be taken into consideration.

- B. At least ten (10) days before the end of the billing period, the Contractor shall submit to the Department an itemized Requisition for Payment, supported by such data substantiating the Contractor's right to payment as the Department may require. If payment is to be made on account of materials or equipment not incorporated in the work, but delivered and suitably stored at the site, such payment shall be conditional upon submission by the Contractor of bills of sale or such other procedure satisfactory to the Department to establish the State's title to such materials or equipment or otherwise protect the State's interest including applicable insurance.
- C. Immediately upon receipt of the Department Approved Monthly Requisition for Payment, Contractor shall post same at the Contractor's Field Office or project site in a location where Subcontractors and Suppliers have clear access.
- D. A five (5) percent retainage of the value of the work performed on each partial estimate will be deducted and retained by the Department until after completion of the entire Contract in an acceptable manner. The balance remaining after the specified percentage has been retained, less all previous payments, will be certified for payment on each partial estimate.
- E. Within thirty (30) days after acceptance, the Department shall pay to the Contractor the amount of the Contract less all prior payments. All prior payments and estimates, including those relative to extra work, shall be subject to correction by this payment, which is throughout this Contract called the Final Payment.
- F. Retainage will be released at Final Payment.
 - a. After the Certificate of Substantial Completion has been issued, upon written application by the Contractor and with the approval of the Surety, the Department **may** release a portion of the retained amount.
- G. Payment for Material On Hand:
 - a. Partial payments are made for materials to be incorporated in the Work, provided the materials meet the requirements of the Contract and are delivered on, or in the vicinity of, the Project site and stored in acceptable places. Partial payments will not exceed 90 percent of the Contract unit price for the item or the amount supported by copies of paid invoices, freight bills, or other supporting documents required by the Department. The quantity paid will not exceed the corresponding quantity estimate in the Contract. No partial payment will be made on living or perishable materials until incorporated in the Work.
 - b. When material payments exceed \$100,000 or 10 percent (10%) of the total contract amount, whichever is less, notarized copies of paid invoices or copies of canceled checks for all such materials must be submitted to the Department within 45 days of the end date of the estimate on which the material allowance was paid. Failure to provide such documentation will result in the deduction of

- such material allowance from future estimates until documentation is provided.
- c. All material and work covered by partial payments made shall thereupon become the sole property of the Department, but this provision shall not be construed as relieving the Contractor of the sole responsibility of all materials and work upon which payments have been made or the restoration of any damaged work or as a waiver of the right of the State to require the fulfillment of all the terms of the Contract.
- H. Payment for Material Not on Hand:
- a. The Department will not pay for products and or materials that have not been delivered and stored properly on the construction site.
- I. Release of Claims:
- a. Neither the final payment nor any part of the retained percentage shall become due until the Contractor shall deliver a complete release of all claims arising under and by virtue of this Contract, including claims for all Subcontractors and suppliers of either materials or labor, plus a release of the Contract Bond and a statement that all Subcontractors and suppliers have been paid. The Department, may pay any and all such claims, in whole or in part, and deduct the amount or amounts so paid from any partial or final payment.
- J. Final Payment:
- a. Application for Final Payment received from the Contractor will be processed for payment not less than 60 days after project acceptance and final completion unless accompanied by a release of the Contract Bond. This payment shall be the amount of the Contract, amended by approved change orders, less previous payments minus liquidated damages, additional penalties or holdbacks. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.
- K. Acceptance of Final Payment Constitutes Release:
- a. The acceptance of the Final Payment by the Contractor shall be and shall operate as a release to the Contractor of all claims and of all liability to the Department for all things done or furnished in connection with this work. No payment, however, final or otherwise, shall operate to release the Contractor and its Sureties from any obligations under this Contract or the Contract Bond. Acceptance of Final Payment shall not impact any warranties provided by the Contractor with respect to this project.

11. LIMITATION OF CONSTRUCTION OPERATIONS

- A. The normal working hours will be from 7:00 am until 3:30 pm M-F unless otherwise agreed in writing by the department.
- B. The contractor may be displaced at any time with no notice in the event of a military mission that takes priority over construction.
- C. In the State of New Hampshire, legal holidays occur on:

- a. New Year's Day
 - b. Washington's Birthday
 - c. Memorial Day Fourth of July
 - d. Labor Day
 - e. Veterans' Day
 - f. Thanksgiving Day and Day After
 - g. Christmas Day
- D. Whenever a holiday is observed on a Friday or a Monday. The Contractor shall be required to suspend work for three (3) calendar days.
- E. No work shall be performed on Saturday, Sundays or legal holidays except in cases of emergency and upon permission of the Department.

12. CONTRACTOR'S TITLE TO MATERIALS

- A. No materials or supplies for the work shall be purchased by the Contractor or any Subcontractor subject to any chattel mortgage or under a conditional sale or other agreement by which an interest is retained by the seller. The Contractor warrants that he has good title to all materials and supplies for which he accepts partial payment. If any claim is made with respect to materials provided by the contractor, subcontractors, or Independent Contractors, the Contractor shall defend any such claim and shall pay any judgment or settlement thereon.

13. CHANGES IN WORK

- A. The Department may at any time, by a written order, and without notice to the Sureties, make changes in the Drawings and Specifications and Completion Date of this Contract and within the general scope thereof.
- B. The order shall stipulate the mutual agreed upon lump sum price, which shall be added to or deducted from the Contract Price. The Contractor shall furnish an itemized breakdown of the prices used in computing the value of any change that might be ordered.
- C. The compensation herein provided shall be accepted by the Contractor as payment in full, including superintendence, bond, overhead, and profit, for extra work performed on a force account basis. For all such work, the Contractor shall furnish certified copies of the payrolls on forms provided for that purpose, invoices of all materials, and such other information as may be required by the Department.

14. PERMITS AND FEES

- A. The selected Contractor is to obtain and pay for all construction licenses, permits, and fees as may be required by law for construction of State's facility, and pay for all fees and charges, and use of the property other than the site of the work for storage of materials or other purposes.

- B. The Contractor shall pay all applicable Federal, State and Local sales and other taxes, except taxes and assessments on the real property comprising the site of the Project.

15. PATENTS

- A. The Contractor shall hold and save the Department and its officers, agents, servants, and employees harmless from liability of any nature including cost and expenses, for or on account of any patented or unpatented invention, process, article or applicable manufactured or used in the performance of the Contract, including its use, unless otherwise specifically stipulated in the Contract Documents.

16. ASSIGNMENTS

- A. The Contractor shall not assign the whole or any part of this Contract or any monies due or to become due hereunder, without the written consent of the Department and of all Sureties executing any Bonds on behalf of the Contractor if in connection with said Contract.

17. SUPERINTENDENCE BY CONTRACTOR

- A. The Contractor shall employ a competent Foreman or Superintendent, satisfactory to the Department, on the work site **at all times** to supervise the work in progress, with authority to act for him. The Contractor shall not change superintendents without permission from the Department and shall submit a request in writing with justification for such a change.
- a. The superintendent shall be responsible for verifying that all materials, installation, coordination, and workmanship are in conformance with the contract documents.
 - b. Unless the Department has granted prior written approval, the superintendent shall not, himself, engage in "hands on" construction work.
 - c. In the event the superintendent fails or refuses to perform functions mentioned above as determined by the Department, the Contractor agrees to a stipulated penalty of up to \$500.00 per day, in addition to any liquidated damages provided hereunder.

18. FAILURE TO COMPLETE WORK ON TIME

- A. If the Contractor fails to complete all of the work or sections of the Project, if sections are indicated, within the time specified in the Contract or within any additional time allowed, for each working day the Liquidated Damages identified in Section C below will be deducted from any money due the Contractor. This deduction will be made, not as a penalty, but as fixed, agreed liquidated damages for inconvenience to the Department and for reimbursing the Department the cost of the Administration of the Contract, including personnel, time, engineering and inspection. Should the amount of

money otherwise due the Contractor be less than the amount of such liquidated damages, the Contractor and its Surety shall be liable to the Department for such deficiency.

- B. If the Department permits the Contractor to continue and finish the work after the time fixed for its completion, it shall in no way operate as a waiver on the part of the Department of any of its rights under the Contract. When the final acceptance has been duly made by the Department, any liquidated damage charges shall end.
- C. The fixed, agreed, liquidated damages shall be assessed in accordance with the following schedule.

<u>Original Contract Amount</u>		<u>Amount of Liquidated damages per day</u>
From more than:	to and including:	
0	25,000	\$200.00
25,000	50,000	\$300.00
50,000	100,000	\$400.00
100,000	500,000	\$500.00

19. SUBSTANTIAL COMPLETION AND FINAL INSPECTION

- A. When the Contractor believes the project is substantially complete, they shall submit an application for substantial completion to the Department. The Contractor shall submit to the Department a list of items of work to be completed or corrected, accompanied by a cost value of these items. The Department will also provide a "punch List" of items to be completed based on their interpretation of the required finished product. 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. On the basis of an inspection by the Department which determines that the work is substantially complete, a certificate of Substantial Completion shall be issued which will establish the Date of Substantial Completion and state the responsibilities of the Department and the Contractor for such as security, maintenance, heat, utilities, damage to the work and insurance, any other pertinent issues and fix the time limit within which the Contractor shall complete the items listed herein. Warranties required by the Contract Documents shall commence on the Date of Substantial Completion unless otherwise provided in the Certificate of Substantial Completion.
- B. If the Contractor fails to proceed to complete the items on the "punch list," then in addition to the corrective measures listed in the Certificate of Substantial Completion, the Department may use the monies still due the Contractor to have such items completed and the Contractor shall lose any claim to the monies so used.
- C. Upon written notice that the work is ready for final inspection and acceptance, the Department shall promptly make such inspection, and when they find the work acceptable under the Contract Documents and the Contract fully performed, the Contractor will be provided written notice to that effect. The Contractor shall provide

all certificates and reports, as required, throughout the contract and shall coordinate their preparation and submission. Failure to submit such certificates and reports shall be considered default of contract.

20. TERMINATION OF CONTRACT WITH FAULT

- A. If the Contractor:
- a. Fails to begin work under Contract within the time specified in the notice to proceed, or
 - b. Fails to perform the work with sufficient workmen and equipment, or with sufficient materials to assume prompt completion of said work, or
 - c. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
 - d. Discontinues the prosecution of the work, or
 - e. Fails to resume work, which has been discontinued, within a reasonable time after notice to do so, or
 - f. Becomes insolvent or has declared bankruptcy, or commits any act of bankruptcy or insolvency, or
 - g. Fails to pay subcontractors and material/product suppliers, or
 - h. Makes an assignment for the benefit of creditors, or
 - i. For any other causes whatsoever, fails to carry on the work in an acceptable manner.
- B. The Department will give notice, in writing, to the Contractor and his Surety for such delay, neglect, and default for any item identified above.
- a. If the Contractor or Surety does not proceed in accordance with the Notice, then the Department will, upon the Contractor's failure to comply with such Notice, have full power and authority without violating the Contract, to take the prosecution of the work out of the hands of the Contractor. The Department may enter into an agreement for the completion of said Contract according to the terms and conditions thereof or use such other methods as in his opinion will be required for the completion of said Contract in an acceptable manner.
 - b. All extra costs and charges incurred by the Department as a result of such delay, neglect or default, together with the cost of completing the work under the Contract will be deducted from any monies due or which may become due said Contractor. If such expenses exceed the sum that would have been payable under the Contract, then the Contractor and the Surety shall be liable and shall pay to the Department, the amount of such excess.

21. TERMINATION OF CONTRACT WITHOUT FAULT

- A. Except in cases controlled by the preceding section, the Department, for any cause, including, but not limited to an order of any Federal authority or petition of the Contractor due to circumstances beyond his control may by written notice to the

Contractor and the Surety terminate the Contract or any portion thereof subject to the Condition(s) i, ii, iii and iv provided below.

- B. Notwithstanding anything to the contrary contained in these condition, it is understood and agreed by the parties hereto that all obligations of the Department hereunder, including the continuance of payments, are contingent upon the availability and continued appropriation of State and/or Federal Funds, and in no event shall the Department be liable for any payments hereunder in excess of such available or appropriated funds. In the event of a reduction, termination or failure to appropriate any or all such available funds or appropriations or a reduction of expenditures of State funds the Department may, by written notice to the Contractor and Surety, immediately terminate this Contract in whole or in part in accordance with the following conditions:
- a. When a Contract, or portion thereof, is terminated before completion of all items of work in the Contract, payment will be made for the actual items of work completed. Payment of items of work not completed at time of termination shall be the greater of the following amounts: (1) a percentage of the Contract unit price, which percentage shall be the percentage of completion of the particular item at time of termination or (2) such amount as shall be mutually agreed upon by the parties. No claim for loss of anticipated profits on items or units of work not completed will be allowed.
 - b. Reimbursement for organization of the work and mobilization, when not otherwise included in the Contract, shall be made where the volume of work completed is too small to compensate the Contractor for these expenses under the Contract; the intent being that an equitable settlement be made with the Contractor.
 - c. Acceptable materials, obtained or ordered by the Contractor for the work, and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor based upon the delivered cost of the materials at such points of delivery as may be designated by the Department. The Contractor shall do everything possible to cancel unfilled orders.
 - d. Termination of a Contract, or a portion thereof, shall not relieve the Contractor of his responsibilities for the work completed nor shall it relieve his Surety of its obligations for and concerning any claims arising out of the work performed.

22. ASSIGNMENT PROVISION

- A. The Contractor hereby agrees that it will assign to the Department all causes of action that it may acquire under the anti-trust laws of New Hampshire and the United States as a result of conspiracies, combinations or contracts in restraint of trade which affect the price of goods or services obtained by the Department under this Contract, if so requested by the Department.

SECTION 3 – EXECUTION REQUIREMENTS

1. CLOSEOUT PROCEDURES

- A. Submit a signed Substantial Completion Application attesting that the Contract Documents have been reviewed, Work has been inspected, and that all Work is complete in accordance with Contract Documents and ready for the Department review.
- B. Only after completion of all Punch List items and submission of all items the Contractor shall submit a Final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

2. FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- 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. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned. Clean new light fixtures free from dust, dirt and fingerprints.
- D. Replace filters of operating equipment.
- E. Clean debris from roofs, roof drains, downspouts, and drainage systems.
- F. Clean site, sweep paved areas, rake landscaped surfaces.
- G. Remove waste and surplus materials, rubbish, and construction facilities from site.

3. STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify the Department seven days prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- G. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturer's instructions.

- H. Submit a written report stating that the equipment or system has been properly installed and is functioning correctly.

4. PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturers.
- F. Prohibit traffic from landscaped areas.

5. PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - a. Drawings.
 - b. Specifications.
 - c. Addenda.
 - d. Change Orders and other modifications to the Contract.
 - e. Reviewed Shop Drawings, Product Data, approved submittals and Samples.
 - f. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure data is complete and accurate, enabling future reference by the Department.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - a. Manufacturer's name and product model and number.
 - b. Product substitutions or alternates utilized.
 - c. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - a. Measured depths of foundations in relation to finish floor datum.
 - b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

- d. Field changes of dimension and detail.
- e. Details not on original Contract drawings.
- f. Contractor to provide record drawings in AutoCad or Revit format compatible with current Department software as well as in PDF format.
- g. Contractor to supply two (2) full size paper sets of record drawings to Department.

G. Submit documents to the Department prior to final payment and release of retainage.

6. OPERATION AND MAINTENANCE DATA

- A. Submit data bound in 8 1/2 x 11 inch text pages, three D side ring binders with durable plastic covers. (2 complete copies of all materials required.)
- B. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - a. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineers), Contractor, Subcontractors, and major equipment suppliers.
 - b. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - i. Significant design criteria.
 - ii. List of equipment.
 - iii. Parts list for each component.
 - iv. Operating instructions.
 - v. Maintenance instructions equipment and systems.
 - vi. Maintenance instructions for special finishes, including recommended cleaning methods, materials and schedules, and special precautions identifying detrimental agents.
 - c. Part 3: Project documents and certificates, including the following as required:
 - i. Shop drawings and product data.
 - ii. Air and water balance reports.
 - iii. Certificates.
 - iv. Originals and Photocopies of warranties and bonds.

7. MANUAL FOR MATERIALS AND FINISHES

- A. Submit one copy of preliminary draft or proposed formats and outlines of contents before start of Work. The Department will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by the Department, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes prior to Substantial Completion. Draft copy be reviewed and returned with Architect/Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes in final form prior to final inspection.
- E. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom manufactured products.
- F. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- G. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- H. Additional Requirements: As specified in individual product specification sections.
- I. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

8. MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Contract Administrator will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by the Department, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes 15 days prior to Substantial Completion. Draft copy shall be reviewed and returned after Substantial Completion, with Architect/Engineer comments. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes in final form prior to final inspection.
- E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed and/or by label machine.
- G. Include color coded wiring diagrams as installed.

- H. Operating Procedures: Include stall-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.
- I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- J. Include servicing and lubrication schedule, and list of lubricants required.
- K. Include manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by controls manufacturer.
- M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Include control diagrams by controls manufacturer as installed.
- O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.
- P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Include test and balancing reports as specified in Section 01400.
- S. Additional Requirements: As specified in individual product specification sections.
- T. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

9. SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site and place in location as directed by State; obtain receipt prior to final payment.

10. PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after Substantial Completion. All warranties start dates shall be the Substantial Completion Date, if project is phased all warranties to start at the date of Substantial Completion of each phase.
- B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Include Table of Contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.

G. Time Of Submittals:

- a. For equipment or component parts of equipment put into service during construction with State's permission, submit documents within ten days after acceptance.
- b. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
- c. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date or acceptance as beginning or warranty or bond period.

11. MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in specification sections during warranty period.
- B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.
- D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of the Department.

12. GUARANTEE OF WORK

- A. Except as otherwise specified, all work shall be guaranteed by the Contractor against defects resulting from the use of inferior materials, equipment or workmanship for one (1) year from the Date of Substantial Completion of the work.
- B. If, within any guarantee period, repairs or changes are required in connection with guaranteed work, which in the opinion of the Department, is rendered necessary as a result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the Contract shall, promptly upon receipt of notice from the Department and at his own expense:
 - a. Place in satisfactory condition in every particular, all such guaranteed work, correct all defects therein.
 - b. Make good all damage to the building or site, or equipment or contents thereof; which in the opinion of the Department is the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the Contract.
 - c. Make good any work or material, or the equipment and contents of said building or site disturbed in fulfilling any such guarantee.
- C. In any case, wherein fulfilling the requirements of the Contract or of any guarantee, embraced in or required thereby, the Contractor disturbs any work guaranteed under

another contract, he shall restore such disturbed work to a condition satisfactory to the Department and guarantee such restored work to the same extent as it was guaranteed under such other contracts.

- D. If the Contractor, after notice, fails to proceed promptly to comply with the terms of the guarantee, the Department may have the defects corrected and the Contractor and his/her Surety shall be liable for all expense incurred.
- E. All special guarantees applicable to definite parts of the work that may be stipulated in the Specifications or other papers forming a part of the Contract shall be subject to the term of this paragraph during the first year of the life of such special guarantee.
- F. Failure to adhere to guarantee terms may result in suspension or barring from the prequalification list, or, alternatively, the requirement of a Letter of Credit or other guaranty equal to a percentage of the Contract amount.

SECTION 4 – SUBMITTAL PROCEDURES

1. SUBMITTALS

- A. Submittals shall be made for all materials to be used in construction of the project for review and acceptance of the Department PRIOR to installation of said materials.
- B. The word “Submittals” shall include all products and materials that will become part of the finished product whether or not they are specified in the construction documents. This shall also include any shop drawings that need to be approved for any kind of layout of installation. (i.e.: Rebar, steel fabrication, etc...)
- C. Shop drawings will be reviewed for the limited purpose of checking for conformance with information given and design concept expressed in the contract documents.
- D. Contractor to indicate any special utility and/or electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances on shop drawings as applicable.
- E. Transmit each submittal electronically via e-mail with a cover sheet and all pertinent information for review to the Department and the Department’s Consultant simultaneously. Schedule submittals to expedite the Project.
- F. Sequentially number transmittal forms and separate items logically. Mark revised submittals with original number and sequential alphabetic suffix.
- G. Identify Project, Contractor, subcontractor and supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.
- H. Apply Contractor’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 requirements of the Work and Contract Documents. Incomplete items or items submitted without the Contractor’s signed stamp of approval thereon will be returned rejected.

- I. For each submittal for review, allow 14 days excluding delivery time to and from Architect, Engineer and the Department and Contractor.
- J. The Department and the Department's Consultant will review submittals and coordinate return of same to the Contractor.
- K. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.
- L. Allow space on submittals for Contractor and Architect or Engineer review stamps.
- M. When revised for resubmission, identify changes made since previous submission.
- N. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
- O. Work shall not begin until submittal items have been approved and returned to General Contractor by the Department.
- P. Contractor shall keep a binder on site of all approved submittals for review by the Department and their consultants at any time during construction.

2. CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial schedule at Preconstruction Meeting.
- B. Submit revised Progress Schedules with each Application for Payment.
- C. Distribute copies of revised schedules to Project site file, subcontractors, suppliers, and other concerned parties.
- D. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.
- E. Submit horizontal bar chart with separate line for each section of Work, identifying first work day of each week.

3. SAMPLES

- A. Submit for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.
- B. Samples For Selection as specified in individual specification sections or as noted on plans:
 - a. Submit to the Department for aesthetic, color, or finish selection.
 - b. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for the Department and Architect/Engineer selection.
- C. Submit samples to illustrate functional and aesthetic characteristics of Products, with integral parts and attachment devices, Coordinate sample submittals for interfacing work.
- D. Include identification on each sample with full Project information.
- E. Submit number of samples specified in individual specification sections; the Department will retain one sample and Architect or Engineer will retain one sample.
- F. Reviewed samples which may be used in the Work are indicated in individual specification sections.

4. TEST REPORTS

- A. Submit for Department and Architect and Engineer's knowledge as required per plans or individual specification sections.
- B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

5. CERTIFICATES

- A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor, to the Department in quantities specified for Product Data.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to the Department.

6. MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to the Department in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention and special environmental criteria required for application or installation.

7. CONSTRUCTION PHOTOGRAPHS

- A. Provide photographs of site and construction throughout progress of Work.
- B. Contractor will **NOT** take any photographs of military personnel or equipment.
- C. Contractor will **NOT** use any project photographs for any reason other than stated in this section without prior written consent of the Department.
- D. Each month submit photographs with Application for Payment.
- E. Photographs: Submit digital images via email.
- F. In addition to progress photos, contractor is to take four site photographs from differing directions and four interior photographs of each building area indicating relative progress of the work, five days maximum, prior to submitting.
- G. Take photographs as evidence of existing project conditions.
- H. Identify each image, identify name of Project, orientation of view, date and time of view.

SECTION 5 – TEMPORARY FACILITIES AND CONTROLS

1. TEMPORARY ELECTRICITY

- A. The Department will pay cost of energy used. Exercise measures to conserve energy.
- B. Provide flexible power cords as required for portable construction tools and

equipment.

- C. Provide main service disconnect and over-current protection at convenient location.
- D. Permanent convenience receptacles may be utilized during construction.

2. TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain lighting for construction operations.
- B. Provide and maintain lighting to interior work areas after dark for security purposes.
- C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps for specified lighting levels.
- D. Maintain lighting and provide routine repairs.
- E. Permanent building lighting may be utilized during construction.

3. TEMPORARY HEATING

- A. Existing building heating system may be used during construction. Exercise measures to conserve energy.

4. TEMPORARY COOLING

- A. Existing building cooling system may be used during construction. Exercise measures to conserve energy.

5. TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- B. Provide temporary fan units as required to maintain clean air for construction operations.

6. TELEPHONE SERVICE

- A. Contractor may not use internal state/federal phone system.

7. WATER SERVICE

- A. The Department will pay cost of temporary water used. Exercise measures to conserve energy. Utilize Department's existing water system, extend and supplement with temporary devices as needed to maintain specified conditions for construction operations.

8. TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of project mobilization.

9. FIELD OFFICES AND SHEDS

- A. If the contractor decides to have a field office the location shall be coordinated with the department prior to placement. There is limited space available in the construction area for storage or a field office.

- B. Provide Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors. Maintain during progress of Work; remove at completion of Work.
- C. Storage Areas And Sheds: Size to storage requirements fill products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products.
- D. Maintenance and Cleaning: Maintain approach walks free of mud, water, and snow.
- E. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

10. PARKING

- A. Contractor and subcontractors to park in department directed spaces only.

11. PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in 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 spaces.
- 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 rubbish from site weekly and dispose off-site.
- E. Elevator may be used for removal of construction waste. Contractor is responsible for maintaining cleanliness of said elevator as it is the only one in the building.

12. BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas to allow for the Department's use of the site and facility, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

13. ENCLOSURES AND FENCING

- A. Interior Enclosures:
 - a. Provide temporary partitions and ceilings as indicated on Drawings to separate work areas from Department occupied areas, to prevent penetration of dust and moisture into Department occupied areas, and to prevent damage to existing materials and equipment.
 - b. Construction: Framing with reinforced polyethylene and plywood sheet materials with closed joints and scaled edges at intersections with existing surfaces.

14. SECURITY

A. Security Program:

- a. Protect new Work and existing premises from theft, vandalism, and unauthorized entry.

B. Entry Control.

- a. Restrict entrance of persons and vehicles into Project site and existing facilities.
- b. Allow entrance only to authorized persons with proper identification.
- c. Maintain log of workers and visitors, make available to Department on request.
- d. Coordinate access of Department personnel to site in coordination with Department security forces.

C. Personnel Identification

- a. Maintain list of accredited persons, submit copy to Department on request.
- b. A driver's license or other acceptable positive identification will be required.

15. DUST CONTROL

- A. Execute Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.
- C. After completion of work, clean all interior work surfaces.

16. POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.
- B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

17. RODENT CONTROL

- A. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

18. REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.

SECTION 6 – TEMPORARY FACILITIES AND CONTROLS

1. REQUISITION FOR PAYMENT

- A. Submit one copy of each application on the AIA Application and Certificate for Payment G702 and Continuation sheet G703 or another document/form that has been previously approved by the Department.
- B. Content and Format: Items on the Requisition for Payment shall be consistent with the items on the Proposal Form. Utilize the Schedule of Values as documentation for payment items.
- C. Submit updated construction schedule with each Requisition for Payment.
- D. Payment Period: Submit at intervals stipulated in the General Conditions.
- E. Submit with transmittal letter to the attention of the project Architect/Engineer for review and approval.
- F. Substantiating Data: When the Department requires substantiating information, submit data justifying dollar amounts in question.

2. SCHEDULE OF VALUES

- A. Submit printed schedule on AIA Form G703 - Continuation Sheet for G702 or approved equal. (See item 1.A above)
- B. Submit Schedule of Values within 15 days after date of issuance of Notice to Proceed. Failure to submit within specified time period will constitute Default of Contract.
- C. Format: Utilize Table of Contents of these specifications. Identify each line item with number and title of major specification section. Identify bonds, insurance, general conditions, allowances etc.
- D. Include a separate line item for closeout to include record drawings, owner's manuals and other pertinent information due to the Department.
- E. Include a separate line item for the amount of each Allowance and Alternates specified in this section. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by unit cost to achieve total for each item.
- F. Revise schedule to list approved Change Orders, with each Requisition or Payment.

3. UNIT PRICES

- A. Authority: Measurement methods are delineated in individual specification sections.
- B. Measurement methods delineated in individual specification sections complement criteria of this section. In event of conflict, requirements of individual specification section govern,
- C. Take measurements and compute quantities. Architect/Unit Quantities: Quantities and measurements indicated in Bid Form are for contract purposes only. Quantities and measurements supplied or placed in the Work shall determine payment
 - a. When actual Work requires more or fewer quantities than those quantities indicated, provide required quantities at unit sum/prices contracted.

- D. Payment Includes: Full compensation for required labor, products, tools, equipment, plant and facilities, transportation, services, and incidentals; erection, application or installation of item of the Work; overhead and profit,
- E. Final payment for Work governed by unit prices will be made on basis of actual measurements and quantities accepted by Architect/Engineer multiplied by unit sum/price for Work incorporated in or made necessary by the Work.
- F. Measurement of Quantities: Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
- G. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.
- H. Measurement by Area: Measured by square dimension using mean length and width or radius.
- I. Linear Measurement: Measured by linear dimension, at item centerline or mean chord.
- J. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.

4. CHANGE PROCEDURES

- A. Submittals: Submit name of individual authorized to receive change documents and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- B. The Department will advise of minor changes in the Work not involving adjustment to Contract Sum/Price or Contract Time, or that may be necessary to carry out the work included in the Contract, by issuing Supplemental Instructions.
- C. The Department may issue a Proposal Request including a detailed description of proposed changes with supplementary or revised Drawings and specifications, with or without a change in Contract Time for executing the change. The Contractor will prepare and submit estimate within ten days.
- D. Contractor may propose changes by submitting a request for change(s) to the Department, describing proposed change and its full effect on the Work. Each request shall be a separate item and sequentially numbered. Include a statement describing reason for the change, and effect on Contract Sum/Price and Contract Time with full documentation and a statement describing effect on Work by separate or other Contractors.
- E. Stipulated Sum/Price Change Order: Based on Proposal Request and Contractor's fixed price quotation or Contractor's request for Change Order as approved by the Department. Submit the breakdown of the following items on a Department Change Order Form for review and approval by the Department:
 - a. The Contractor shall include the following indirect costs for work performed by the General Contractor as part of the Contractors' price:
 - i. Worker's Compensation and Employee Liability.

- ii. Unemployment and Social Security Taxes.
 - b. In addition to the above indirect costs the General Contractor shall be allowed the following markups:
 - i. Twenty percent (20%). Said twenty percent (20%) shall be all inclusive for overhead, supervision, and profit for Work performed by the General Contractor.
 - ii. Ten percent (10%) on that part of work performed by all Subcontractors.
 - c. On any change that involves a net credit to the State, no allowance for overhead, supervision and profit shall be figured.
 - d. Contractor shall provide back-up information for all change order pricing.
 - e. Extension of Contract Time: State any requests for extension of Contract Time with justification for such a request.
- F. Unit Price Change Order: For contract unit prices and quantities, the Change Order will be executed on fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute Work under Construction Change Directive. Changes in Contract Sum/Price or Contract Time will be computed as specified for Time and Material Change Order.
- G. Construction Change Directive: The Department may issue a directive instructing the Contractor to proceed with changes in the Work, for subsequent inclusion in a Change Order. Document will describe changes in the Work, and designate method of determining any change in Contract Sum/Price or Contract Time. Promptly execute change. Failure to comply will result in Default of Contract.
- H. Time and Material Change Order: Submit itemized account and supporting data within 10 days of completion of change. The Department will determine change allowable in Contract Sum/Price and Contract Time as provided in Contract Documents.
- a. Maintain detailed records of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.
- I. Execution of Change Orders: The Contractor is responsible for preparing and updating a spreadsheet log itemizing all Proposed Changes. A separate spreadsheet shall be completed for each Allowance Item. The spreadsheet shall include columns for Proposed Change Number, Description, Amount of Change, Status, and Approved Amounts. In addition, a current balance remaining shall be included. Change Orders will be processed per the following procedures:
- a. The Department reviews cost for Change in Work. If needed the Department will request additional items, back-up information, and request any possible changes or clarifications.
 - b. Contractor can proceed with Change Order Work with direction from

- the Department.
- c. Contractor shall not proceed with any work that will exceed the amount of Allowance remaining.
- d. Fully signed and executed Change Order is issued by the Department to the Consultant and Contractor.
- J. Correlation Of Contractor Submittals:
 - a. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line item and adjust Contract Sum/Price.
 - b. Promptly revise progress schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
 - c. Promptly enter changes in Project Record Documents.

5. DEFECT ASSESSMENT

- A. Any work or materials found to be defective or not in compliance with the plans and specifications in the determination of the Department shall be handled in the following manner.
- B. Replace the Work, or portions of the Work, not conforming to specified requirements.
- C. If, in the opinion of the Department, it is not practical to remove and replace the Work, the Department will direct appropriate remedy or adjust payment.
- D. The defective Work may remain, but unit sum/price will be adjusted to new sum/price at discretion of the Department.
- E. Defective Work will be repaired to instructions of and acceptance by the Department and unit sum/price will be adjusted to new sum/price at discretion of the Department.
- F. Authority of the Department to assess defects and identify payment adjustments, is final.
- G. Non-Payment For Rejected Products: Payment will not be made for rejected products for any of the following:
 - a. Products wasted or disposed of in a manner that is not acceptable.
 - b. Products determined as unacceptable before or after placement.
 - c. Products not completely unloaded from transporting vehicle.
 - d. Products placed beyond lines and levels of required Work.
 - e. Products remaining on hand after completion of the Work.
 - f. Loading, hauling, and disposing of rejected products.

6. ALTERNATES

- A. Alternates quoted on Proposal Forms will be reviewed and accepted or rejected at the Department's discretion. Accepted Alternates will be identified in the Department - Contractor Agreement.
- B. Coordinate related work and modify surrounding work.

7. ALLOWANCES

- A. Allowances: If included in the Contract, a stipulated amount of funding for use only upon the Department's instruction. An allowance will make money available for modifications and/or additions to contract items due to owner initiated changes, unforeseen conditions, for unknown, latent or differing existing conditions, for testing of hazardous materials or for the removal of hazardous materials, asbestos, lead, mercury, sealant etc. that are encountered by construction
- B. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from an Allowance. The cost of the bond for the amount of Allowance shall be included as part of the lump sum base bid.
- C. Funds will be drawn from an Allowance only by Change Order. Contractor can proceed with Change Order Work against Allowance with direction from the Department. The Contractor shall not proceed with any work that will exceed the amount of Allowance remaining.
- D. Notwithstanding the Contractor's objection, the Department may at any time reduce the funds remaining in the Allowance by Change Order.
- E. At Final Payment of the Contract, funds remaining in the Allowance will be credited to the Department.

8. TESTING AND INSPECTION

- A. Testing and Inspecting: Cost to engage testing and inspecting agency; execution of tests and inspecting; and reporting results are to be paid by the Contractor.
- B. Testing as required by plan and specification shall be performed by an independent certified testing agency that may not be a subsidiary or employee of the Contractor.
- C. Contractor shall make all testing information readily available to the Department for review before proceeding to the next phase of any such tested work.

**STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS AND VETERANS SERVICES**

**EXHIBIT B – APPENDIX 1
Project Manual**

SUBJECT: Center Strafford MEP Upgrades

STATEMENT OF UNDERSTANDING

By initialing and dating the following pages, The Contractor clearly understands the following Center Strafford MEP Upgrades - Project Manual (Pages 1-178) and will meet all requirements specified herein.

Initials: 

Date: 7/22/26

Project Manual

Center Strafford Site MEP Upgrades New Hampshire Army National Guard

State of New Hampshire Department of Military affairs and
Veterans Services

March 23, 2026



**Tighe &
Bond**

Initial: _____
Date: _____

**Center Strafford Energy Upgrades
Department of Military Affairs and Veteran Services
Center Strafford, New Hampshire**

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DIVISION 23 - MECHANICAL

SECTION 230000

HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of HVAC system(s), quality expectations, materials and general requirements.

1.2 SYSTEM(S) DESCRIPTION

- A. HVAC systems of this contract shall include:
 - 1. Furnish and install new natural gas fired boilers.
 - 2. Furnish and install new hot water system pumps.
 - 3. Hot water piping and specialties.
 - 4. Thermal insulation for all systems.
 - 5. Testing and adjusting of all systems.
 - 6. General Conditions of the contract.
 - 7. Control systems and specialties.
 - 8. Miscellaneous itemized.
 - 9. Secure all required permits.

1.3 RELATED DIVISIONS AND SECTIONS

- A. DIVISION 00 - General
- B. DIVISION 01 - General Requirements
- C. DIVISION 07 - Thermal and Moisture Protection
- D. DIVISION 21 - Fire Suppression
- E. DIVISION 22 - Plumbing
- F. DIVISION 25 - Integrated Automation
- G. DIVISION 26 - Electrical

1.4 REFERENCES

- A. 2021 International Building Code with NH amendments
- B. 2021 NFPA 101, Life Safety Code with NH amendments
- C. New Hampshire State Fire Code Saf-C6000
- D. 2021 NFPA 1, Fire Prevention Code with NH amendments
- E. UFC 3-600-01 Fire Protection Engineering for Facilities

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230000-1

Heating, Ventilation and
Air Conditioning (HVAC)

- F. 2021 International Plumbing Code with NH amendments
- G. 2021 International Mechanical Code with NH amendments
- H. 2018 International Energy Conservation Code with NH amendments
- I. 2009 ASHRAE Standard 189.1 (referenced in NH State high Performance Building Code)
- J. 2020 NFPA 70, National Electric Code with NH amendments
- K. New Hampshire Bureau of Public Works Design Guidelines
- L. City of Concord, New Hampshire ordinances, rules and regulations
- M. Concord Fire Department rules and regulations
- N. All applicable ASTM Standards
- O. NHARNG Rules and Regulations

1.5 SUBMITTALS

- A. See Section 01330 - Submittal Procedures, for Submittal Requirements.
- B. Ordering of equipment and materials for installation shall not proceed without an approved submittal.

END OF SECTION

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Center Stafford Electrical\Specifications\Div 23\230000 Heating, Ventilation and Air Conditioning
(HVAC).docx

SECTION 230100

OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 GENERAL

1.1 GENERAL CONDITIONS

- A. Provide all items, articles, materials, operations, or methods listed, mentioned, scheduled on the drawings and/or specified herein including all labor, materials, equipment and incidentals necessary and required for completion of this contract.

1.2 INTENT

- A. The intent of the specifications and drawings is to call for finish work, tested and ready for operation.
- B. Any apparatus, appliance, material or service not specified or indicated, but necessary to make the work complete and perfect in all respects and ready for operation shall be provided.
- C. The drawings are generally diagrammatic, intended to convey the scope of work and indicate the general arrangement of equipment and piping, plus approximate size and locations of equipment.

1.3 WORKMANSHIP

- A. All work shall be executed in the best and most thorough manner under the direction of, and to the satisfaction of, the Owner's representative.
- B. This contractor shall, at all times, keep a competent foreman in charge of the work and shall facilitate inspection of installations by the Owner's representative.

1.4 RULES, REGULATIONS, PERMITS AND FEES

- A. All work shall comply with applicable portions of all state or local laws, ordinances, rules and regulations, plus NHARNG construction standards.
- B. Nothing contained in these specifications or indicated on the drawings shall be construed to conflict with applicable portions of any laws, ordinances, rules and regulations.
 - 1. All required permits and fees relative to this Division shall be obtained and paid for by this contractor.

1.5 OPERATING AND MAINTENANCE MANUAL

- A. In accordance with DIVISION 01 - GENERAL REQUIREMENTS, manufacturer's printed operating and maintenance instructions for each piece of equipment furnished under DIVISION 23.
- B. Each manual shall be suitably and neatly marked to identify the particular equipment furnished and shall include lubricating charts.

- C. All instructions and charts shall be bound in appropriate cover binders properly indexed, identified, and titled to provide three (3) complete manuals.
- D. Completed manuals shall be submitted for review. After approval, the manuals shall become property of the Owner.

1.6 OWNER INSTRUCTION

- A. This contractor and suppliers, if necessary, shall thoroughly instruct the Owner's representative and maintenance personnel in the proper maintenance and operation of materials and systems installed under this Division, as follows:
 - 1. Detailed written instructions shall be provided for all mechanical systems, including but not limited to:
 - a. Winter shut-down, spring start-up of systems, if applicable.
 - b. Heating fuel conversion, if applicable.
 - c. All other operations that, if improperly performed, might endanger the building's occupants or damage the building's equipment or contents.
 - 2. Sessions shall be held at the completed facility to instruct the Owner in the proper operation, cleaning, lubricating and maintenance of all mechanical systems, as well as water systems chemical treatment.

END OF SECTION

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SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 INTENT

- A. Furnish all labor and materials to complete the installation of the HVAC systems as shown on the drawings, specified herein, or both as follows:
 - 1. Furnish and install new Natural gas fired boilers.
 - 2. Furnish and install new hot water system pumps.
 - 3. Hot water piping and specialties.
 - 4. Thermal insulation for all systems.
 - 5. Testing and adjusting of all systems.
 - 6. General Conditions of the contract.
 - 7. Control systems and specialties.
 - 8. Miscellaneous itemized.
 - 9. Secure all required permits.

END OF SECTION

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SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

- A. Provide suitable and substantial hangers and supports for all horizontal and vertical lines as manufactured by B-Line, Allegheny Industrial, Tolco, ITT Grinnell, or approved equal.
- B. Support copper, steel, cast iron, and PVC piping in accordance with the pipe manufacturer's published instructions.
- C. Piping, ductwork and equipment shall not be hung from the work of other trades.
- D. Hang and support ductwork in accordance with SMACNA standards and best trade practices.
- E. For equipment mounted outside of the building, calculate forces developed by 30 psf wind loads for the attachment of supports.
- F. Refer to specification section 230548 for vibration isolation and seismic restraint requirements.

PART 2 PRODUCT

2.1 SUBSTITUTIONS

- A. Materials shall be as specified herein, except consideration shall be given to other products that meet or exceed those specified if requested five (5) business days prior to the date of bid opening in accordance with Section 016000, Product Requirement.

2.2 MATERIAL

- A. Hangers shall be of heavy construction suitable for the size of pipe to be supported. All materials, except pipe rollers, shall be wrought or malleable iron or steel. Hangers shall be adjustable type.
- B. Hangers and pipe clamps used on copper piping shall be solid copper or copper plated. Where tube is in contact with dissimilar metal, protect with shield or plastic cover.
- C. The intention is to provide supports which in each case shall be amply strong and rigid for the load, but which shall not weaken or unduly stress the building construction.
- D. Hangers for pipes up to and including 4" shall be swivel ring, split ring, wrought pipe clamp, band, or adjustable wrought clevis type.
- E. Hangers for pipes above 4" shall be standard clevis or roller.
- F. Corrosion protection for vibration isolators for outdoor applications shall be as follows:

1. Hardware shall be cadmium or zinc plated, all other metal parts shall be hot dipped galvanized or zinc electroplated.
 2. All hangers shall be capable of withstanding three times the rated load without failure.
- G. Furnish and install shields and blocks to protect insulation and maintain thickness integrity at hanger rest points.

END OF SECTION

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Center Stafford Electrical\Specifications\Div 23\230529 Hangers and Supports for HVAC Piping and
Equipment.docx

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART I GENERAL

1.1 SCOPE

- A. Identification shall be provided on all piping that is exposed, as well as at all concealed locations such as shafts and above removable ceilings in which piping may be viewed.
 - 1. Furnish and affix approved adhesive bands/markers identifying the service and direction of flow of the various piping systems.
 - 2. A set of such bands/markers shall be affixed to each pipe not less than 30' and there shall be at least one set of identifying bands/markers in every room where piping may be viewed.
 - 3. Each set shall consist of one band/marker on which the name of the service is printed and one band/marker on which is printed a black directional arrow.
- B. Identification bands/markers shall have adhesive backing. Submit same for approval.
 - 1. The name of the service shall be printed with the lettering not to be less than 1 1/4" high for 3" pipe and larger; 3/4" high for pipe 2 1/2" and smaller.
 - 2. Bands/markers shall be applied where they can be read with their long dimension parallel to the axis of the pipe or duct. Bands/markers shall be applied only after finish painting is completed.
 - 3. Bands/markers shall be applied only after finish painting is complete.
 - 4. Identification bands/markers shall conform to ASME/ANSI A13.1 2013 and ANSI Z 535.1 established standards for color.
 - 5. All existing pipe services currently void of identification that fall within the contract area shall be labeled as part of this contract. New labels shall be applied over existing insulation in cases where existing piping remains as is.
- C. Provide nameplates for all equipment, motor starters, push button stations, pilot light stations or control points, and any other points in the building deemed necessary by the Owner's representative.
 - 1. Nameplates shall be fabricated from black bakelite with white recessed letters permanently secured with screws.
 - 2. Nameplate schedule and sample shall be submitted for approval.
 - 3. Coordinate identification of exhaust fan switches provided by the Electrical Contractor.
- D. Provide permanent labels on all pieces of mechanical equipment designating the unit tag as it is shown on mechanical drawings.

- E. As part of the Owner Instruction session, review the location of valves, circulators, dampers and other specialties concealed above ceilings. Furnish and install adhesive dots on ceiling tiles (in the corner) for access reference.

<u>Dot Color</u>	<u>Service</u>
Red	Heating
Blue	Cooling
Green	Air-side specialty

PART 2 PRODUCT

2.1 SUBSTITUTIONS

- A. Materials shall be as specified herein, except consideration shall be given to other products that meet or exceed those specified if requested five (5) business days prior to the date of bid opening in accordance with Section 01600, Product Requirements.

2.2 MATERIAL

- A. Identification bands, tags, charts and dots shall be as manufactured by Seton, Carlton or Brimar.

END OF SECTION

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SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC GENERAL

PART 1 GENERAL

1.1 TESTING AND BALANCING

- A. Procure the service of an independent Testing and Balancing Agency that specializes in the testing and balancing of heating, ventilating and air conditioning systems.
- B. Work shall not begin until the agency has been notified in writing that all systems have been completed, cleaned and placed in full working sequence by this contractor. Clean filters shall be installed by this contractor prior to start of balancing work.
- C. Test, balance and adjust all air moving equipment, terminals, supply, return and exhaust systems. Work together with the ATC Contractor to adjust setpoints of outside/return/exhaust dampers where applicable.
- D. When all control systems and preliminary testing and balancing are complete, this contractor, with the cooperation of the ATC Contractor, shall perform an independent test of all systems for specified sequences of operation. Refer to DIVISION 25.
 - 1. The test shall include all operations as specified in DIVISION 25, "Sequences of Operation".
 - 2. All dampers, valves, and similar appurtenances shall be visually or physically confirmed to operate as specified. Operating and safety devices such as aquastats and frezestats shall be verified operational.
 - 3. All interlocks between equipment shall be confirmed to operate as specified.
 - 4. This contractor shall provide the ATC Contractor with operating setpoints as well as alarm setpoints such as dirty filters, high/low limits, etc., as required.
 - 5. Report findings per H. below.
- E. Perform all tests in accordance with standard procedures such as those outlined by the Associated Air Balance Council (AABC) and/or Sheet Metal and Air Conditioning Contractors National Association, Inc., (SMACNA).
- F. At completion of all testing and balancing, leave all equipment systems, components, etc., adjusted within the limits of installed equipment and to within 10% of design requirements. Mark all setpoints of all dampers and valves with distinguishing marks. If requested, conduct tests in the presence of the Owner's representative.
- G. Within 15 days after completion of testing and balancing, submit for review six (6) copies of the testing and balancing results on industry recognized forms. Include a warranty period of 90 days during which time the Owner's representative may request recheck or re-adjustment of any part of the job.
- H. All reports shall clearly indicate the following minimum information:
 - 1. Air - System name, rated and actual HP, BHP, motor nameplate efficiency, voltage, amperage, fan rpm, suction, discharge and total static pressures, total

system flow rate (system traverse), individual terminal flow rates. Terminal readings must show location, make, model and size of register, grille, or diffuser. Include a static pressure profile of all AHU's components.

2. ATC Sequence Check: Report shall include a paragraph-by-paragraph review of the sequence of controls specification, noting either "operates as specified", or detailing any deviations or deficiencies.
 - a. Should the HVAC systems be found incomplete or not performing per specification, the ATC Contractor shall correct deficiencies and the Testing and Balancing Subcontractor shall recheck until all sequences have been verified proper.

END OF SECTION

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SECTION 230713

DUCT INSULATION

PART 1 GENERAL

1.1 SCOPE

- A. Provide all insulating materials required for piping and mechanical equipment. The execution of the work shall be by an experienced Insulation Contractor in strict accordance with the best practice of the trade and the intent of the specifications.
- B. Insulation thermal properties and thickness shall comply with 2018 International Energy Conservation Code.

PART 2 PRODUCT

2.1 MATERIAL

- A. Insulation shall be as manufactured by Owens-Corning Fiberglass Corp., Knauf, Johns-Manville Co., or approved equal.
- B. Insulating materials, jackets, adhesives, accessories and applications shall develop a system having a UL rating with a flame spread of not over 25, a fuel contributed rating of not over 50 and a smoke developed rating of not over 50.
- C. Insulate all fresh air intake ductwork, ventilation and supply air ductwork, relief and exhaust fan plenums and ceiling or inline exhaust fan discharge ductwork to louvers and wallcaps, and air conditioning supply air ductwork concealed above ceiling or in chases externally with 1½" foil faced .75 PCF (R = 5.2) fiberglass insulation. Insulation shall be wrapped tightly on ductwork with all circumferential joints butted together and longitudinal joints overlapped 2". Staple longitudinal joints securely and foil tape all joints air tight.
- D. Where applicable, insulate outdoor (outside the building) ductwork with polyisocyanurate rigid insulation. Adhere to galvanized duct with chemically adhered perforated base pins. Ductwork flanges must be covered by notching insulation to form fit around each flange. After the board is installed, all joints must be sealed with a FSK tape. Insulation shall be jacketed with Alumguard 60 adhered product.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All external insulation systems on ductwork shall be applied in strict accordance with the insulation manufacturer's published instructions.
- B. The Mechanical Contractor shall furnish and install access doors in all acoustically lined ductwork for visual inspection and cleaning of liner.

END OF SECTION

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Center Stafford Electrical\Specifications\Div 23\230713 Duct Insulation.docx

SECTION 230923

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. DDC system for monitoring and controlling of HVAC systems of all buildings on site
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- B. Related Sections:
 - 1. Section 250000 - Integrated Automation: For overall building automation and control systems.
 - 2. Division 26 – Electrical

1.3 SYSTEM DESCRIPTION

- A. The NHARNG Strafford Campus central server, located in Cooper House, operates on the most recent N4 software. Contractor may use or replace existing infrastructure (fiber, network cabling, switches, etc...), however, if existing infrastructure is reused, the contractor shall fully test and warranty the infrastructure for the full warranty period. In no event shall change orders to repair, upgrade or modify the existing infrastructure be accepted.
- B. Scope: Furnish all labor, materials, and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Equipment replacement and/or upgrades will be limited to front end equipment. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over an open protocol bus (BACnet) or IP Network.
 - 1. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
 - 2. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, BACnet, LonTalk, KNX, and Modbus.
 - 3. System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.

4. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset. The use of configurable or programmable controllers that require additional software tools for initial/ post-installation maintenance shall not be acceptable.
 5. Any control vendor that requires supplemental additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
 6. The Jace Network Controller (JNC) for each building shall host all graphic files for the control system of its building. The system network controller shall host the graphic for the central map with campus one line diagram depicting all connected buildings. All graphics and navigation schemes for this project shall match those that are on the existing campus Niagara 4 Framework Concord, Building A server, unless a written request for changes is received from engineer.
 7. Owner shall receive all Administrator level logins and passwords for the engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
 8. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*" and "accept.wb.in=*" and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.
- C. All products of the BMS shall be provided with the following applicable agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable:
1. FIPS 140-2 Level 1 Conformance (Federal Information Processing Standard)
 2. Federal Communications Commission (FCC), Rules and Regulations, Volume II -July 1986 Part 15 Class A Radio Frequency Devices.
 3. FCC, Part 15, Subpart B, Class B.
 4. FCC, Part 15, Subpart C.
 5. FCC, Part 15, Subpart J, Class A Computing Devices.
 6. UL 504 - Industrial Control Equipment.
 7. UL 506 - Specialty Transformers.
 8. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces.
 9. UL 916 - Energy Management Systems All.
 10. UL 1449 - Transient Voltage Suppression.
 11. UL 1666 - Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts.

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12. EIA/ANSI 232-E - Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange.
 13. EIA 455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
 14. IEEE C62.41- Surge Voltages in Low-Voltage AC Power Circuits.
 15. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 16. NEMA 250 - Enclosures for Electrical Equipment.
 17. NEMA ICS 1 - Industrial Controls and Systems.
 18. NEMA ST 1 - Specialty Transformers.
 19. NCSBC Compliance, Energy: Performance of control system shall meet or surpass the requirements of ASHRAE/IESNA 90.1-1999.
- D. The new ATC work shall be achieved using BACnet/MSTP or BACnet/IP protocol and hardware. BACnet/IP protocol shall be the default system type. Utilization of BACnet/MSTP shall be at owner discretion.
 - E. The BMS shall consist of BACnet/MSTP protocol DDC controllers that may be written to, and read from the existing front end workstation or by directly connecting a laptop. Each controller shall provide sequences of operation independent of the central workstation and continue to function if the network is down.
 - F. The contractor shall be fully responsible for coordination of all details necessary for establishing the seamless integration between the new controller(s) and established BMS. New graphical interface screens shall be provided, as necessary, for all new work.
 - G. The Contractor is responsible for fully understanding the existing building controls system and associated intricacies to ensure that new work does not affect the operation of equipment remaining on the existing building control system. Adjustments to the existing system by this Contractor shall also include any work required to maintain current function of equipment not included in this contract.
 - H. All ATC work shall be in keeping with current NHARNG requirements and practices, including submittals, programming responsibilities, equipment, controllers, wiring methods, sequences of operation, input/output points and Owner instruction.

1.4 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. ATC: Automatic Temperature Controls Contractor
- D. BACnet Specific Definitions:

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1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 4. BACnet/MSTP: is a communication protocol that allows devices to communicate with each other over a low-speed, half-duplex RS-485 network. It uses a Master-Slave/Token-Passing scheme (now often referred to as a Client/Server scheme, which means that one device on the network acts as the master, controlling the flow of data between the other devices. Devices on the network are assigned unique addresses and communicate using packets of data called frames.
 5. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 6. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- E. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
 - F. BMS: Building HVAC controls Management system.
 - G. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
 - H. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
 - I. COV: Changes of value.
 - J. DDC: Direct Digital Control, is a computer-based system that uses sensors to monitor conditions and automatically control processes.
 - K. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
 - L. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication,

subsystems shall be capable of operating in a standalone mode using the last best available data.

- M. DOCSIS: Data-Over Cable Service Interface Specifications.
- N. Enterprise System: A system comprised of multiple buildings connected to one central server such as a College or Corporate Campus.
- O. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- P. GUI: Graphic User Interface.
- Q. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- R. IP: Internet Protocol
- S. JACE: JAVA Application Control Engine.
- T. JNC: JACE network controller.
- U. LAN: Local area network.
- V. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- W. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- X. Modbus: An open protocol for exchange of process data.
- Y. MS/TP: Master-slave/token-passing, IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- Z. MTBF: Mean time between failures.
- AA. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- BB. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- CC. NIC: Niagara Information and Conformance or Compatibility.
- DD. NiCS: Niagara Information and Conformance or Compatibility Statement.
- EE. NPICU: Niagara embedded Programmable IP Control Unit CIPer Model 30.
- FF. Peer to Peer: Networking architecture that treats all network stations as equal partners.

- GG. PICU: Programmable IP Control Unit
- HH. POT: Portable operator's terminal.
- II. PUE: Performance usage effectiveness.
- JJ. RAM: Random access memory.
- KK. RF: Radio frequency.
- LL. Router: Device connecting two or more networks at network layer.
- MM. Server: Computer used to maintain system configuration, historical and programming database.
- NN. SNC: System Network Controller
- OO. TCP/IP: Transport control protocol/Internet protocol.
- PP. UPS: Uninterruptible power supply.
- QQ. USB: Universal Serial Bus.
- RR. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- SS. VAV: Variable air volume.
- TT. WLED: White light emitting diode.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at the NHARNG Center Strafford Campus prior to any installation but after acceptance of submittals. Attendees shall include the General Contractor/Construction Manager, Architect, Engineer, Mechanical Contractor, Testing, Adjusting, and Balancing Contractor, any affected sub-contractors, and Owner or Owner's Representative.

1.6 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 3. Product description with complete technical data, performance curves, and product specification sheets.
 4. Installation, operation and maintenance instructions including factors effecting performance.
 5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - a. Workstations.
 - b. Servers.
 - c. Gateways.
 - d. Routers.
 - e. Protocol analyzers.
 - f. DDC controllers.
 - g. Enclosures.
 - h. Electrical power devices.
 - i. UPS units.
 - j. Accessories.
 - k. Instruments.
 - l. Control dampers and actuators.
 6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.
- C. Software Submittal:
1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
 2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
 3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.

4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:
 - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
 - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
 - c. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
 - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.

- e. Network communication cable and raceway routing.
 - f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
6. Schematic drawings for each controlled HVAC system indicating the following:
- a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to HVAC system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Narrative sequence of operation.
 - h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.
8. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
 - b. Interconnection of each different network in DDC system.
 - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.

- d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
- 9. DDC system electrical power riser diagram indicating the following:
 - a. Each point of connection to field power with requirements (volts / phase / hertz / amperes / connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts / phase / hertz / amperes / connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
- 10. Monitoring and control signal diagrams indicating the following:
 - a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
 - c. Control signal tubing to sensors, switches and transmitters.
 - d. Process signal tubing to sensors, switches and transmitters.
- 11. Color graphics indicating the following:
 - a. Itemized list of color graphic displays to be provided.
 - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
 - c. Intended operator access between related hierarchical display screens.
- E. Provide Validation Test Report. See Part 3 Execution for report requirements.
- F. System Description:
 - 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
 - 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
 - 3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outpoints.
 - d. Operator workstation failure.
 - e. Server failure.

- f. Gateway failure.
- g. Network failure
- h. Controller failure.
- i. Instrument failure.
- j. Control damper actuator failure.
- 4. Complete bibliography of documentation and media to be delivered to Owner.
- 5. Description of testing plans and procedures.
- 6. Description of Owner training.
- G. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- H. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

- 1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Product installation location shown in relationship to room, duct, pipe and equipment.
 - b. Structural members to which products will be attached.
 - c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
 - d. Size and location of wall access panels for products installed behind walls and requiring access.
- 2. Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Ceiling components.
 - b. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
 - c. Items penetrating finished ceiling including the following:
 - 1) Lighting fixtures.
 - 2) Air outlets and inlets.
 - 3) Speakers.
 - 4) Sprinklers.

- 5) Access panels.
- 6) Motion sensors.
- 7) Pressure sensors.
- 8) Temperature sensors and other DDC control system instruments.

B. Qualification Data:

1. Systems Provider Qualification Data:

- a. Resume of project manager assigned to Project.
- b. Resumes of application engineering staff assigned to Project.
- c. Resumes of installation and programming technicians assigned to Project.
- d. Resumes of service technicians assigned to Project.
- e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
- f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
- h. Owner contact information for past project including name, phone number, and e-mail address.
- i. Contractor contact information for past project including name, phone number, and e-mail address.

2. Manufacturer's qualification data.

3. Testing agency's qualifications data.

C. Product Certificates:

- 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with BACnet.

D. Product Test Reports: For each product that requires testing to be performed by manufacturer.

E. Preconstruction Test Reports: For each separate test performed.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For manufacturer's warranty.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
- b. Testing and startup reports and checklists of completed final versions of reports, checklists, and trend logs.
- c. As-built versions of submittal Product Data.
- d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
- e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
- f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
- g. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on electronic media such as USB thumb drives.
- j. List of recommended spare parts with part numbers and suppliers.
- k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- m. Licenses, guarantees, and warranty documents.
- n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

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- o. Owner training materials.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.
- D. If the following equipment listed below is installed, furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. Room Carbon Dioxide Sensor and Transmitter: One.
 - 2. Room Temperature Sensor and Transmitter: One.
 - 3. General-Purpose Relay: One.
 - 4. Transformer: One.
 - 5. DC Power Supply: One.
 - 6. Supply of 20 percent spare optical fiber cable splice organizer cabinets for several re-terminations.

1.10 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
 - 1. Nationally recognized manufacturer of DDC systems and products.
 - 2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
 - 3. DDC systems and products that have been successfully tested and in use on at least five past projects.
 - 4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
 - 5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing and quality control.
 - d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
 - e. Owner operator training.
- B. DDC System Provider Qualifications:

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1. Authorized representative of, and trained by, DDC system manufacturer.
 2. In-place facility located within 100 miles of Project.
 3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
 4. Demonstrated past experience on five projects of similar complexity, scope and value.
 5. Each person assigned to Project shall have demonstrated past experience.
 6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
 7. Service and maintenance staff assigned to support Project during warranty period.
 8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
 9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.
- C. Testing Agency Qualifications: Member company of NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- D. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative or installer for the primary DDC components manufacturer for at least 5 years. All control panels shall be provided as assemblies by the Control System Contractor produced in a UL- Certified 508A panel shop.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
 - a. Install updates only after receiving Owner's written authorization.
 3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.

4. Warranty Period: Two year(s) from date of Substantial Completion.

a. For Gateway: Two-year parts and labor warranty for each.

PART 2 PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

- A. Honeywell Building Solutions; WEBs-N4 - Tridium Niagara N4 Platform.
- B. Schneider Electric; Ecostruxure Series Tridium Niagara N4.
- C. KMC Controls, Tridium Niagara N4.
- D. Johnson Controls, Inc. (JCI), Facility Explorer Tridium Niagara N4.
- E. Siemens Talon, Tridium Niagara 4.
- F. Distech, Tridium Niagara 4.

2.2 DDC SYSTEM DESCRIPTION

- A. General:
 - 1. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.
 - 2. The installed system shall provide Multi-level secure password access to all software features, functions and data contained in the overall BMS.
 - 3. All controllers installed in the BMS shall be manufactured by an IEC 62443-4-1 Certified Development Organization.
 - a. This ensures the system is manufactured to an ISASecure SDLA (Secure Development Life-cycle Assurance) compliance for industrial automation and control systems and reduces cybersecurity risk.
 - b. <https://isasecure.org/end-users/iec-62443-4-1-certified-development-organizations>
- B. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 - 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Products that are obsolete or are in the process of being phased out by the manufacturer are not acceptable. Confirm prior to submittal that all products submitted on are the

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most current product available and are not scheduled to be phased out. If at any time, through the end of the warranty period it is discovered that the products provided were listed on a publication at the time of the submittal indicating that the products were obsolete or in the process of being phased out, the installing Contractor shall replace them at no additional cost. Other system modifications required to integrate the replaced equipment shall also be provided at no additional cost. The warranty period for all replaced equipment shall start when the new equipment is fully installed and operational.

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system including Analytics for BMS fault detection and diagnostics, including sub-system alarm suppression as described in ASHRAE Guideline 36-2021.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, in new construction shall be via Ethernet or IP. BACnet MS/TP connection shall be acceptable in retrofit/ upfit projects of devices where IP is not an available option.
- C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside:
 1. On Premise in the Operating System Server located in the Facilities Office on the LAN
 2. Off Premise in a Microsoft Azure cloud supported framework dashboard.
 3. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the Owner's internal Intranet network. Systems employing a "flat" single-tiered architecture shall not be acceptable.
 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

- F. BMS Manufacturer to guarantee Niagara OS version released is fully tested and supported on their controllers using a documented Software Inter-operability Testing plan and present if requested. This shall guarantee end-user is purchasing a system which is fully supported and warranted by manufacturer.

2.4 WEB ACCESS

- A. DDC system shall be Web based.
 - 1. Web-Based Access to DDC System:
 - a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet[through Owner's LAN].
 - b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - c. Web access shall be password protected.

2.5 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. DDC System Speed:
 - 1. Response Time of Connected I/O:
 - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 - d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 - 2. Display of Connected I/O:

- a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
 - b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
 - c. Alarms of analog and digital points connected to DDC system shall be displayed within 30 seconds of activation or change of state.
 - d. Graphic display refresh shall update within eight seconds.
 - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- C. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- D. DDC System Data Storage:
1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
 2. Local Storage:
 - a. Provide server with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
- E. DDC Data Access:
1. When logged into the system, operator shall be able to also interact with any DDC controller connected to the DDC system as required for functional operation of DDC system.
 2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
- F. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
 2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
 3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- G. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with this requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3
 - b. Outdoors, Unprotected: Type 4X
 - c. Indoors, Heated with Filtered Ventilation: Type 2
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 12
 - e. Indoors, Heated and Air Conditioned: Type 1
 - f. Mechanical Equipment Rooms:
 - 1) Chiller and Boiler Rooms: Type 4X
 - 2) Air-Moving Equipment Rooms: Type 12
 - g. Localized Areas Exposed to Washdown: Type 4X
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X
 - j. Hazardous Locations: Explosion-proof rating for condition.

H. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled, and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent

requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

- a. Outdoors, Protected: Type 3
- b. Outdoors, Unprotected: Type 4X
- c. Indoors, Heated with Filtered Ventilation: Type 2
- d. Indoors, Heated with Non-Filtered Ventilation: Type 12
- e. Indoors, Heated and Air Conditioned: Type 1
- f. Mechanical Equipment Rooms:
 - 1) Chiller and Boiler Rooms: Type 4X
 - 2) Air-Moving Equipment Rooms: Type 12
- g. Localized Areas Exposed to Washdown: Type 4X
- h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 3
- i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X
- j. Hazardous Locations: Explosion-proof rating for condition.

I. DDC System Reliability:

- 1. Insert Final Vendor Response: Design, install and configure DDC controllers, gateways, and routers to yield a MTBF of at least 20,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
- 2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
- 3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

J. Electric Power Quality:

- 1. Power-Line Surges:
 - a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
 - b. Do not use fuses for surge protection.
 - c. Test protection in the normal mode and in the common mode, using the following two waveforms:

- 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.
 2. Power Conditioning:
 - a. Protect susceptible system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
 - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.
 3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.
- K. Backup Power Source:
1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- L. UPS:
1. DDC system products powered by UPS units shall include the following:
 - a. Servers.
- M. Continuity of Operation after Electric Power Interruption:
1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.6 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:

- a. Desktop and portable workstation with hardwired connection through LAN port.
 - b. Portable operator terminal with hardwired connection through LAN port.
 - c. Portable operator workstation with wireless connection through LAN router.
 - d. Mobile device and application with secured wireless connection through LAN router or cellular data service.
 - e. Remote connection through web access.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations where applicable:
- 1. Each mechanical equipment room.
 - 2. Each boiler room.
 - 3. Each chiller room or outdoor chiller yard.
 - 4. Each cooling tower location.
 - 5. Each different roof level with roof-mounted air-handling units or rooftop units.
- D. Desktop Workstations:
- 1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 - 2. Able to communicate with any device located on any DDC system LAN.
- E. Critical Alarm Reporting:
- 1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
 - 2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
 - 3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.
- F. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.7 NETWORK COMMUNICATION PROTOCOL

- A. Commercial side network connection:
- 1. In addition to the internal network, owner's IT personnel will provide IP address information (IP address, subnet mask, gateway, etc) to connect each device to the

"commercial network". All configuration of commercial network connections will be by customer. Contractor will be responsible for all data drops.

- B. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.
- C. ASHRAE 135 (BACnet) Protocol:
 - 1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
 - 2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
 - 3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
 - 4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.8 SERVERS

- A. Provide new server to serve all new and existing DDC systems.
- B. The existing server specification to be provided by the Owner's IT department. Software shall be compatible with this existing hardware.
- C. Minimum Computer Configuration (Hardware Independent).
 - 1. Central Server. Owner shall provide a dedicated BMS server with configuration that includes the following components as a minimum:
 - 2. Processor: Intel Pentium Core 2 Duo, 2GHz.
 - 3. Memory: 6 GB minimum, 8 GB or more recommended for larger systems (if a 64-bit installation)
 - 4. Hard Drive: 4 GB minimum, more recommended depending on archiving requirements. 10 GB is recommended for any Supervisor
 - 5. RAM Memory: 2 GB, with 8 GB recommended is a 64-bit installation
 - 6. Network Support: Ethernet adapter 100 Mb or 1 GB NIC (network interface card) with TCP/IP support
 - 7. Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant
 - 8. Display: Video card and monitor capable of displaying 1024 x 768-pixel resolution, 1080p (1920 x 1080) minimum resolution recommended
 - 9. Network Support: Ethernet 100 Mb NIC (network interface card) with TCP/IP support.

10. Valid license.
11. Internet access for confirming license.

D. Supported Operating Systems

1. Windows 10 (64-bit)
2. Windows 11 (64-bit)
3. Windows Server 2016
4. Windows Server 2019
5. Red Hat Enterprise Linux 7, 8.x (64-bit)
6. VMware – ESXi 6,7

E. Supported Mobile Operating Systems: iOS 12, iOS 13, Android 8 Oreo, Android 9 Pie, Android 10.0

F. Supported Browsers: Chrome, Firefox, Microsoft Edge, Niagara Web Launcher

G. Supported Mobile Browsers: Safari on iOS, Chrome on Android

H. Supported Databases: MySQL Server 8.0; MS SQL 2016, 2017, 2019; Oracle (SQL) 12c, 18c, 19c

I. Memory: 6 GB minimum

2.9 LOCAL AREA NETWORKS (LAN)

- A. Furnish communication between control units over existing local area network (LAN).
- B. The existing network consists of Cat 5e cable or similar.
- C. Contact Owner to determine existing bandwidth at site. Coordinate with Owner if existing backbone is to be used or a separate LAN backbone should be provided.

2.10 ASHRAE 135 PROTOCOL ANALYZER

- A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.
- B. Analyzer shall include the following minimum capabilities:
 1. Capture and store to a file data traffic on all network levels.
 2. Measure bandwidth usage.
 3. Filtering options with ability to ignore select traffic.

2.11 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.

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- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
- F. Power and Noise Immunity:
 - 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- G. DDC Controller Spare Processing Capacity:
 - 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 50 percent.
 - c. Application-Specific Controllers: Not less than 50 percent.
 - 2. Memory shall support DDC controller's operating system and database and shall include the following:
 - a. Monitoring and control.
 - b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.
- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
 - 1. Network Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:

- 1) AIs: Three.
 - 2) AOs: Three.
 - 3) BIs: Five.
 - 4) BOs: Five.
2. Programmable Application Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: Three.
 - 2) AOs: Three.
 - 3) BIs: Five.
 - 4) BOs: Five.
 3. Application-Specific Controllers:
 - a. [10] percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: Two.
 - 2) AOs: Two.
 - 3) BIs: Two.
 - 4) BOs: Two.
- I. Maintenance and Support: Include the following features to facilitate maintenance and support:
1. Mount microprocessor components on circuit cards for ease of removal and replacement.
 2. Means to quickly and easily disconnect controller from network.
 3. Means to quickly and easily connect to field test equipment.
 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- J. Input and Output Point Interface:
1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
 2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
 3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.

4. AIs:
 - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
 - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection shall be provided for each AI.
 - e. Capable of being individually calibrated for zero and span.
 - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
 - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
 - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.
 - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:
 - a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
 - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
 - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
 - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:

- a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
 - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
- b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
- c. BOs shall be selectable for either normally open or normally closed operation.
- d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
- e. Limit use of three-point floating devices to VAV terminal unit control applications. Control algorithms shall operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.12 BMS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

- A. Niagara N4 Supervisor Software shall be installed on the owner's Network. BMS contractor to coordinate with owner IT Department.
- B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BMS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.
- C. The BMS server software shall support at least the following server platforms
 - 1. Operating System
 - a. Windows 10 (64-bit)
 - b. Windows 11 (64-bit)
 - c. Windows Server 2016
 - d. Windows Server 2019
 - e. Red Hat Enterprise Linux 7, 8.x (64-bit)
 - f. VMware – ESXi 6.7
- D. The BMS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

- E. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
1. Trending.
 2. Scheduling.
 3. Electrical demand limiting.
 4. Duty Cycling.
 5. Downloading Memory to field devices.
 6. Real time 'live' Graphic Programs.
 7. Tree Navigation.
 8. Parameter change of properties.
 9. Set point adjustments.
 10. Alarm / event information.
 11. Configuration of operators.
 12. Execution of global commands.
 13. Add, delete, and modify graphics and displayed data.
- F. Software Components: All software shall be the most current version. All software components of the BMS system software shall be provided and installed as part of this project. BMS software components shall include:
1. Server Software, Database and Web Browser Graphical User Interface.
 2. Three (3) Year Software Maintenance license. Labor to implement not included.
 3. Embedded System Configuration Utilities for future modifications to the system and controllers.
 4. Embedded Graphical Programming Tools.
 5. Embedded Direct Digital Control software.
 6. Embedded Application Software.
- G. BMS Server Database: Systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
- H. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.

2. Secure Socket Layers: Communication between the Web Browser GUI and BMS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).
- I. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework® shall satisfy the requirements of this section.
- J. Each Building JACE shall host all graphic files for the associated building control system. All campus one line graphics shall reside within the N4 Site Supervisor.
- K. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.

2.13 JACE NETWORK CONTROLLER (JNC) -9000

- A. These controllers are designed to manage communications between the Niagara embedded SNC, PICU, Programmable Plant Control Units (PPCU), Unitary IP Control Unit (UICU), and non-Niagara embedded Programmable IP Control Unit (NPICU), Advanced Unitary Controllers (AUC), Advanced VAV Controller (AVC), and BACnet Touchscreen Communication Thermostats (BCT) which are connected to its communications trunks or directly on the IP network, manage communications between itself and other JACE network controllers (JNC), SNCs, PICUs, PPCUs, UICUs, NPICUs, AUCs, AVCs, BCTs, and with any operator workstations (OWS) that are part of the BMS, whether the OWS is directly connected or connected via the Internet, and perform control and operating strategies for the system based on information from any controller connected to the BMS.
- B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control, including Analytic calculations.
- C. The JNC shall host all graphic files for the control system for its associated building.
- D. The communication protocols utilized for peer-to-peer communications between JNCs, SNCs, PICUs, PPCUs, and UICUs will be Niagara 4 FoxS, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between, JNCs, SNCs, PICUs, PPCUs, and UICUs is not allowed.
- E. The JNC shall employ a device count capacity license model that supports expansion capabilities.
- F. The JNC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
 1. BACnet
 2. Lon
 3. MODBUS
- G. The JNC shall be capable of executing application control programs to provide:

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1. Calendar functions.
 2. Scheduling.
 3. Trending.
 4. Alarm monitoring and routing.
 5. Time synchronization.
 6. Integration of LonWorks, BACnet, and MODBUS controller data.
 7. Network management functions for all JNC, SNC, PICU, PPCU, UICU, NPICU, AUC, AVC, and BCT based devices.
 8. Analytics for BMS fault detection and diagnostics, including sub-system alarm suppression as described in ASHRAE Guideline 36-2018.
- H. The JNC shall provide the following hardware features as a minimum:
1. Two 10/100/1000 Mbps Ethernet ports.
 2. Two Isolated RS-485 ports with biasing switches.
 3. 2 GB Low Power Double Data Rate RAM (LPDDR4).
 4. 8 GB Removable micro-SD card.
 5. i.MX 8M Plus, quad Arm Cortex-A53 processor, 1.2 GHz.
 6. Real-Time Clock Timekeeping
 7. Integrated 24 VAC/DC Global Power Supply
 8. Batteryless
 9. Secure boot
 10. -4 degrees to 140 degrees F Ambient Operating Temperature
 11. Integrated 24 VAC / DC Global Power Supply
- I. The JNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- J. The JNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- K. The JNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. Alarm.
 - b. Return to normal.
 - c. To default.

2. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text.
 - b. Email of complete alarm message to multiple recipients.
 - c. Graphics with flashing alarm object(s).
3. The following shall be recorded by the SNC for each alarm (at a minimum):
 - a. Time and date.
 - b. Equipment (air handler #, access way, etc.).
 - c. Acknowledge time, date, and user who issued acknowledgement.
- L. Programming software and all controller "Setup Wizards" shall be embedded into the JNC.
- M. The JNC shall support the following security functions.
 1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
 2. Role-Based Access Control (RBAC) for managing user roles and permissions.
 3. Require users to use strong credentials.
 4. Data in Motion and Sensitive Data at Rest be encrypted.
 5. LDAP and Kerberos integration of access management.
- N. The JNC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
 1. Metadata: Descriptive tags to define the structure of properties.
 2. Tagging: Process to apply metadata to components
 3. Tag Dictionary
- O. The JNC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PICU, PPCU, UICU, NPICU, AUC, AVC, BCT) shall have an associated template file for reuse on future project additions.
- P. The SNC shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

2.14 PROGRAMMABLE APPLICATION CONTROLLERS

- A. General Programmable Application Controller Requirements:
 1. Include adequate number of controllers to achieve performance indicated.
 2. Controller shall have enough memory to support its operating system, database, and programming requirements.

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3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.
2. The communication protocols utilized for peer-to-peer communications between PICU's will be BACnet TCP/IP or MS/TP. Use of a proprietary communication protocol for peer-to-peer communications between PICU's is not allowed.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.
2. Local Keypad and Display:
 - a. Equip controller with local keypad and digital display for interrogating and editing data.
 - b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.15 APPLICATION-SPECIFIC CONTROLLERS

- A. Description:** Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
1. Capable of standalone operation and shall continue to include control functions without being connected to network.
 2. Data shall be shared between networked controllers and other network devices.

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- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Serviceability:
 - 1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 - 2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - 3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.16 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
 - 1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
 - 2. I/O points shall be identified by up to 30 -character point name and up to 16 -character point descriptor. Same names shall be used at operator workstations.
 - 3. Control functions shall be executed within controllers using DDC algorithms.
 - 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 - 1. Operator access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
 - 3. Operator log-on and log-off attempts shall be recorded.
 - 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
 - 1. Weekly Schedule:
 - a. Include separate schedules for each day of week.
 - b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
 - c. Each schedule may consist of up to 10 events.

- d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
- 2. Exception Schedules:
 - a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
- 3. Holiday Schedules:
 - a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Schedules may be placed on scheduling calendar and will be repeated each year.
 - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
 - 1. Include standard application for proper coordination of equipment.
 - 2. Application shall include operator with a method of grouping together equipment based on function and location.
 - 3. Group may then be used for scheduling and other applications.
- E. Binary Alarms:
 - 1. Each binary point shall be set to alarm based on operator-specified state.
 - 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 - 1. Each analog object shall have both high and low alarm limits.
 - 2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
 - 1. Operator shall be able to determine action to be taken in event of an alarm.
 - 2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
 - 3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Electric Power Demand Limiting:
 - 1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.

2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:
 - a. Reset air-handling unit supply temperature set points.
 - b. Reset space temperature set points.
 - c. De-energize equipment based on priority.
4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum shutoff time for equipment.
 - e. Minimum shutoff time for equipment.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed and restore priority.
7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.
- I. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- K. Control Loops:
 1. Support any of the following control loops, as applicable to control required:

- a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
 - e. Adaptive (automatic tuning).
- L. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
- M. Energy Calculations:
- 1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 - 2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 - 3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- N. Anti-Short Cycling:
- 1. BO points shall be protected from short cycling.
 - 2. Feature shall allow minimum on-time and off-time to be selected.
- O. On and Off Control with Differential:
- 1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
 - 2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.
- P. Run-Time Totalization:
- 1. Include software to totalize run-times for all BI and BO points.
 - 2. A high run-time alarm shall be assigned, if required, by operator.

2.17 GRAPHICAL PROGRAMMING

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- A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.
- D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
 1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
 4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e., two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
 6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall

contain various editable and non-editable fields and shall contain 'push buttons' for the purpose of selecting default parameter settings.

8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
10. Live Graphical Programs: The Graphic Programming software shall support a 'live' mode, where all input/output data, calculated data and set points shall be displayed in a 'live' real-time mode.

2.18 ENCLOSURES

- A. General Enclosure Requirements: House each controller and associated control accessories in a single, or one or more adjacent enclosure(s). Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
- B. Coordinate size and quantity of all enclosures with available space. Verify location of all enclosures with Owner.
- C. Fabricate panels minimum 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged, locking doors. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
- D. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door
- E. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
- F. Include an insulated barrier between line-voltage and low-voltage electrical and electronic products.
- G. Terminate field cable and wire using heavy-duty terminal blocks
- H. Include spare terminals, equal to not less than 20 percent of used terminals.
- I. Include enclosure field power supply with a toggle-type switch with over-current protection located at entrance inside enclosure to disconnect power.
- J. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
- K. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch high lettering.

- L. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
- M. Size enclosure internal panel to include at least 25 percent spare area on face of panel.
- N. Enclosure NEMA type shall be suitable for ambient conditions encountered by application.
 - 1. Controllers used in conditioned ambient space shall be mounted in NEMA 1 enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.
 - 2. Controllers used in utility and mechanical rooms shall be mounted in NEMA 12 enclosures, and shall be rated for operation at 32°F to 122°F and 5 to 95% RH, non-condensing.
 - 3. Controllers used outdoors and/or in wet ambient conditions shall be mounted within NEMA 4 or 4X enclosures, and shall be rated for operation at -40°F to 140°F and 5 to 95% RH, non-condensing.
- O. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.
- P. Provide dedicated system power and alarm indicator lights separate from the touchscreen panel.

2.19 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
 - 1. Wire size shall meet manufacturer requirements.
 - 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
 - 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
 - 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
 - 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
 - 1. Wire size shall meet manufacturer requirements.
 - 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
 - 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
 - 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 - 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.

6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall meet manufacturer requirements.
 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be balanced twisted pair.
 2. Comply with the following requirements and for balanced twisted pair cable.
 - a. Cable shall be plenum rated.
 - b. Cable shall have a unique color that is different from other cables used on Project.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Verify conditioned power supply is available to control units and to operator workstation

3.2 CONTROL DEVICES FOR INSTALLATION BY HVAC CONTRACTOR

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- C. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- D. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Firestop penetrations made in fire-rated assemblies.
- F. Seal penetrations made in acoustically rated assemblies.
- G. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- H. Corrosive Environments:
 - 1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
 - a. Laboratory exhaust-air streams.
 - b. Process exhaust-air streams.
 - 2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 WORKSTATION INSTALLATION

- A. Desktop Workstations Installation:
 1. Install workstation(s) at location(s) directed by Owner.
 2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
 3. Install software on workstation(s) and verify software functions properly.
 4. Develop Project-specific graphics, trends, reports, logs and historical database.
 5. Power each workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.
- B. Portable Workstations Installation:
 1. Turn over portable workstations to Owner at Substantial Completion.
 2. Install software on workstation(s) and verify software functions properly.
- C. Color Graphics Application:
 1. Use system schematics indicated as starting point to create graphics.
 2. Develop Project-specific library of symbols for representing system equipment and products.
 3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
 4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Engineer's review before creating graphic using graphics software.
 5. Seek Owner input in graphics development once using graphics software.
 6. Final editing shall be done on-site with Owner's and Engineer's review and feedback.
 7. Refine graphics as necessary for Owner acceptance.
 8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.5 SERVER INSTALLATION

- A. Install server at location directed by Owner.
- B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed location in Shop Drawings.
- C. Install software indicated on server and verify that software functions properly.

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D. Develop Project-specific graphics, trends, reports, logs, and historical database.

E. Power servers through UPS unit. Locate UPS adjacent to server.

3.6 CONTROLLER INSTALLATION

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply and to UPS units where indicated.

C. Install controller with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.

2. Install controllers in a protected location that is easily accessible by operators.

3. Top of controller shall be within 72 inches of finished floor.

F. Installation of Programmable Application Controllers:

1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.

2. Install controllers in a protected location that is easily accessible by operators.

3. Top of controller shall be within 72 inches of finished floor.

G. Application-Specific Controllers:

1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.

2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.7 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.

2. Routers.

3. Controllers.

4. Electrical power devices.

5. UPS units.

6. Relays.

7. Accessories.

8. Instruments.
9. Actuators
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:
 1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
 2. For NEMA 250, Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
 3. Install plastic caps on exposed cut edges of strut.
- C. Align top or bottom of adjacent enclosures of like size.
- D. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

3.8 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.9 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

3.10 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.
- B. Wire and Cable Installation:
 1. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
 2. Terminate wiring in a junction box.

- a. Clamp cable over jacket in junction box.
- b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
3. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
4. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
5. Use shielded cable to transmitters.
6. Use shielded cable to temperature sensors.
7. Perform continuity and megger testing on wire and cable after installation.

3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Testing:
 1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
 2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
 5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
 6. Test Results: Record test results and submit copy of test results for Project record.

3.12 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. Control Damper Checkout:
 - 1. Verify that control dampers are installed correctly for flow direction.
 - 2. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 3. Verify that damper frame attachment is properly secured and sealed.
 - 4. Verify that damper actuator and linkage attachment is secure.
 - 5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 - 6. Verify that damper blade travel is unobstructed.
- F. Instrument Checkout:
 - 1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
 - 2. Verify that attachment is properly secured and sealed.
 - 3. Verify that conduit connections are properly secured and sealed.
 - 4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
 - 5. Inspect instrument tag against approved submittal.
 - 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
 - 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
 - 8. For temperature instruments:
 - a. Verify sensing element type and proper material.
 - b. Verify length and insertion.

3.13 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
 - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
 - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.

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- 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
- N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- O. Switches: Calibrate switches to make or break contact at set points indicated.
- P. Transmitters:
 - 1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
 - 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.14 DDC SYSTEM CONTROLLER CHECKOUT

- A. Verify power supply.
 - 1. Verify voltage, phase and hertz.
 - 2. Verify that protection from power surges is installed and functioning.
 - 3. Verify that ground fault protection is installed.
 - 4. If applicable, verify if connected to UPS unit.
 - 5. If applicable, verify if connected to a backup power source.
 - 6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

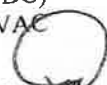
3.15 DDC CONTROLLER I/O CONTROL LOOP TESTS

- A. Testing:
 - 1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
 - 2. Test every I/O point throughout its full operating range.
 - 3. Test every control loop to verify operation is stable and accurate.
 - 4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
 - 5. Test and adjust every control loop for proper operation according to sequence of operation.

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6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.16 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 3. HVAC equipment motors operate below full-load amperage ratings.
 4. Required DDC system components, wiring, and accessories are installed.
 5. Installed DDC system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. DDC system network communications function properly, including uploading and downloading programming changes.
 9. Using BACnet protocol analyzer, verify that communications are error free.
 10. Each controller's programming is backed up.
 11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
 12. All I/O points are programmed into controllers.
 13. Testing, adjusting and balancing work affecting controls is complete.

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14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Meter, sensor and transmitter readings are accurate and calibrated.
17. Control loops are tuned for smooth and stable operation.
18. View trend data where applicable.
19. Each controller works properly in standalone mode.
20. Safety controls and devices function properly.
21. Interfaces with fire-alarm system function properly.
22. Electrical interlocks function properly.
23. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
24. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.

3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
 4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
 5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
 6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
 7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
- G. DDC System Response Time Test:
1. Simulate HLC.
 - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
 2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
 3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
 4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
 5. Passing test is contingent on the following:
 - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
 - b. All alarms, both binary and analog, are reported and printed; none are lost.
 - c. Compliance with response times specified.
 6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.17 FINAL REVIEW

- A. Submit written request to Engineer and Owner when DDC system is ready for final review. Written request shall state the following:
 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.
- B. Review by Engineer and Owner shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
 3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of 20 percent of I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O

points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.

- b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 percent of I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
- c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
- d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
- e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
- f. Trends, summaries, logs and reports set-up for Project.
- g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
- h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
- i. Software's ability to edit control programs off-line.
- j. Data entry to show Project-specific customizing capability including parameter changes.
- k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
- l. Execution of digital and analog commands in graphic mode.
- m. Spreadsheet and curve plot software and its integration with database.
- n. Online user guide and help functions.
- o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- p. System speed of response compared to requirements indicated.
- q. For Each Network and Programmable Application Controller:
 - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.

- 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
- 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.
- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
 - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
 - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.

- 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
 - a. Display of network device status.
 - b. Display of BACnet Object Information.
 - c. Silencing devices transmitting erroneous data.
 - d. Time synchronization.
 - e. Remote device re-initialization.
 - f. Backup and restore network device programming and master database(s).
 - g. Configuration management of routers.

3.18 ADJUSTING

- A. Occupancy Adjustments: When requested within 14 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.19 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.20 DEMONSTRATION

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- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide the extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide one four-hour initial training session of on-site orientation by a field engineer who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the control system software layout and naming conventions, and a walk through of the facility to identify panel and device locations.
 - b. Provide one follow up four-hour training session 6 months after the initial training indicated above.
 - c. All training shall occur before end of warranty period.
- C. Training Schedule:
 - 1. Schedule training with Owner 20 business days before expected Substantial Completion.
 - 2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
 - 3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
 - 4. Provide staggered training schedule as requested by Owner.
- D. Attendee Training Manuals:
 - 1. Provide each attendee with a color hard copy of all training materials and visual presentations.
 - 2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.

3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a flash drive with PDF copy of all hard-copy materials.

E. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

F. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

G. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.
3. Provide capability to remotely access to Project DDC system for use in training.
4. Operator Training: Operator training shall include the detailed review of the control installation drawings, points list, and equipment list. The instructor shall then walk through the building identifying the location of the control devices installed. For each type of systems, the instructor shall demonstrate how the system accomplishes the sequence of operation.
5. From the workstation, the operator shall demonstrate the software features of the system. As a minimum, the operator demonstrate and explain logging on, demonstrating point adjustments, required seasonal changes, setting up a schedule, trend, point history, alarm, and archiving the database.
6. Acceptance Check List:
 - a. An acceptance checklist shall be completed that documents compliance with each item of this Specification.
7. Testing Procedure:

- a. Upon completion of the installation, the Controls Contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. The Controls Contractor shall be responsible for generating all software and entering all database information necessary to perform the sequences of control herein specified.
- 8. Testing Documentation:
 - a. Prior to acceptance testing, the Controls Contractor shall create, on an individual system basis, trend logs of input and output points, or have an automatic Point History feature for documentation purposes.
- 9. Field Points Testing:
 - a. This step shall verify that all of the installed points receive or transmit the correct information prior to loading/activating the system software.
 - b. ON/OFF commands from the workstation shall be performed in order to verify each binary output point.
 - c. All binary input points are to be tested using the HAND/OFF/AUTOMATIC selector switch on the associated motor control center or by manually jumping across the field device contacts.
 - d. All analog output points shall be tested using a command from the workstation to modulate the output device from minimum calibrated signal to maximum calibrated output.
 - e. All analog input points are to be tested by comparing the reading obtained through the workstations or portable terminal to the value of an independent testing meter.
- H. Training Content for Daily Operators:
 - 1. Basic operation of system.
 - 2. Understanding DDC system architecture and configuration.
 - 3. Understanding each unique product type installed including performance and service requirements for each.
 - 4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
 - 5. Operating operator workstations, printers and other peripherals.
 - 6. Logging on and off system.
 - 7. Accessing graphics, reports and alarms.
 - 8. Adjusting and changing set points and time schedules.
 - 9. Recognizing DDC system malfunctions.
 - 10. Understanding content of operation and maintenance manuals including control drawings.

11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.

- d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
- e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
- f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
- g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

I. Training Content for Advanced Operators:

- 1. Making and changing workstation graphics.
- 2. Creating, deleting and modifying alarms including annunciation and routing.
- 3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
- 4. Creating, deleting and modifying reports.
- 5. Creating, deleting and modifying points.
- 6. Creating, deleting and modifying programming including ability to edit control programs off-line.
- 7. Creating, deleting and modifying system graphics and other types of displays.
- 8. Adding DDC controllers and other network communication devices such as gateways and routers.
- 9. Adding operator workstations.
- 10. Performing DDC system checkout and diagnostic procedures.
- 11. Performing DDC controllers operation and maintenance procedures.
- 12. Performing operator workstation operation and maintenance procedures.
- 13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
- 14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
- 15. Adjusting, calibrating and replacing DDC system components.

J. Training Content for System Managers and Administrators:

- 1. DDC system software maintenance and backups.
- 2. Uploading, downloading and off-line archiving of all DDC system software and databases.
- 3. Interface with Project-specific, third-party operator software.
- 4. Understanding password and security procedures.

5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

END OF SECTION

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SECTION 233100

HVAC DUCTS AND ACCESSORIES

PART 1 GENERAL

1.1 SCOPE

- A. Furnish and install all ductwork, grille boxes, plenum chambers, dampers, and all auxiliary work of any kind necessary to make the various air handling systems of the building complete and ready for satisfactory operating. All ductwork shall be constructed in accordance with SMACNA Standards for the applicable pressure classification.
- B. Ductwork shall be shipped to the site sealed with tape and plastic. Throughout construction, all open end supply/return air ductwork and terminals shall be sealed with tape and plastic until the building is free of dust. No air handling equipment shall be operated until the building is clean. Refer to Division 01.

1.2 SUBMITTALS

- A. Duct Cleaning Report:
 - 1. A full assessment report should include before and after photos of all HVAC components and sections of the ductwork associated with the RTU replacement, taken from the same vantage points.
 - 2. System areas found to be damaged or in need of repair.

PART 2 PRODUCT

2.1 SUBSTITUTIONS

- A. Materials shall be as specified herein, except consideration shall be given to other products that meet or exceed those specified if requested five (5) business days prior to the date of bid opening in accordance with Section 01600, Product Requirements.

2.2 MATERIAL

- A. Rectangular Low Pressure and Medium Pressure Ductwork:
 - 1. Ductwork, except where otherwise specified, shall be made of the best grade galvanized iron, constructed in accordance with the recommendations of the ASHRAE Guide, and SMACNA Guide, latest edition.
 - 2. Volume dampers shall be furnished and installed as shown or required for balancing the systems. Dampers operators shall be of the quadrant type provided with approved operating and locking device mounted outside the duct in accessible location. Install handles to indicate position of damper blades.
 - 3. Ductwork layouts as shown on the drawings shall be adhered to as closely as possible, however, the right is reserved to vary the runs and sizes of ductwork and to make offsets where necessary to accommodate conditions arising in the field.

4. Flexible connections shall be installed at the inlet and outlet of each fan and in main runs of ductwork where indicated. Flexible connections shall be 30 oz. glass cloth with neoprene coating on each face.
5. Seal all joints with a water based sealant, equal to DUCTMATE PROseal or approved equal, applied per manufacturer's recommendations. Joints shall be sealed to meet SMACNA Seal Class A.
6. Dimensions of acoustically lined ductwork shown on plans are inside dimensions of the duct after the lining has been installed.
7. Sheet metal angle closures shall be provided around all ductwork penetrating walls exposed to view.
8. Flat seam construction shall be employed where standing seam may present a hazard to personnel.
9. All exposed ductwork shall have a paintable finish and shall be field cleaned and prepared for final painting by others.

B. Spiral and Flat Oval Ductwork:

1. Spiral and flat oval ductwork shall be SMACNA recommended gauge, medium and low pressure uniseal duct and fittings as manufactured by United Sheet Metal or approved equal.
2. Duct shall be machine formed, made from standard gauge premium grade, coiled, galvanized sheet metal in a series of continuous automatic operations.
3. Duct shall be manufactured from galvanized steel meeting ASTM A-527-71 in manufacturer's gauges.
4. Fittings shall be die-stamped SMACNA recommended gauge galvanized steel, continuously welded seams.
5. Joints shall be slip coupling type sealed with DUCTMATE PROseal or equal. Low pressure ductwork shall be sealed to meet SMACNA Seal Class C - 2" w.g., and medium pressure Seal Class A - 4" w.g., as applicable.
6. All exposed ductwork shall have a paintable finish and shall be field cleaned and prepared for final painting by others.

C. Snap Lock Ductwork:

1. Longitudinal snap-lock galvanized ductwork (ASTM A653 and A924) with G-60 galvanized coating of SMACNA recommended gauge, equal to Ductmate Greenseam pipe, and associated fittings, including adjustable elbows and volume dampers, may be used for concealed low pressure (-1" w.g. to 2" w.g.) applications. Install one (1) mechanical fastener (screw) in longitudinal seam of each straight run. Spiral duct shall be used for all exposed and medium pressure applications.

D. Flex Duct:

1. Flexible duct shall be coated, fiberglass cloth fabric liner as manufactured by Buckley "Flexmaster Type 4", Thermaflex, Novaflex or equal, uninsulated for

ventilating applications (exhaust and return) and insulated for heating and cooling applications (supply).

E. Access Doors:

1. Access doors shall be provided no smaller than 12"x12" (if duct size permits) to completely access and functionally service equipment contained within the ductwork.
2. Access doors shall meet ASHRAE Standards criteria, and be equal to Ruskin model ADC22 for rectangular ductwork, or United McGill bolted access doors for spiral ductwork.
3. Access doors shall be installed in ductwork on upstream and downstream sides of all heating coils and as required to reset fire dampers.
4. Coordinate location of access doors with all trades to allow full door size access to interior of ductwork.

F. Fire Dampers:

1. Fire dampers shall be installed where shown and/or required by all applicable codes and regulations. Dampers shall be Type B, low leakage, out airstream type and meet UL 555 rating requirements for dynamic systems. All dynamic fire dampers installed in low pressure ductwork shall be rated for 2000 feet per minute and 4" w.g. static pressure as required by UL 555.

PART 3 EXECUTION

3.1 DUCT CLEANING

- A. Clean existing supply and return duct system associated with RTU-1 before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).

2. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
3. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris

END OF SECTION

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Center Stafford Electrical\Specifications\Div 23\233100 HVAC Duct and Accessories.docx

SECTION 237410

PACKAGED ROOFTOP AIR CONDITIONERS

PART 1 GENERAL

SCHEDULES FOR DECENTRALIZED HVAC EQUIPMENT

1.1 DECENTRALIZED UNITARY HVAC EQUIPMENT SCHEDULE:

A. Rooftop unit schedule:

1. Schedule is per the project specification requirements.

HVAC EQUIPMENT INSULATION

1.2 DECENTRALIZED, ROOFTOP UNITS:

A. Evaporator fan compartment:

1. Interior cabinet surfaces shall be insulated with a minimum 1/2-in. thick, minimum 1-1/2 lb density aluminum foil-faced insulation on the air side.
2. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
3. Unit internal insulation linings shall be resistant to mold growth in accordance with "mold growth and humidity" test in ASTM C1338, G21, and UL 181 or comparable test method. Air stream surfaces shall be evaluated in accordance with the "Erosion Test" in UL 181, as part of ASTM C1071.

B. Gas heat compartment:

1. Aluminum foil-faced fiberglass insulation shall be used.
2. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

1.3 SENSORS AND TRANSMITTERS:

A. Thermostats:

1. Thermostat must
 - a. energize both "W" and "G" when calling for heat.
 - b. have capability to energize 3 different stages of cooling, and 2 different stages of heating.
 - c. include capability for occupancy scheduling.

23 09 23 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

1.4 DECENTRALIZED, ROOFTOP UNITS:

A. SystemVu™ intelligent integrated Direct Digital Control (DDC) shall provide:

1. Integrated unit operation for comfort cooling, heating ventilation as well as all monitoring, recording and reporting capabilities. Controller shall also provide diagnostics and alarms of abnormal unit operation through the controller.

Controller shall have an intuitive user display and be able to be used in a standalone operation or via building automation system (BAS).

2. Quick Unit Status LEDs of: Run - meaning all systems are go, ALERT - that indicates there is currently a non-critical issue with the unit, like filters need to be replaced and FAULT - that indicates the unit has a critical issue and will possibly shut down.
3. Six large navigation keys for easy access. Navigation keys shall consist of: TEST, BACK, ENTER, and MENU along with UP and DOWN arrows.
4. Full back lit user display with 4 line by 30 character text capabilities. Display menu shall be designed to provide guided major menus and sub menus main menus provided below:
 - a. Shutdown Unit
 - b. Run Status
 - c. Settings
 - d. Alerts/Faults
 - e. Service
 - f. Inputs
 - g. Outputs
 - h. USB
5. The capability for standalone operation with conventional thermostat/sensor or use with building automation systems (BAS) of Carrier i-Vu®, BACnet¹ and Carrier Comfort Network® (CCN) systems. No special modules or boards are required for these capabilities.
6. The ability to read refrigerant pressures at display or via BAS network of; Discharge Pressure and Suction Pressure. The need for traditional refrigerant gages is not required.
7. USB Data Port for flash drive interaction. This will allow the transfer of data for uploads, downloads, perform software upgrades, back-up and restore data and file transfer data such as component number of starts and run hours.
8. Reverse Rotation Protection of compressors if field three phase wiring is misapplied.
9. Provide Service Capabilities of:
 - a. Auto run test
 - b. Manual run test
 - c. Component run hours and starts

¹ BACnet is a trademark of ASHRAE

- d. Commissioning reports
- e. Data logging
- f. Alarm history
- 10. Economizer control and diagnostics. Set up economizer operation, receive feedback from actuator. Also meets the most recent California Title 24 Fault Detection and Diagnostic (FDD) requirements.
- 11. Unit cooling operation down to 40°F (4°C)
- 12. Controller shall have easy access connections around the controller perimeter area and consist of Mate-N-Lok, terminal block and RJ style modular jack connections.
- 13. 365 day real time clock, 20 holiday schedules along with occupied and unoccupied scheduling.
- 14. Auto-Recognition for easy installation and commissioning of devices like economizers, space sensors, etc.
- 15. A 5°F temperature difference between cooling and heating set points to meet the latest ASHRAE 90.1- 2022 Energy Standard.
- 16. Contain return air sensor, supply air sensor and outdoor air sensor to help monitor and provide data for the unit comfort operation, diagnostic and alarms.
- 17. Use of Carrier's field accessory hand-held Navigator™ display.
- 18. Control of the operation of unit VFD (Variable Frequency Drive) or EC Motor to work in conjunction with the cooling, heating and ventilation modes.
- 19. Units with the factory-installed Humidi-MiZer® system option are capable of providing multiple modes of improved dehumidification as a variation of the normal cooling cycle.
- 20. Supply Air Tempering control operates the gas heat to maintain a minimum supply air temperature during conditions where very cold outdoor air causes the supply air temperature to fall below the configured Supply Air Tempering Setpoint. This occurs during periods where DCV is active and increasing the amount of outdoor air or in cases where the system is operating at very low airflow and the calculated economizer position has increased to maintain a constant ventilation rate.
- 21. 3-year limited part warranty

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

1.5 DECENTRALIZED, ROOFTOP UNITS:

A. General:

- 1. Shall be complete with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-v transformer side. Transformer shall have 75VA capability.
- 2. Shall utilize color-coded wiring.

3. hall control two stages of compressor logic, two or three stages of the indoor fan motor logic as well as staging of the outdoor fan motor. Shall also have a green LED indicator to indicate GO operation as well as a fault LED indicator for thermostat mis-wiring, no fan operation and safety.
4. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor. See heat exchanger section of this specification.

B. Safeties:

1. Compressor over-temperature, over-current. High internal pressure differential.
2. Low-pressure Protection.
3. High-pressure Protection.
 - a. High-pressure switch shall use different color wire than the low-pressure switch. The purpose is to assist the installer and service technician to correctly wire and or troubleshoot the rooftop unit.
4. Automatic reset, motor thermal overload protector.
5. Heating section shall be provided with the following minimum protections:
 - a. High-temperature limit switches.
 - b. Induced draft motor speed sensor.
 - c. Flame rollout switch.
6. Flame proving controls.A2L Refrigerant Leak Dissipation System:
 - a. Leak dissipation system shall consist of control board and A2L sensor certified to UL 60335-2-40, integrated with SystemVu controller.
 - b. System shall be designed for the life of the unit.
 - c. Dissipation system shall be automatic, ship pre-wired, and require no additional field connections to function.
 - d. Refrigerant leak sensor shall be installed in UL-certified location and orientation. Sensor shall be self-correcting and resettable. Single use refrigerant leak sensor shall not be permitted.
 - e. Factory-installed dissipation system shall use onboard microprocessor and include:
 - 1) Automatic leak detection and dissipation algorithm.
 - 2) Automatic reset after a dissipation event has occurred.
 - 3) Onboard LED with flash code to indicate current unit status and hardware failures.
 - 4) Depressible "Test" button to allow for a system test and recall/reset of leak detection history.
 - 5) 24-v dry contact alarm terminal on dissipation control board to allow for external notification of leak detection.

- 6) Ability to notify BAS system of dissipation event via readable alarm point through SystemVu.
- 7) Recallable dissipation alarm history on SystemVu controller.
- f. Dissipation control board shall be accessible via normal maintenance locations and LED shall be visible.
- g. Dissipation system shall "Fail Safe" per UL requirements.
- h. Dissipation shall allow smoke and building fire systems to override in case of event.

PANEL AIR FILTERS

1.6 DECENTRALIZED, ROOFTOP UNITS:

- A. Standard filter section:
 - 1. Shall consist of factory-installed, low velocity, disposable 2-in. thick fiberglass filters of commercially available sizes.
 - 2. Unit shall use only one filter size. Multiple sizes are not acceptable.
 - 3. Filters shall be accessible through a dedicated, weather tight access panel.
 - 4. 4-in. filter capabilities shall be capable with pre-engineered and approved Carrier filter track field- installed accessory. This kit requires field furnished filters.

SELF-CONTAINED AIR CONDITIONERS

1.7 MEDIUM-CAPACITY SELF-CONTAINED AIR CONDITIONERS (48FE)

- A. General:
 - 1. Outdoor, rooftop mounted, DDC electrically controlled, heating and cooling unit utilizing fully hermetic scroll compressors for cooling duty and gas combustion for heating duty.
 - 2. Factory assembled, single-piece heating and cooling rooftop unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start-up.
 - 3. Unit shall use Puron Advance (R-454B) refrigerant.
 - 4. Unit shall be installed in accordance with the manufacturer's instructions.
 - 5. Unit must be selected and installed in compliance with local, state, and federal codes.
- B. Quality Assurance:
 - 1. Unit meets and exceeds ASHRAE 90.1-2019 minimum efficiency requirements.
 - 2. Unit shall be rated in accordance with AHRI Standard 340/360.
 - 3. Unit shall be designed to conform to ASHRAE 15.
 - 4. Unit shall be ETL-tested and certified in accordance with ANSI Z21.47 Standards and ETL-listed and certified under Canadian standards as a total package for safety requirements.

5. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
6. Unit internal insulation linings shall be resistant to mold growth in accordance with "mold growth and humidity" test in ASTM C1338, G21, and UL 181 or comparable test method. Air stream surfaces shall be evaluated in accordance with the "Erosion Test" in UL 181, as part of ASTM C1071.
7. Unit casing shall be capable of withstanding 500-hour salt spray exposure per ASTM B117 (scribed specimen).
8. Roof curb shall be designed to conform to NRCA Standards.
9. Unit shall be subjected to a completely automated run test on the assembly line. The data for each unit will be stored at the factory, and must be available upon request.
10. Unit shall be designed in accordance with UL Standard 1995, ETL listed including tested to withstand rain.
11. Unit shall be constructed to prevent intrusion of snow and tested to prevent snow intrusion into the control box up to 40 mph.
12. Unit shake tested to assurance level 1, ASTM D4169 to ensure shipping reliability.
13. High-Efficiency Motors listed shall meet section 313 of the Energy Independence and Security Act of 2007 (EISA 2007).

C. Delivery, Storage, and Handling:

1. Unit shall be stored and handled per manufacturer's recommendations.
2. Lifted by crane requires either shipping top panel or spreader bars.
3. Unit shall only be stored or positioned in the upright position.

D. Project Conditions:

1. As specified in the contract.

E. Operating Characteristics:

1. Unit shall be capable of starting and running at 125°F (52°C) ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 340/360 at ± 10% voltage.
2. Compressor with standard controls shall be capable of operation down to 40°F (4°C), ambient outdoor temperatures. For lower operation, an integrated economizer shall be utilized to allow lower temperatures and accommodate indoor air quality initiatives.
3. Unit shall discharge supply air vertically or horizontally as shown on contract drawings.
4. Unit shall be factory configured and ordered for vertical supply and return configurations.

5. Unit shall be factory furnished for either vertical or horizontal configuration without the use of special conversion kits. No field conversion is possible.

F. Electrical Requirements:

1. Main power supply voltage, phase, and frequency must match those required by the manufacturer.

G. Unit Cabinet:

1. Unit cabinet shall be constructed of galvanized steel, and shall be bonderized and coated with a pre-painted baked enamel finish on all externally exposed surfaces.
2. Unit cabinet exterior paint shall be: film thickness, (dry) 0.003-in. minimum, gloss (per ASTM D523, 60°F / 16°C): 60, Hardness: H-2H Pencil hardness.
3. Evaporator fan compartment interior cabinet insulation shall conform to AHRI Standard 340/360 minimum exterior sweat criteria. Interior surfaces shall be insulated with a minimum 1/2-in. thick, 1 lb density, aluminum foil-faced fiberglass insulation. Aluminum foil-faced fiberglass insulation shall also be used in the gas heat compartment.
4. Unit internal insulation linings shall be resistant to mold growth in accordance with "mold growth and humidity" test in ASTM C1338, G21, and UL 181 or comparable test method. Air stream surfaces shall be evaluated in accordance with the "Erosion Test" in UL 181, as part of ASTM C1071.
5. Base of unit shall have a minimum of four locations for thru-the-base gas and electrical connections standard. Both gas and electric connections shall be internal to the cabinet to protect from environmental issues.
6. Base Rail:
 - a. Unit shall have base rails on a minimum of 2 sides.
 - b. Holes shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
 - c. Holes shall be provided in the base rail for moving the rooftop by fork truck.
 - d. Base rail shall be a minimum of 16 gage thickness.
7. Condensate Pan and Connections:
 - a. Shall be a sloped condensate drain pan made of a non-corrosive material.
 - b. Shall comply with ASHRAE Standard 62.
 - c. Shall use a 3/4-in. -14 NPT drain connection, through the side of the drain pan. Connection shall be made per manufacturer's recommendations.
8. Top Panel:
 - a. Shall be a multi-piece top panel linked with water tight flanges and locking systems.
9. Gas Connections:

- a. All gas piping connecting to unit gas valve shall enter the unit cabinet at a single location on side of unit (horizontal plane).
 - b. Thru-the-base capability
 - 1) Standard unit shall have a thru-the-base gas-line location using a raised, embossed portion of the unit basepan.
 - 2) Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.
 - 3) No basepan penetration, other than those authorized by the manufacturer, is permitted.
10. Electrical Connections:
- a. All unit power wiring shall enter unit cabinet at a single, factory-prepared, knockout location.
 - b. Thru-the-base capability.
 - 1) Thru-the-base provisions/connections are available as standard with every unit. When bottom connections are required, field furnished couplings are required.
 - 2) No basepan penetration, other than those authorized by the manufacturer, is permitted.
11. Component Access Panels (standard):
- a. Cabinet panels shall be easily removable for servicing.
 - b. Unit shall have one factory installed, tool-less, removable, filter access panel.
 - c. Panels covering control box and filter shall have molded composite handles while the blower access door shall have an integrated flange for easy removal.
 - d. Handles shall be UV modified, composite, permanently attached, and recessed into the panel.
 - e. Screws on the vertical portion of all removable access panel shall engage into heat resistant, molded composite collars.
 - f. Collars shall be removable and easily replaceable using manufacturer recommended parts.

H. Gas Heat:

- 1. General:
 - a. Heat exchanger shall be an induced draft design. Positive pressure heat exchanger designs shall not be allowed.
 - b. Shall incorporate a direct-spark ignition system and redundant main gas valve.

- c. Gas supply pressure at the inlet to the rooftop unit gas valve must match that required by the manufacturer.
- 2. The heat exchanger shall be controlled by an integrated gas controller (IGC) microprocessor.
 - a. IGC board shall notify users of fault using an LED (light-emitting diode).
 - b. The LED shall be visible without removing the control box access panel.
 - c. IGC board shall contain algorithms that modify evaporator-fan operation to prevent future cycling on high temperature limit switch.
 - d. Unit shall be equipped with anti-cycle protection with one short cycle on unit flame rollout switch or 4 continuous short cycles on the high temperature limit switch. Fault indication shall be made using an LED.
- 3. Standard Heat Exchanger Construction:
 - a. Heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gage steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
 - b. Burners shall be of the in-shot type constructed of aluminum-coated steel.
 - c. Burners shall incorporate orifices for rated heat output up to 2000 ft (610 m) elevation. Additional accessory kits may be required for applications above 2000 ft (610 m) elevation, depending on local gas supply conditions.
 - d. Each heat exchanger tube shall contain multiple dimples for increased heating effectiveness.
- 4. Stainless Steel Heat Exchanger Construction:
 - a. Use energy saving, direct-spark ignition system.
 - b. Use a redundant main gas valve.
 - c. Burners shall be of the in-shot type constructed of aluminum-coated steel.
 - d. All gas piping shall enter the unit cabinet at a single location on side of unit (horizontal plane).
 - e. The optional stainless steel heat exchanger shall be of the tubular-section type, constructed of a minimum of 20-gage type 409 stainless steel.
 - f. Type 409 stainless steel shall be used in heat exchanger tubes and vestibule plate.
 - g. Complete stainless steel heat exchanger allows for greater application flexibility.
- 5. Induced Draft Combustion Motor and Blower:
 - a. Shall be a direct-drive, single inlet, forward-curved centrifugal type.
 - b. Shall be made from steel with a corrosion-resistant finish.
 - c. Shall have permanently lubricated sealed bearings.

- d. Shall have inherent thermal overload protection.
- e. Shall have an automatic reset feature.

I. Coils:

- 1. e-coated Aluminum-Fin Evaporator and Condenser Coils:
 - a. Shall have a flexible epoxy polymer coating uniformly applied to all coil surface areas without material bridging between fins.
 - b. Coating process shall ensure complete coil encapsulation of tubes, fins and headers.
 - c. Color shall be high gloss black with gloss per ASTM D523-89.
 - d. Uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges.
 - e. Superior hardness characteristics of 2H per ASTM D3363-92A and cross-hatch adhesion of 4B- 5B per ASTM D3359-93.
 - f. Impact resistance shall be up to 160 in. lb. (ASTM D2794-93).
 - g. Humidity and water immersion resistance shall be up to minimum 1000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92).
 - h. Corrosion durability shall be confirmed through testing to be no less than 6000 hours salt spray per ASTM B117-90.

J. Refrigerant Components:

- 1. Refrigerant circuit shall include the following control, safety, and maintenance features:
 - a. Thermostatic Expansion Valve (TXV) shall help provide optimum performance across the entire operating range. Shall contain removable power element to allow change out of power element and bulb without removing the valve body.
 - b. Refrigerant filter drier - Solid core design.
 - c. Service gage connections on suction and discharge lines.
 - d. Pressure gage access through a specially designed access screen on the side of the unit.
 - e. Single circuit design with tandem compressor and fully activated evaporator coil.
- 2. Compressors:
 - a. Models shall use fully hermetic tandem scroll compressors optimized for comfort staging and IEER energy savings.
 - b. Models shall be available with a single refrigerant circuit and two-stage cooling operation on all models.

- c. Compressor motors shall be cooled by refrigerant gas passing through motor windings.
- d. Compressors shall be internally protected from high discharge temperature conditions.
- e. Compressors shall be protected from an over-temperature and over-amperage conditions by an internal, motor overload device.
- f. Compressor shall be factory mounted on rubber grommets.
- g. Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
- h. Crankcase heaters shall be standard on each compressor and deactivated whenever the compressor is in operation.

K. Filter Section:

- 1. Filters access is specified in the unit cabinet section of this specification.
- 2. Filters shall be held in place by a preformed, slide-out filter tray, facilitating easy removal and installation.
- 3. Shall consist of factory-installed, low velocity, throw-away 2-in. thick fiberglass filters.
- 4. Filters shall be standard, commercially available sizes.
- 5. Only one size filter per unit is allowed.
- 6. 4-in. filter capability is possible with a field-installed pre-engineered slide out filter track accessory. 4-in. filters are field furnished.

L. Evaporator Fan and Motor:

- 1. Evaporator Fan Motor:
 - a. Shall have permanently lubricated bearings.
 - b. Shall have inherent automatic-reset thermal overload protection or circuit breaker.
 - c. Shall have a maximum continuous bhp rating for continuous duty operation; no safety factors above that rating shall be required.
 - d. Shall be Variable Frequency duty to match the two-stage compression logic.
 - e. Shall contain motor shaft grounding ring to prevent electrical bearing fluting damage by safely diverting harmful shaft voltages and bearing currents to ground.
- 2. Variable Frequency Drive (VFD) or ECM. For indoor fan motor Staged Air Volume (SAV™) operation:
 - a. Shall be installed inside the unit cabinet, mounted, wired and tested.
 - b. Shall contain Electromagnetic Interference (EMI) frequency protection.

- c. Insulated Gate Bi-Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.
 - d. Self-diagnostics with fault and power code LED indicator. Field accessory Display Kit available for further diagnostics and special setup applications.
 - e. RS485 capability standard.
 - f. Electronic thermal overload protection.
 - g. 5% swinging chokes for harmonic reduction and improved power factor.
 - h. All printed circuit boards shall be conformal coated.
 - i. Shall not contain visual display to adjust internal setting. Available only as field-installed kit.
3. Direct Drive Evaporator Fan Motor:
- a. Shall be an ECM, direct drive motor design.
 - b. Shall have permanently lubricated bearings.
 - c. Shall have inherent automatic-reset thermal overload protection.
 - d. Shall have slow ramp up to speed capabilities.
 - e. Shall be internally protected from electrical phase reversal.

M. Condenser Fans and Motors:

- 1. Condenser Fan Motors:
 - a. Shall be a totally enclosed - multi speed ECM motor.
 - b. Shall use permanently lubricated bearings.
 - c. Shall have inherent thermal overload protection with an automatic reset feature.
 - d. Shall use a shaft-down design.
- 2. Condenser Fans:
 - a. Shall be a direct-driven propeller type fan.
 - b. Shall have galvanized aluminum (galvalum) blades riveted to corrosion-resistant steel spiders and shall be dynamically balanced.

N. Special Features Options and Accessories:

- 1. Ultra-Low Leak Economizers:
 - a. Ultra-Low Leak economizer dampers meet California's Title 24 section 140.4 prescriptive requirements for leakage, reliability testing, etc., and ASHRAE 90.1-2013 requirements for damper leakage.

- b. Integrated, gear driven opposed blade design type capable of simultaneous economizer and compressor operation.
 - c. Damper blades shall be galvanized steel with composite gears. Plastic or composite blades on intake or return shall not be acceptable.
 - d. Shall be equipped with gear driven dampers for both the outdoor ventilation air and the return air for positive air stream control.
 - e. Shall be capable of introducing up to 100% outdoor air.
 - f. Economizer's barometric relief dampers shall be sized to allow up to 100% relief (actual results will be based on specific job conditions).
2. EconoMiSer2 Economizer Controls:
- a. EconoMiSer2 economizers are controlled by RTU Open or SystemVu unit controllers, which shall be 4 to 20mA design.
 - b. RTU Open and SystemVu controls meet California's Title 24 section 120.2 mandatory requirements for economizer Fault Detection and Diagnosis.
 - c. Field-installed accessories (vertical or horizontal) are available with dry bulb outside air sensors only.
 - d. Outdoor air sensor setpoint shall be adjustable and shall range from 40°F to 100°F (4°C to 38°C). Additional sensor options shall be available as accessories.
 - e. Shall be designed to spring return close outside air damper during loss of power.
 - f. Actuator shall be direct coupled to economizer gear. No linkage arms or control rods shall be acceptable.
 - g. The economizer controller shall also provide control of an accessory power exhaust unit function. Factory set at 100%, with a range of 0% to 100%.
 - h. The economizer shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
 - i. Controller shall drive outside air dampers completely closed when the unit is in the unoccupied mode.
 - j. Economizer controller shall accept a 4 to 20mA CO2 sensor input for IAQ/DCV control. In this mode, dampers shall modulate the outdoor air damper to provide ventilation based on the sensor input.
 - k. Economizer controller shall provide indications when in free cooling mode, in the DCV mode, or the exhaust fan contact is closed.
3. Propane Conversion Kit:
- a. Package shall contain all the necessary hardware and instructions to convert a standard natural gas unit for use with liquefied propane. Kits shall be available for elevations from 0 up to 14,000 ft (4,276 m).

4. Condenser Coil Hail Guard Assembly:
 - a. Shall protect against damage from hail.
 - b. Shall be louvered style design.
5. Unit-Mounted, Non-Fused Disconnect Switch:
 - a. Switch shall be factory-installed, internally mounted.
 - b. National Electric Code (NEC) and ETL approved non-fused switch shall provide unit power shutoff.
 - c. Shall be accessible from outside the unit.
 - d. Shall provide local shutdown and lockout capability.
 - e. Sized only for the unit as ordered from the factory. Does not accommodate field-installed devices.
6. Convenience Outlet:
 - a. Non-Powered convenience outlet.
 - 1) Outlet shall be powered from a separate 115/120v power source.
 - 2) A transformer shall not be included.
 - 3) Outlet shall be factory-installed and internally mounted with easily accessible 115-v female receptacle.
 - 4) Outlet shall include 15 amp GFI receptacles with independent fuse protection.
 - 5) Outlet shall be accessible from outside the unit.
 - 6) Outlet shall include a field-installed "Wet in Use" cover.
7. Flue Discharge Deflector:
 - a. Flue discharge deflector shall direct unit exhaust vertically instead of horizontally.
 - b. Deflector shall be defined as a "natural draft" device by the National Fuel and Gas (NFG) code.
8. Outdoor Air Enthalpy Sensor:
 - a. The outdoor air enthalpy sensor shall be used to provide single enthalpy control. When used in conjunction with a return air enthalpy sensor, the unit will provide differential enthalpy control. The sensor allows the unit to determine if outside air is suitable for free cooling.
9. Return Air Enthalpy Sensor:
 - a. The return air enthalpy sensor shall be used in conjunction with an outdoor air enthalpy sensor to provide differential enthalpy control.
10. Indoor Air Quality (CO2) Sensor:

- a. Shall be able to provide demand ventilation indoor air quality (IAQ) control.
 - b. The IAQ sensor shall be available in duct mount, wall mount, or wall mount with LED display. The set point shall have adjustment capability.
11. Smoke Detectors:
- a. Shall be a four-wire controller and detector.
 - b. Shall be environmental compensated with differential sensing for reliable, stable, and drift-free sensitivity.
 - c. Shall use magnet-activated test/reset sensor switches.
 - d. Shall have tool-less connection terminal access.
 - e. Shall have a recessed momentary switch for testing and resetting the detector.
 - f. Controller shall include:
 - 1) One set of normally open alarm initiation contacts for connection to an initiating device circuit on a fire alarm control panel.
 - 2) Two Form-C auxiliary alarm relays for interface with rooftop unit or other equipment.
 - 3) One Form-C supervision (trouble) relay to control the operation of the Trouble LED on a remote test/reset station.
 - 4) Capable of direct connection to two individual detector modules.
 - 5) Can be wired to up to 14 other duct smoke detectors for multiple fan shutdown applications
12. Horn/Strobe Annunciator:
- a. Provides an audible/visual signaling device for use with factory-installed option or field-installed accessory smoke detectors.
 - 1) Requires installation of a field-supplied 24-v transformer suitable for 4.2 VA (AC) or 3.0 VA (DC) per horn/strobe accessory.
 - 2) Requires field-supplied electrical box, North American 1-gang box, 2-in. (51 mm) x 4-in. (102 mm).
 - 3) Shall have a clear colored lens.
13. Time Guard Device:
- a. Shall prevent compressor short cycling by providing a 5 minute delay ($\pm$ 2 minutes) before restarting a compressor after shutdown for any reason.
 - b. One device shall be required per compressor.
14. Barometric Hood (Horizontal Economizer Applications):

- a. Shall be required when a horizontal economizer and barometric relief are required. Barometric relief damper must be installed in the return air (horizontal) duct work. This hood provides weather protection.
- 15. Hinged Access Panels:
 - a. Shall provide easy access through integrated quarter turn latches.
 - b. Shall be on major panels of - filter, control box, fan motor and compressor.
- 16. Display Kit for Variable Frequency Drive or EC Motor:
 - a. Kit allows the ability to access the VFD controller or EC Motor programs to provide special setup capabilities and diagnostics.
 - b. Kit contains display module and communication cable.
 - c. Display Kit can be permanently installed in the unit or used on any SAV™ system VFD controller or EC Motor as needed.
- 17. Thermostat:
 - a. Due to the three-stage cooling capacity design of these units, a three-stage cooling thermostat is required for the unit to perform at listed operating efficiencies.
 - b. ATC Contractor to provide sensor.
- 18. Humidi-MiZer® (liquid sub cooling and hot gas reheat) Adaptive Dehumidification System:
 - a. The Humidi-MiZer Adaptive Dehumidification System shall be factory installed, certified and tested to provide greater dehumidification of the occupied space by providing two distinct models of dehumidification operation in addition to its normal design cooling mode:
 - 1) Subcooling mode further sub cools the hot liquid refrigerant leaving the condenser coil as well as reheat leaving air stream. It can provide both better cooling capacity as well as dehumidification process when both temperature and humidity in the space are not satisfied.
 - 2) Hot gas reheat mode shall mix a portion of the hot gas from the discharge of compressor with the hot liquid refrigerant leaving the condenser coil to create a two-phase warm refrigerant in the reheat coil which results in a neutral leaving air temperature when only humidity in the space is not satisfied.
- 19. High Short Circuit Current Rating (SCCR):
 - a. An optional SCCR of 65kA shall be provided for 460 volt and 60kA for 208/230 volt units.

END OF SECTION

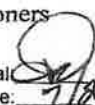


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Packaged Rooftop Air Conditioners


7/27/26

DIVISION 25 - INTEGRATION AUTOMATION

SECTION 250000

INTEGRATED AUTOMATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of Integrated Automation system(s), quality expectations, materials and general requirements.

1.2 SYSTEM(S) DESCRIPTION

- A. The NHARNG Strafford Campus is currently served by a series of R2 and N4 JACEs running outdated N4 software. A central server, located in Building 7, runs outdated N4 software. The intent is upgrade the existing controller in the Mess Hall by providing a new head end controller capable of offering remote access. In addition, the existing N4 server shall be updated to run the most recent N4 software in preparation for future campus wide system.
- B. This contract shall involve the installation of a new head end controller dedicated to the Mess Hall, and extending the controller to absorb all building control points currently available. This includes, but is not limited to:
 - 1. New RTU
 - 2. Existing Boiler Plant
 - 3. Existing Pumps
 - 4. Existing Domestic Water plant
 - 5. Existing heating terminals and VAV units
 - 6. Existing Exhaust Fan
- C. System shall be based on an open network protocol and shall allow for secured internet based access for remote monitoring and control of mechanical systems. Owner requires a Tridium Niagara 4 platform framework utilizing non-proprietary branded JACE 9000 Controller and BACnet Network Controllers. Substitutes are not allowed without written pre-approval.
- D. New ATC work shall be achieved using BACnet/MSTP protocol and hardware.
- E. The EMS shall consist of BACnet/MSTP protocol DDC controllers that may be written to, and read from the existing front end workstation or by directly connecting a laptop. Each controller shall provide sequences of operation independent of the central workstation and continue to function if the network is down.
- F. This contractor shall be fully responsible for coordination of all details necessary for establishing the seamless integration between the new controller(s) and established EMS. New graphical interface "screens" shall be provided, as necessary, for all new work.
- G. This Contractor is responsible for fully understanding the existing building controls system and associated intricacies to ensure that new work does not affect the operation

equipment remaining on the existing building control system. Adjustments to the existing system by this Contractor shall also include any work required to maintain current function of equipment not included in this contract.

- H. All ATC work shall be in keeping with current NHARNG requirements and practices, including submittals, programming responsibilities, equipment, controllers, wiring methods, sequences of operation, input/output points and Owner instruction.
- I. Equipment Controls - Vendor equipment shall be procured "stripped" of sensors and controllers whenever practicable, with provisions for wiring remote I/O and controller mounting by the ATC. All safety interlocks and equipment functions required for an agency certified listing shall be provided factory installed. Equipment Vendors to provide complete sequence and network addresses to integrate all on-board functions to the EMS. Where integrated factory controls are required all I/O control and monitoring points shall be addressable and available to the EMS through a BACnet/MSTP network interface card provided as part of the Vendor system controls.
- J. System shall be configured with dynamic system graphics screens and historical trending capabilities. Data acquisition storage capacity (on-site) to be a minimum of one year (365) days at 15 second sampling frequency of all analog data points plus all digital change of state conditions. EMS shall provide local Owner accessibility to all data and include color plotting capability for multiple (minimum 6) variables on a single trend.
- K. System shall be configured with dynamic system graphics screens and historical trending capabilities. Data acquisition storage capacity (on-site) to be a minimum of one year (365) days at 15 second sampling frequency of all analog data points plus all digital change of state conditions. EMS shall provide local Owner accessibility to all data and include color plotting capability for multiple (minimum 6) variables on a single trend.

1.3 RELATED DIVISIONS AND SECTIONS

- A. DIVISION 00 - General
- B. DIVISION 01 - General Requirements
- C. DIVISION 07 - Thermal and Moisture Protection
- D. DIVISION 21 - Fire Suppression
- E. DIVISION 22 - Plumbing
- F. DIVISION 23 - Heating, Ventilating and Air-Conditioning (HVAC)
- G. DIVISION 26 - Electrical

1.4 REFERENCES

- A. 2021 International Building Code with NH amendments
- B. 2021 NFPA 101, Life Safety Code with NH amendments
- C. New Hampshire State Fire Code Saf-C6000
- D. 2021 NFPA 1, Fire Prevention Code with NH amendments

- E. UFC 3-600-01 Fire Protection Engineering for Facilities
- F. 2021 International Plumbing Code with NH amendments
- G. 2021 International Mechanical Code with NH amendments
- H. 2018 International Energy Conservation Code with NH amendments
- I. 2020 NFPA 70, National Electric Code with NH amendments
- J. Town of Strafford, New Hampshire ordinances, rules and regulations
- K. Strafford Fire Department rules and regulations
- L. All applicable ASTM Standards
- M. NHARNG Rules and Regulations

1.5 SUBMITTALS

- A. See Section 01330 - Submittal Procedures, for Submittal Requirements.
- B. Ordering of equipment and materials for installation shall not proceed without an approved submittal.

END OF SECTION

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SECTION 250800

COMMISSIONING OF INTEGRATED AUTOMATION

PART I GENERAL

1.1 SECTION INCLUDES

- A. A. The ATC Contractor shall be responsible for self-commissioning the installed ATC controls and demonstrating proper operation and functions at conclusion of the contract.

END OF SECTION

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SECTION 259000

INTEGRATED AUTOMATION CONTROLS

PART 1 GENERAL

1.1 SCOPE

- A. Refer to Division 250000, Section 1.2 for description of the required work.
- B. All ATC work shall be in keeping with current NHARNG requirements and practices, including submittals, programming responsibilities, equipment, controllers, wiring methods, sequences of operation, input/output points and Owner instruction.
- C. The following incidental work shall be furnished by the designated contractor.
 - 1. The Mechanical Contractor shall:
 - a. Install automatic valves and separable wells that are specified to be supplied by the successful Controls Contractor.
 - b. Furnish and install all necessary valved pressure taps, water, drain and overflow connections and piping.
 - c. Provide, on magnetic starters furnished, all necessary step-down transformers and auxiliary contacts, with buttons and switches in the required configurations.
 - d. Provide necessary sheet metal baffle plates to eliminate stratification and attain proper mixing of air streams. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.
 - e. Provide access doors or other approved means of access through ducts for service of control equipment and components.

1.2 COORDINATION

- A. The Controls Contractor shall cooperate with other divisions performing work on this project as necessary to achieve a complete and neat installation. The Controls Contractor shall also consult the drawings and specifications of all trades to determine the nature and extent of others' work.
- B. The Controls Contractor shall support all Commissioning activities, including programming overrides, testing, and data trending.

1.3 SUBMITTALS

- A. The Controls Contractor shall submit within 60 days after award of contract installation drawings and control strategies for review.
- B. Each submittal shall have a cover sheet that includes submittal ID number, date, project name, address, title and project engineer name and phone number.
- C. Each submittal shall include the following information:

1. EMS riser diagram showing all DDC controllers, operator workstations, network repeaters and network wiring.
2. One-line schematics and system flow diagrams showing the location of all control devices.
3. Points list for each DDC controller, including tag, point type, system name, object name, expanded ID, display units, controller type, address, cable destination, module type, terminal ID, panel, slot number, reference drawing and cable number.
4. The Controls Contractor shall submit written description for each sequence of operation to include the following:
 - a. Sequences shall reference input/output and software parameters by name and description.
 - b. The sequences of operations provided in the submittal by the Controls Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
 - c. Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
 - d. The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
5. User interface functional outline. The outline shall include each display screen to be provided, data to be displayed, and links to other screens. The outline level hierarchy shall be:
 - a. Site
 - b. Building
 - c. Floor
 - d. System
6. Detailed Bill of Material list for each panel, identifying quantity, part number, description and associated options.
7. Control Damper Schedules: This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including code number, fail position, damper type, damper operator, blade type, bearing type, seals, duct size, damper size, mounting and actuator type.
8. Control Valve Schedules: This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including code number, configuration, fail position, pipe size, valve size, body configuration, close off pressure, capacity, valve CV, calculated CV, design pressure, actual pressure and actuator type.
9. Cataloged cut sheets of all equipment used. This includes, but is not limited to, DDC panels, peripherals, sensors, actuators, dampers, control air system components and the like.

10. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.
 11. Training course outlines for each four-hour session.
 12. Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.
 13. Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.
 14. Initial project team Quality Assurance compliance report.
- D. The Controls Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. The Controls Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

1.4 O&M MANUALS

- A. Submit three (3) sets of each manual.
1. Include the following documentation in the Hardware Manual:
 - a. General description and cut sheets for all components.
 - b. Detailed wiring and installation illustrations and complete calibration procedures for each field and panel device.
 - c. Complete trouble-shooting procedures and guidelines.
 - d. Complete operating instructions for all systems.
 - e. Document all equipment maintenance and repair/replacement procedures.
 2. Include the following documentation in the DDC Software Manual:
 - a. Sequence of Operations
 - b. Program listing of software source code or flow chart diagrams of programming objects.
 - c. Printed listing of controller and operator workstation database files.
 - d. Software point name abbreviation list. Include name, description, controller where located, point type and point ID.
 - e. I/O Point List. Include point name, controller location, point number, control device, range and span.
 - f. Printouts of all reports, group listings and alarm messages.
 - g. Index of all DDC point names with documentation manual page number references.

3. Provide three copies of all manufacturers manuals covering the installed system. This shall include, at a minimum:
 - a. System Engineering Manual
 - b. System Installation Manual
 - c. Programming Manual
 - d. Engineering and Troubleshooting Bulletins
 - e. Operator Workstation Software Manual
 - f. All other pertinent manuals published by the control system manufacturer.

- B. All manuals shall be provided in hard copy format or on a single Compact Disk (CD) as part of an on-line documentation system through the operator workstation.
- C. Record Drawings shall be included in the O&M Manual.

1.5 WARRANTY

A. Material:

1. The Control System shall be free from defects in material and workmanship under normal use and service. If within eighteen (18) months from the date of substantial completion any of the equipment herein described is defective in operation, workmanship or materials, it will be replaced, repaired or adjusted at the option of the Controls Contractor.

B. Installation:

1. The EMS shall be free from defects in installation workmanship for a period of 18 months from substantial completion. The Controls Contractor shall correct any defects in workmanship within one week of notification in writing by the Owner.

PART 2 PRODUCT

2.1 SUBSTITUTIONS

- A. Materials shall be as specified herein, except consideration shall be given to other products that meet or exceed those specified if requested five (5) business days prior to the date of bid opening in accordance with Section 01600, Product Requirements.

2.2 INPUT DEVICES

A. Room Temperature Sensors:

1. Room sensors shall be constructed for either surface or wall box mounting.
2. Room sensors shall have the following features:
 - a. LCD displays
 - b. Override (O/R) controls to switch HVAC system from unoccupied to occupied for a period of three (3) hours (adjustable).
 - c. Limited range manual adjustment capability

- d. Protective covers in public and maintenance areas.
- e. Sensor to communicate with EMS through communications network.

B. Thermostats:

- 1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters and ventilation fans, unless noted otherwise. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

2.3 OUTPUT DEVICES

A. Actuators:

- 1. General Requirements:
 - a. Damper and valve actuators shall be electronic.
- 2. Electronic Damper Actuators:
 - a. Electronic damper actuators shall be direct shaft mount.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
 - e. All fire damper actuators shall be shown by manufacturer to be fully compliant with UL 555.

- f. All smoke damper actuators shall be shown by manufacturer to be fully compliant with UL 555S.
 - g. Actuator shall be sized for required damper torque. List torque required and torque available for each damper in a table included with submittal.
3. Electronic Valve Actuators:
- a. Electronic valve actuators shall be manufactured by the valve manufacturer.
 - b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
 - c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

B. Control Dampers:

- 1. The Controls Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the Controls Contractor or as specifically indicated on the Drawings.
- 2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 3. All dampers used for two-position, open/close control may be parallel or opposed blade type arranged for normally open or closed operation, as required.

4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48". Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be provided for any section exceeding 48" in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.5 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
5. Air foil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g.; Ruskin CD50, Vent Products 5650, or approved equal.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below; Ruskin CD36, Vent Products 5800, or approved equal.
7. Multiple section dampers may be jack-shafted to allow mounting actuators and direct connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.

PART 3 EXECUTION

3.1 INSTALLATION PRACTICES

A. EMS Wiring:

1. All conduit, wiring, accessories and wiring connections required for the installation of the Facility Energy Management System, as herein specified, shall be provided by The Controls Contractor unless specifically shown on the Electrical Drawings under Division 26. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All system input wiring shall be twisted shielded pair, minimum 18 gauge wire, or as required. All system analog output wiring shall be twisted shielded pair/3-wire as required, minimum 18 gauge wire. Preconfigured cables between Terminal Unit Controllers and Thermostats are acceptable, minimum 24 gauge.
3. All internal panel device wiring for binary outputs and pilot relay shall be minimum 16 gauge wire.
4. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - a. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.

5. Low voltage control wiring and 24VAC can be run in the same conduit. Power wiring 120VAC and greater must be in a separate conduit.
6. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size 3/4".

B. Identification Standards:

1. Controller Identification: All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
2. Panel Identification: All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.
3. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.
4. Panel Devices: All panel devices shall be identified by a typed label securely fastened to the backplane of the local control panel.
5. Raceway Identification: Refer to Sections 230553 "Identification for HVAC Piping and Equipment" and 260553 "Electrical Identification" for related name plate and marker identification requirements. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
6. Wire Identification: All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

3.2 TRAINING

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" for Controls Contractor training requirements.

3.3 ALARM MANAGEMENT

- A. Alarm management shall be provided to monitor, buffer and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, to minimize network traffic and to prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

PART 4 EXECUTION

4.1 SEQUENCES OF OPERATION

- A. Rooftop HVAC Unit (RTU-1) Control:
 1. Unit shall operate by utilizing the factory installed microprocessor controls, in conjunction with the factory furnished communications card. The unit shall operate as a single zone, variable volume system (SZVAV).

2. The unit shall operate whenever the space is occupied.
3. Space Temperature Control: The factory installed DDC Controller shall operate RTU-1 as a single zone VAV system. In cooling mode, the controller shall operate the unit if free cooling conditions allows and stage the mechanical cooling to maintain a discharge air temperature of 55°F (adj.). The supply fan shall modulate to maintain a space cooling setpoint of 74°F (adj.). If the supply fan is at a minimum and the space temperature falls below the cooling setpoint plus deadband, the supply air temperature shall be reset upwards to a maximum 62°F to prevent overcooling the space. If the outside air damper is at minimum position, mechanical cooling is off, the supply air temperature is 62°F, and the space temperature falls below the heating setpoint of 70°F (adj.), the controller shall switch to heating mode. In the heating mode, the gas burner shall modulate to maintain a discharge air temperature of 95°F and the supply fan shall modulate to maintain the heating setpoint. The DDC controller shall prevent simultaneous heating/cooling operation and include appropriate deadbands too allow smooth transitions between heating and cooling modes.
4. Power Exhaust Fan Control: ATC Contractor shall furnish and install a building pressure sensor for control of the modulating exhaust fan. The Exhaust fan shall modulate to maintain building pressure.
5. Economizer: The unit shall have 100% enthalpy economizer control. When economizing, the power exhaust shall modulate open to provide exhaust flow equal to 100% of the outdoor air supply airflow.
6. Schedules:
 - a. Space temperature maximum setpoint during cooling mode shall be 74°F (adj.)
 - b. Space temperature minimum setpoint during heating mode shall be 70°F (adj.)
7. Monitoring and Control points:
 - a. Supply and exhaust fan operating status
 - b. Building static pressure
 - c. Supply and exhaust fan speed
 - d. Supply air temperature
 - e. Return air temperature
 - f. Economizer status
 - g. Exhaust air damper command position
 - h. Exhaust air damper position
 - i. Filter section pressure drop
 - j. All zone temperatures
 - k. Alarms

END OF SECTION

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DIVISION 26 - ELECTRICAL

SECTION 260500

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Basic Electrical Requirements specifically applicable to Division 26 Sections
 - 2. As-Built Documentation
- B. Related Sections
 - 1. Section 260800 - Electrical Testing

1.2 REFERENCES

- A. ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures
- B. International Building Code – IBC 2021
- C. National Electrical Code with New Hampshire Amendments
- D. New Hampshire State Building Code
- E. NFPA 70 - National Electrical Code
- F. NFPA 79 – Electrical Standard for Industrial Machinery

1.3 SUBMITTALS

- A. Submit shop drawings, product data, and reports.
- B. Submit as-built documentation.
- C. Submit a written warranty.
- D. Seismic restraint details including stamped certification from a professional engineer.
- E. Provide a schedule of all Electrical system related Owner training, within one month of the Notice to Proceed. Prior to training, resubmit schedule if training is rescheduled and resubmit upon completion of all training. At a minimum, for each piece of equipment or system to be demonstrated, the schedule should include the following:
 - 1. Equipment or system to be demonstrated
 - 2. Related specification section
 - 3. Anticipated date of training
 - 4. Anticipated duration of training session
 - 5. Name and company of instructor providing the training
 - 6. Date completed
 - 7. Actual duration of training session

- F. Submit a Sequence of Construction for the demolition and installation of equipment with restrictions listed in this document. Sequence of Construction shall be updated during construction (if changes are required) and resubmitted for comment.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable New Hampshire Building Code.
- B. Electrical - Conform to the state-adopted version of the National Electrical Code with New Hampshire amendments. All references to the National Electrical Code or NEC in the project manual or on the drawings shall be construed as references to the New Hampshire Electrical Code.
- C. Conform to applicable Local Building Codes.
- D. Obtain and pay for all applicable permits.
- E. Schedule and pay for all inspections necessary for the electrical installation including but not necessarily limited to the general electrical inspection and fire department inspections.

1.5 PROJECT CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission from the Engineer before proceeding.
- C. Location of electrical equipment, devices, and similar items, as indicated, are approximate only. Exact locations are to be determined by the Contractor during construction. If any location is different from those indicated (greater than 5 feet away from location shown on Drawings), the Engineer must give approval to the change.
- D. Verify in field, existing conditions and final locations of equipment installed under other Sections that require electrical work.
- E. Where it is necessary to core a hole through an existing concrete slab or wall, the Contractor shall conduct a survey with a pachometer or by similar means to identify the location of steel reinforcing bars. The new hole shall be located so as to avoid cutting reinforcing bars. Where reinforcing steel is close enough together that it is not possible to core the required hole without cutting reinforcing bars, contact the Engineer for further direction before cutting a hole. Where reinforcing bars are cut without the consent of the Engineer, the slab or wall will be repaired at the expense of the Contractor.
- F. Equipment wiring
 - 1. Equipment power and control wiring is based on specific manufacturers and models. Actual wiring required may be different.
 - 2. Before pulling any power or control wire or installing conduit, obtain equipment electrical and control installation instructions and wiring diagrams. Any discrepancies from what is shown on the electrical drawings shall be brought to the attention of the Engineer. The Engineer will provide instructions for any changes that may be necessary.

3. Installation of conduit or wire prior to obtaining the above specified information shall be at the Contractor's risk. The Owner will not be responsible for any extra costs related to removal or replacement of conduit or wire resulting from the failure to coordinate equipment conduit and wire requirements. In the event that additional conductors or larger conductors than shown on the Drawings are required, the Owner will not be responsible for any labor costs related to the installation of these materials unless it can be demonstrated by the Contractor to the satisfaction of the Engineer that these conductors could not have been installed at the same time as the conductors shown on the Drawings. Edit the following as necessary.
4. Provide wiring shown on the Drawings unless specifically excluded.

G. Drawings and Specifications

1. Drawings and Specifications are typical of work done and of arrangement desired. Provide accessories and appurtenances necessary for complete installation (e.g., home runs, conduit and wire for instrumentation and control wiring) that are required to provide a complete electrical system.
- H. As-Built Drawings: Maintain a master set of as-built drawings showing the changes and deviations from the Drawings or the approved shop drawings. Make markups as the changes are made.
- I. Where underground electric facilities are installed, measure, record, and submit as built dimensions.

1.6 SEQUENCING AND SCHEDULING

- A. Shutdown quantity and durations shall be minimized and limited to restrictions as described below.
- B. Provide temporary power source(s), motor controller(s), distribution equipment, wiring (power and signal) and conduit as required to keep all equipment operational at all times (except during switchovers), to meet requirements described below.
- C. Coordinate shutdown schedule and durations with the Owner. The NH Center Strafford buildings contain government-owned metering devices that require the coordination of all parties involved for any disturbance in service continuity. The Contractor shall be responsible for coordinating all shutdowns with the Owner to ensure that these metering devices are not disturbed, and the required parties are notified.
- D. Install all conduit/wire to the extent feasible prior to shutdowns to minimize outage durations.

1.7 WARRANTY

- A. Submit a written warranty, executed by the Contractor and manufacturer agreeing to the replacement and installation of all material, parts and adjustments required due to failure in materials or workmanship within one year from final acceptance of the Work.
- B. This warranty shall be in addition to, and not a limitation of, other rights and remedies the Owner may have against any party under the Contract Documents. This warranty is in addition to all other warranties existing under either the Contract Documents or required by Law.

1.8 SEISMIC REQUIREMENTS

- A. Components, systems and their supports shall be designed by the contractor in accordance ASCE 7-16, Section 13.6 Mechanical and Electrical Components, the International Building Code, and the New Hampshire Amendments.
- B. Submit details showing the seismic restraints.
- C. Submit stamped, signed certification from a New Hampshire licensed professional structural engineer that the design meets the seismic restraint requirements.

PART 2 PRODUCTS

2.1 GENERAL

- A. Products shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) recognized by OSHA if a listing for that product is available. NRTL shall be Underwriter's Laboratory (UL), Electrical Testing Laboratory (ETL), Factory Mutual (FM) or equal.
- B. Equipment Ampere Interrupting Capacity (AIC) and/or Short Circuit Current Rating (SCCR): Electrical equipment shall be labeled in accordance with NFPA 70 and have an Ampere Interrupting Capacity rating or Short Circuit Current Rating of equal to or greater than the following:
 - 1. 208- or 240-volt equipment: 10,000 amps where fed from a transformer rated 45KVA or less, otherwise 35,000 amps

2.2 FINAL SYSTEM DOCUMENTATION

- A. Prior to final acceptance of the system, provide operating and maintenance manuals (O&M's) covering instruction and maintenance on each type of equipment.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Perform all work in accordance with OSHA (Occupational Safety and Health Administration) requirements.
- B. Perform all work in accordance with NFPA 70E, Handbook for Electrical Safety in the Workplace.
- C. Install all equipment in accordance with manufacturer's instructions and recommendations.
- D. Test all electrical components in accordance with Section 260800 and as indicated in individual electrical equipment specification sections.
- E. Perform all electrical equipment installation, checkout, and test in a safe manner. Provide the following special safety precautions, as appropriate:
 - 1. Locking and tagging procedures
 - 2. Barricades
 - 3. De-energization and/or isolation of equipment prior to testing
 - 4. Review of procedures with the Engineer and the Owner
 - 5. Erection of warning signs

6. Stationing of guards and watchmen
 7. Maintenance of voice communications
 8. Personnel orientation
- F. Do not install electrical equipment in its permanent location until structures are weather-tight or equipment is properly protected from the weather.
- G. Before energizing any machine, visually inspect for serviceability. Verify that equipment and machines have been properly lubricated and aligned. Verify nameplate for electrical power requirements.
- H. Contractor shall provide a label on each of the following types of equipment that indicates the maximum available short circuit current at that equipment. Obtain available short circuit current values from the engineer during construction. Unless values are shown on drawings, Contractor shall request values from Engineer at least 4 weeks prior to starting up equipment.
1. Switchboards
 2. Switchgear
 3. Panelboards
 4. Equipment that is required to be marked with a short circuit current rating, such as motor controllers and industrial control panels of multi-motor and combination load equipment.

3.2 INSTRUCTION - STAFF TRAINING

- A. Provide training for facility personnel on the various electrical/controls/monitoring systems that are provided under Division 26. The training shall be conducted at the facility. The system training shall be structured such that the operating personnel will understand the system's operation and the functions available in the system. Training shall also include preventive and corrective maintenance of hardware and systems.
- B. The amount of training shall be a minimum of one 8-hour day, scheduled as convenient for the Owner.
- C. The System Supplier shall be responsible for providing detailed Operation and Maintenance (O&M) Manuals. The O&M Manuals shall include specific details of equipment supplied and details of operations specified to this project.
- D. The O&M Manuals shall include descriptions of all equipment, the nature and intended modes of operation, testing procedures of all units in the System, and safety measures to be taken in operation. All necessary procedures and methods for effective operation of the System shall be included.
- E. O&M Manuals shall include record drawings and instructions necessary for the planned maintenance of all equipment in the system. The O&M Manuals will incorporate maintenance procedures and schedules, and they will coordinate and be cross-referenced to detailed operation procedures provided by the manufacturers.

END OF SECTION

SECTION 260505

MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Electrical demolition

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: as specified in individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on field observation and existing record documents. Report discrepancies to the Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary power source(s), 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.
- C. Existing Electrical System: Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Verify permission to disable with the Owner immediately before the work. See 260500 for additional requirements.
- D. Existing Fire Alarm System: Disable system only to make switchovers and connections. Notify Owner and local fire service at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. See 260500 for additional requirements.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under the provisions of this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.

- D. Remove exposed abandoned conduit, boxes, supports and fasteners, including above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Voids created by the removal of conduit in floors or walls above or below ceilings shall be patched and sealed with materials matching the existing construction.
- F. 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.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Repair adjacent construction and finishes damaged during demolition and extension work with materials matching the existing construction.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangements.

3.5 INSTALLATION

- A. Install relocated materials and equipment as indicated.

END OF SECTION

SECTION 260519

CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Building wire and cable
 - 2. Shielded signal cable
 - 3. Device Net cable
 - 4. Ethernet cable
 - 5. RS-485 cable
 - 6. Wire connectors
- B. Related Sections
 - 1. Section 260553 - Electrical Identification

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code

1.3 SUBMITTALS

- A. Submit shop drawings, product data and reports.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.5 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions. Determine required separation between cable and other work.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.1 BUILDING WIRE AND CABLE

- A. Description: Stranded conductor insulated wire, multi-conductor control cable and tray cable.
- B. Conductor: copper
- C. Insulation Voltage Rating: 600 volts

- D. Insulation Temperature Rating: 90°C
- E. Insulation: ANSI/NFPA 70; all power and control wiring shall be XHHW-2 unless otherwise indicated in this specification.
- F. Manufacturer
 - 1. Okonite Co.
 - 2. Rome Cable Corp.
 - 3. American Insulated Wire Corp.
 - 4. Southwire
 - 5. or equal

2.2 SHIELDED SIGNAL CABLE

- A. Description: twisted pair shielded instrumentation wire, NEC type TC listed, wet location, approved for Class 1 circuits as permitted in NEC Article 725.
- B. Conductor: tinned copper 18 AWG
- C. Insulation Material: PVC with a nylon overcoat
- D. Insulation Temperature Rating: 75°C wet, 90°C dry
- E. Shield: 100% coverage, with drain wire
- F. Jacket: 90°C PVC
- G. Insulation voltage rating: 600 volts
- H. Manufacturer
 - 1. Belden No. 9341
 - 2. Approved equal by Alpha
 - 3. Approved equal by Clifford
 - 4. or equal

2.3 SHIELDED 3-CONDUCTOR CABLE

- A. Description: Three-conductor shielded instrumentation cable, NEC type TC listed, wet location, approved for Class 1 circuits as permitted in NEC Article 725.
- B. Conductor: Tinned copper 18 AWG
- C. Insulation Material: PVC with nylon overcoat
- D. Insulation Temperature Rating: 75°C wet, 90°C dry
- E. Insulation Voltage Rating: 600 volts
- F. Shield: 100% shield coverage. with drain wire
- G. Jacket: 90°C PVC

- H. Manufacturer
 - 1. Belden No. 1121A
 - 2. Approved equal by Alpha
 - 3. Approved equal by Clifford
 - 4. or equal

2.4 SHIELDED DEVICENET SIGNAL CABLE

- A. Description: Twisted pair shielded instrumentation wire, NEC type TC listed, approved for Class 1 circuits as permitted in NEC Article 725
- B. Power Conductor: tinned copper, 16 AWG
- C. Power Conductor Insulation Material: PVC with a nylon overcoat
- D. Power conductors colored Red/Black
- E. Data Conductor: tinned copper 18 AWG
- F. Data Conductor Insulation Material: F-R Polypropylene
- G. Data conductors colored Blue/White
- H. Insulation Temperature Rating: 75°C
- I. Shield: 100% coverage, with 18 AWG stranded drain wire
- J. Insulation voltage rating: 600 volts
- K. Manufacturer
 - 1. Belden No. 7896A
 - 2. Approved equal by Alpha
 - 3. Approved equal by Clifford

2.5 ETHERNET CABLE

- A. Description: NEC CMR cable, Category 6 unbonded-pair cable
- B. Construction: 23 AWG solid bare copper, 4 twisted pairs, overall shield, drain wire, RJ-45 compatible, non-plenum, polyolefin (PO) or PO+FEP insulation, PVC jacket.
- C. Manufacturer
 - 1. Belden 2412F
 - 2. Approved equal by Alpha
 - 3. Approved equal by Quabbin

2.6 RS-485 CABLE

- A. Description: Twisted 4-pair, NEC CL2, shielded, low capacitance cable.
- B. Temperature Rating: 80°C
- C. Voltage Rating: 30 volts

- D. Conductor: 28 AWG stranded, tinned copper
- E. Shielding: 100% coverage with 28 AWG tinned copper drain wire
- F. Insulation: Datalene
- G. Jacket: Chrome PVC
- H. Manufacturer
 - 1. Belden 8134FO
 - 2. Approved equal

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

- A. Minimum size for power wiring shall be AWG #12.
- B. Minimum size for control wiring shall be AWG #14.
- C. All wiring shall be run in conduit, unless otherwise noted.
- D. Install products in accordance with manufacturer's instructions.
- E. Use stranded conductors for all wire sizes.
- F. In raceways, mechanically complete the installation in all details. Pull all conductors into raceway at same time.
- G. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- H. Protect exposed cable from damage.
- I. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure. Do not rest cable on ceiling panels.
- J. Use suitable cable fittings and connectors.
- K. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- L. Clean conductor surfaces before installing lugs and connectors.
- M. Instrumentation, control and signal wiring shall be continuous with no splices from source to destination, unless otherwise shown on drawings.
- N. Splices
 - 1. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 2. Properly connect and insulate shields at all splice points.

3. Underground Splices or Splices called out to be Submersible
 - a. Provide Polaris Submersible Splice Connectors or equal one-piece system by Burndy, Blackburn or equal.
 - b. Underground splices shall be made in a handhole or manhole provided by the contractor and sized per the NEC.
4. Above grade splices
 - a. 8 AWG and Larger: Use split bolt connectors for copper conductor splices and taps. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
 - b. 10 AWG and smaller: Use insulated spring wire connectors with plastic caps for copper conductor splices and taps.
5. Above ground splices wire reducer
 - a. When wire size has been increased to account for derating and/or voltage drop, provide an In-Line Standard Barrel Reducer Splice Kit to reduce the wire down to the size necessary to terminate at the circuit breaker, disconnect, equipment, etc.
 - b. The reduced wire shall be sized by the contractor per NEC Table 310.15(B)(16) using the 60°C Column. The wire shall be sized according to the upstream over current protective device size.
 - c. The splice kit shall contain clear heat shrink tube to protect the butt splice.
 - d. Tape splice with electrical tape to 150 percent of insulation rating of conductor.
 - e. The Reducer splice kit shall be:
 - 1) Butt splice compression type with inspection window.
 - 2) Tin plated Copper
 - 3) Provide Burndy Hyreducer or equal by Blackburn, Polaris or equal.

O. Ground signal cable shields on receiving end only.

P. Provide Kellems grips for all cord connected devices.

Q. Provide separation of power wiring from control and signal wire in accordance with NEC Article 725.

R. Install Device Net cables in accordance with manufacturer's instructions and NEC Article 725 requirements for Class 1 wiring.

S. Install Ethernet cables in accordance with manufacturer's instructions and industry standards for category 6 wiring.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Section 260553.

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

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Conductors and Cables

Initial
Date: 4/27/26

3.5 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- C. Verify continuity of each branch circuit conductor.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Power system grounding
 - 2. Electrical equipment and raceway grounding and bonding
 - 3. Grounding of piping, tanks, handrails and other conductive equipment
 - 4. Communication system grounding
- B. Related Sections
 - 1. Section 26 08 00 – Electrical Testing

1.2 REFERENCES

- A. NFPA 70 – National Electrical Code
- B. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- C. UL 96 – UL Standard for Safety for Lightning Protection Systems
- D. UL 467 - Grounding and Bonding Equipment
- E. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
- F. UL 1059 – Terminal Blocks
- G. IEEE/ANSI 142 – Latest Edition Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- H. IEEE 837 – Standards for Qualifying Permanent Connections Used in Substation Grounding
- I. ASTM B3 - Solid Conductors
- J. ASTM B8 – Assembly of Stranded Conductors
- K. ASTM B33 – Tinned Conductors
- L. NEMA GR1 – Ground Rods and Ground Rod Couplings

1.3 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral and ground bus at the utility service entrance equipment to grounding electrodes. Grounding electrode system shall include a minimum of three driven ground rods, the underground water service pipe, and the metal frame of the building (if effectively grounded). For new construction, the grounding electrode system shall include the rebar in accordance with NEC 250.52(A)(3). Run exposed grounding electrode conductors in conduit.

- B. Ground each separately derived system neutral to the nearest effectively grounded building structural steel member or, if such is not available, to the nearest grounding electrode other than a water pipe.
- C. Provide communications systems grounding conductor at point of service entrance and connect to nearest effectively grounded building structural steel member or, if such is not available, to the nearest grounding electrode other than a water pipe.
- D. Bond together exposed non-current carrying metal parts of electrical equipment, handrails, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, metallic tanks and all metallic piping.
- E. Install grounding in accordance with NEC Article 250.

1.4 SUBMITTALS

- A. Submit shop drawings, product data, and reports.
- B. Indicate layout of ground rods, location of system grounding electrode connections, and routing of grounding electrode conductor.
- C. Submit ground resistance testing reports in accordance with Section 260800

PART 2 PRODUCTS

2.1 MATERIALS

- A. Grounding Electrode Conductors
 - 1. Type: Medium-hard drawn bare copper
 - 2. Manufacturer
 - a. Okonite Co.
 - b. Rome Cable Corp.
 - c. American Insulated Wire Corp.
 - d. Southwire
 - e. or equal
- B. Grounding Conductors - insulated copper, minimum size #12 AWG and in accordance with NEC Tables 250.66, 250.102(C)(1) and 250.122, or larger if so indicated on the Drawings
- C. Ground Rods: Copper-clad steel, 3/4 inch diameter, minimum length 10 feet
- D. Connectors - Mechanical
 - 1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used and specific types, sizes and combination of conductors and items connected.
 - 2. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of silicon bronze and supplied as part of the connector body and shall be two bolted pressure types.

3. The connectors shall meet or exceed UL467 and be clearly marked with the catalog number, conductor size and manufacturer.

- a. Manufacturer

- 1) ABB Blackburn Installation Products
- 2) Burndy
- 3) IlSCO
- 4) Or equal

E. Connectors - Compression

1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used and specific types, sizes and combination of conductors and items connected.
2. Irreversible compression connectors that meet or exceed the performance requirements of IEEE837, UL467 latest revisions. Compression connectors shall be listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and specific types, sizes and combinations of conductors and other items connected.
3. The irreversible compression connectors shall be manufactured from pure wrought copper.
 - a. The installation of the connectors shall be made with a hydraulic compression tool and die system clearly showing embossed die stamp on each crimp as recommended by the manufacturer of the connectors
 - b. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size
 - c. Each connector shall be factory filled with an oxide – inhibiting compound where applicable.
4. Manufacturer
 - a. ABB Blackburn Installation Products
 - b. Burndy
 - c. IlSCO
 - d. Or equal

F. Connectors - Welded

1. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used and specific types, sizes and combination of conductors and items connected.
2. Exothermic welded connections for copper to copper and copper to steel connections to ground rods, ground buses, ground wires, steel beams etc.
3. Conductors spliced with exothermic welded connections shall be considered as a continuous conductor, as stated in the noted accompanying NEC Article 250.50, 250.64 and IEEE Standard 80 latest edition.

- a. Procedures outlined in the manufacturer's installation instructions shall be followed. Welds shall not be modified during installation in field applications
- b. Weld metals shall be a mixture of copper oxide and aluminum. Only one weld metal mixture shall be required for each grounding connection.
- c. Grounding connections shall be tested and certified in accordance with IEEE837, UL487A and UL 467.
- d. Manufacturer
 - 1) ABB Furseweld Installation Products
 - 2) Burndy Thermoweld
 - 3) Erico Cadweld
 - 4) Or equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide a separate, insulated equipment grounding conductor with each feeder and branch circuit. Terminate each end on a grounding lug, bus, or bushing.
- B. Run all exposed grounding electrode conductors and equipment grounding conductors in conduit.
- C. Use a minimum of #8 AWG copper wire to ground all piping, tanks, handrails and other conductive equipment or structures including ductwork and floor gratings.
- D. Use grounding bushings on all conduits stubbed up below equipment, panelboards, switchboards and motor control centers. Bond all conduits to ground bus. Use grounding bushings to ground electrical equipment and exposed non-current carrying metal parts.
- E. Use the following types of ground connections for the grounding electrode system:
 - 1. Cable to cable & cable to ground rod: Use exothermic weld type
 - 2. Cable to building structural and reinforcing steel: Use compression type
 - 3. Cable to piping: Use mechanical type
- F. Supplementary Grounding Electrode: Use effectively grounded metal frame and rebar of the building and ground rods spaced a minimum of 10 feet apart in sufficient quantity to have a measured resistance to ground of not more than 5 ohms.
- G. Use minimum #6 AWG copper conductor for communications service grounding conductor. Leave 10' slack conductor at terminal board.
- H. Isolated Grounding Systems: Use insulated equipment grounding conductor and connect only to service grounding electrode.
- I. Drive ground rods one foot below finished grade.

- J. Ground the water pipe as required by NEC Article 250. Provide a grounding jumper over the water meter as required. Provide a grounding jumper over all meters installed on incoming metallic piping for utility equipment.

3.2 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation and compliance with NEC Article 250.

3.3 TESTING

- A. Perform ground tests using a low resistance, Null balance type, ground testing ohmmeter, with test lead resistance compensated for. Use the type of test instrument which compensates for potential and current rod resistances.
- B. Test the grounding electrode system and measure ground resistance. Submit tabulation of results to the Engineer. Include identification of electrodes, date of reading and ground resistance value in the test reports. If the resistance is not 5 ohms or less, contact the Engineer. The Engineer will initiate design changes, if necessary, to obtain acceptable values of ground resistance.
- C. Ground resistance of conduits, equipment cases, and supporting frames, shall not vary from that of system as a whole and shall not exceed 0.5 ohms to ground. Measure resistance to ground of representative items, as directed by the Engineer. Submit all readings to the Engineer.

END OF SECTION

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SECTION 260529

ELECTRICAL HANGERS AND SUPPORTS

PART I GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Support channel
 - 2. Fastening hardware
 - 3. Anchor bolts

1.2 REFERENCES

- A. ASTM A-780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dipped Galvanized Coatings

1.3 SUBMITTALS

- A. Submit shop drawings, product data, and reports.

1.4 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 PRODUCTS

2.1 SUPPORT CHANNEL

- A. Support channel shall be hot dipped galvanized steel unless noted otherwise.
- B. Support channel assembly hardware shall be stainless steel.
- C. In wet locations, support channel components in contact with the floor shall be stainless steel.
- D. Manufacturer:
 - 1. Unistrut
 - 2. B-Line
 - 3. ABB Super Strut Installation Products
 - 4. Or equal

2.2 FASTENING HARDWARE

- A. All fastening hardware shall be 304-stainless unless noted otherwise.

2.3 ANCHOR BOLTS

- A. Anchor bolts shall be suitable for cracked or uncracked concrete and CMU construction.
- B. Anchor bolts, nuts, washers, bolt sleeves, and assembly hardware shall be Type 316 stainless steel.

- C. Use expansion anchors in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces.
- D. Manufacturer:
 - 1. Hilti, Kwik-Bolt TZ SS 316
 - 2. Powers Fasteners, Power-Stud+ SD6
 - 3. Simpson Strong-Tie, Strong-Bolt 2
 - 4. Or Equal

2.4 PIPE CLAMPS AND STANDOFFS

- A. Pipe clamps and standoffs shall be rigid one hole, galvanized malleable iron type. They shall be of the same manufacturer and shall be designed to be used together.
- B. Strut pipe clamps shall be 2-piece type galvanized steel.
- C. The finish shall be suitable for the piping system being supported. If PVC coated conduit is being supported, PVC coated clamps and standoffs shall be used. For PVC conduit, stainless steel or PVC coated clamps and standoffs shall be used.

2.5 THREADED RODS

- A. Threaded hanging rods shall be 304 stainless steel and be one piece. The size shall be suitable for the loads being supported.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, preset inserts or beam clamps. Do not use spring steel clips and clamps.
- B. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- C. Do not use powder-actuated anchors.
- D. Hanger rods shall be subjected to tension only. Lateral and axial movements shall be accommodated by proper linkage in the rod assembly.
- E. Fabricate supports from support channel rigidly welded or bolted to present a neat appearance. Galvanized structural steel may be used where galvanized support channel is allowed. Use stainless steel hexagon head bolts with spring lock washers under all nuts. Coat ends of galvanized steel channel that has been cut with zinc-rich paint in accordance with ASTM A-780.
- F. Install freestanding electrical equipment on 4 inch concrete housekeeping pads.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide channel supports to stand cabinet 1 inch off wall.
- H. Bridge studs top and bottom with galvanized steel channels to support flush-mounted cabinets and panelboards in stud walls.
- I. Use standoffs for all surface mounted conduit to maintain 1/4 inch space between conduits and walls.

END OF SECTION

SECTION 260533

CONDUIT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Galvanized rigid steel conduit
 - 2. PVC coated metal conduit
 - 3. Electrical metallic tubing (EMT)
 - 4. Non-metallic (PVC) conduit
 - 5. Liquid tight flexible conduit
 - 6. Fittings and conduit bodies
 - 7. Conduit wall seals, existing walls
 - 8. Fire stop fittings
 - 9. Underground warning tape
 - 10. Conduit expansion joint
 - 11. Conduit sealing bushing
 - 12. Cold galvanizing compound
 - 13. Explosion proof sealing fittings
- B. Related Sections
 - 1. Section 260526, Grounding and Bonding
 - 2. Section 260529, Electrical Hangers and Supports

1.2 REFERENCES

- A. ACI 318 – Building Code Requirements for Structural Concrete
- B. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- C. ANSI/NFPA 70 - National Electric Code
- D. NEMA TC 2 - Electrical Plastic Tubing (EPT)
- E. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit
- F. ANSI C80.1 - Galvanized Rigid Steel Conduit, Zinc Coated
- G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- H. UL-6 – Standard for Rigid Metal Conduit

I. UL-6A – Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless Steel

J. ANSI C80.3 – Electrical Metallic Tubing, Zinc Coated

1.3 SUBMITTALS

A. Shop drawings, product data and reports

B. Riser Diagrams for the electrical installation

1.4 DESIGN REQUIREMENTS

A. Conduit Size: ANSI/NFPA 70

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

C. Protect PVC conduit from sunlight.

1.6 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

D. Provide complete conduit systems between electrical equipment and devices as required.

E. Where it is necessary to core a hole through an existing concrete slab or wall, the Contractor shall conduct a survey with a pachometer or by similar means to identify the location of steel reinforcing bars. The new hole shall be located so as to avoid cutting reinforcing bars or existing embedded conduits. Where reinforcing steel is close enough together that it is not possible to core the required hole without cutting reinforcing bars, contact the Engineer for further direction before cutting a hole. Where reinforcing bars are cut without the consent of the Engineer, the slab or wall will be repaired at the expense of the Contractor.

PART 2 PRODUCTS

2.1 GENERAL CONDUIT REQUIREMENTS

A. Minimum Size: 3/4 inch unless otherwise specified

B. Outdoor locations:

1. Exposed: Use galvanized rigid steel conduit

2. Buried: Use schedule 40 PVC conduit, concrete encased.

3. Buried-to-exposed conduit transitions shall be made below grade.

4. Stub out of concrete or pavement with PVC coated rigid steel conduit. PVC coated conduit shall extend at least 6" above and 6" below the concrete/pavement surface.

- C. Indoor Wet Locations:
 - 1. Stub out of floor with PVC coated rigid steel conduit. PVC coated conduit shall extend at least 6" above and 6" below the floor surface.
- D. Office Areas
 - 1. Use EMT (electrical metallic tubing)
- E. Below floors and embedded in concrete floors and walls:
 - 1. Conduit shall not be installed below or embedded in concrete floors or walls unless otherwise shown on the drawings.
- F. Conduit for Fire Alarm Systems:
 - 1. In office areas, above lay-in tile ceilings, and hollow stud walls, EMT conduit shall be used.
 - 2. In all other locations, Rigid Metal Conduit shall be used.
 - 3. All fire alarm conduit shall be factory painted red on the exterior.
- G. All Other Locations:
 - 1. Concealed: Use galvanized rigid steel conduit
 - 2. Exposed: Use galvanized rigid steel conduit, unless otherwise specified.
- H. Connections to instrumentation and portable equipment from junction boxes and connections to all motors and generators: use liquid tight flexible conduit, metallic where metallic conduit is used and nonmetallic where nonmetallic conduit is used.
 - 1. Minimum Length: 12 inches
 - 2. Maximum Length: 36 inches

2.2 GALVANIZED RIGID STEEL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; all steel fittings
- C. Hot dipped galvanized inside and outside with additional passivation coating for extra protection.

2.3 PVC COATED RIGID STEEL CONDUIT AND FITTINGS

- A. Description: NEMA RN1; rigid steel conduit with external PVC coating, 40 mil thick with 2 mil. urethane interior coating
- B. Fittings and Conduit Bodies; ANSI/NEMA FB 1; steel fittings with external PVC and internal urethane coating to match conduit. Form 8 Type, NEMA 4X rated with stainless steel encapsulated screws.
- C. Provide a PVC coated sealing locknut where transitioning from PVC coated rigid steel conduit to non-metallic conduit.
- D. Manufacturer
 - 1. Robroy Industries

2. ABB OCAL Installation Products

3. Calbond

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

A. Description: Interlocked steel construction with PVC jacket

B. Liquidtight flexible metal conduit and fittings shall be appropriate outer jacket and metallic core for application requirements.

C. Fittings: ANSI/NEMA FB 1. Fittings shall be gasketed. Material shall be zinc-coated in dry locations, galvanized in wet and damp locations, and stainless steel in corrosive locations.

D. Manufacturer

1. ABB Installation Products

2. Carlon

3. Anamet

4. Electriflex

5. Or equal

2.5 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT AND FITTINGS

A. Description: Flexible PVC conduit with smooth inner surface and integral reinforcement within the conduit wall, designated as a Type LFNC-B.

B. Fittings: UL 514B. Fittings shall be gasketed. Material shall be nylon or PVC.

C. Manufacturer

1. ABB Installation Products

2. Carlon

3. Anamet

4. Electriflex

5. Or equal

2.6 NONMETALLIC (PVC) CONDUIT

A. Description: NEMA TC 2; Schedule 40 PVC

B. Fittings: NEMA TC3

2.7 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3; galvanized tubing

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel compression or set screw type

2.8 CONDUIT WALL SEALS, EXISTING WALLS

A. Type - Suitable for core drilled holes

B. Manufacturer

N-0967-098 /3/23/26

260533 -4

Conduit

Initial
Date:


7/27/26

1. O-Z Gedney, Type CSM
2. Equal by Crouse-Hinds
3. Or equal

2.9 FIRE STOP FITTINGS

- A. Type - Fittings with elastomeric rings to seal smoke and fumes
- B. Fire rating of seal to be equal to or greater than rating of wall
- C. Manufacturers
 1. O-Z Gedney, Type CFS
 2. Or equal

2.10 UNDERGROUND WARNING TAPE, DETECTABLE

- A. Warning tape for all buried electrical conduit shall be solid aluminum foil core tape and printed with the words "CAUTION - BURIED ELECTRICAL LINE BELOW."
- B. Tape shall be red and 6 inches wide.
- C. Manufacturers
 1. Ideal Industries
 2. Cable Accessories
 3. E. L. S. Products Corp
 4. Or equal

2.11 FITTINGS AND CONDUIT BODIES

- A. Fittings
 1. Description - Threaded, malleable Iron. Material and coating to correspond with type of conduit system being used, galvanized where galvanized steel conduit is used, PVC where PVC conduit is used, and PVC-coated where PVC-coated conduit is used.
- B. Conduit Bodies
 1. Description - Threaded, gasketed malleable iron or iron alloy. Material and coating to correspond with type of conduit system being used, galvanized where galvanized steel conduit is used, PVC where PVC conduit is used, and PVC-coated where PVC-coated conduit is used.
 2. Manufacturer
 - a. Appleton-Type Mogul - malleable iron or iron alloy
 - b. Equal by ABB Installation Products
 - c. Equal by O-Z Gedney
 - d. Equal by Crouse-Hinds
 - e. or equal

C. Conduit Hubs

1. Metallic hubs shall be threaded and sealing type with neoprene gasket.
2. Material:
 - a. Zinc plated steel or cast zinc in dry locations
 - b. Cast zinc or galvanized steel in damp or wet locations
 - c. Stainless steel in corrosive locations
 - d. PVC coated steel where PVC coated conduit is used
3. Manufacturer
 - a. Crouse Hinds – Myers hub Type HUB
 - b. Equal by O-Z Gedney
 - c. Equal by RACO
 - d. Equal by Appleton
 - e. or equal

2.12 CONDUIT EXPANSION JOINT, RIGID METAL CONDUIT

- A. Weather tight, internal ground, expansion joint for galvanized rigid steel, 4 inch maximum conduit movement
- B. Manufacturer
 1. ABB Type XJG Installation Products
 2. Crouse-Hinds Type XJG
 3. Appleton Type XJ
 4. O-Z Gedney Type AX
 5. or equal

2.13 CONDUIT EXPANSION AND DEFLECTION FITTING, PVC

- A. Expansion fitting for PVC conduit shall compensate for length changes due to temperature variations in exposed conduit runs, 4-inch maximum conduit movement.
- B. Manufacturer
 1. ABB NM-XD Type Installation Products
 2. Equal by Carlon
 3. Or equal

2.14 CONDUIT SEALING BUSHING

- A. Description: Bushing that provides a waterproof seal around wire and cables in a conduit
- B. Construction: Slotted PVC coated steel discs, neoprene sealing ring and stainless steel head cap screws and washers

- C. Manufacturer
 - 1. O-Z Gedney Type CSBI

2.15 COLD GALVANIZING COMPOUND

- A. Cold galvanizing compound shall be applied to all field threads and shall be as manufactured by ZRC Products Company, a division of Norfolk Corp. or equal.

2.16 EXPLOSION PROOF SEALING FITTINGS

- A. Description: Explosion proof and dust-ignition proof sealing fitting.
- B. Ratings:
 - 1. Class I, Division 1 and 2, Groups A, B, C, D
 - 2. Class II, Division 1, Groups E, F, G
 - 3. Class II, Division 2, Groups F, G
 - 4. Class III
- C. Bodies: copper-free aluminum
- D. Plugs: copper-free aluminum
- E. Removable Nipples: copper-free aluminum
- F. Where 1 inch or smaller seals are installed vertically, provide symmetrical and uniform design with no pouring spout. Seal shall be retrofittable in case the need to rerun wires occurs.
- G. Manufacturer:
 - 1. For vertical installation 1 inch and smaller:
 - a. Killark EZ Series (copper-free aluminum)
 - b. Approved equivalent
 - 2. For other installations
 - a. Killark ENY Series (copper-free aluminum)
 - b. Approved equivalent
- H. Sealant:
 - 1. Killark Celox compound, Crouse-Hinds Chico X fiber and Chico A sealing compound or Chico Speed Seal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Junction boxes shown on the Drawings shall be provided in locations indicated. Additional boxes shall be provided as needed to comply with NFPA 70 requirements.
- B. Install conduit in accordance with NECA "Standards of Installation."
- C. Install nonmetallic conduit in accordance with manufacturer's instructions.

- D. Arrange supports to prevent misalignment during wiring installation.
- E. Support rigid steel conduit using galvanized steel or galvanized malleable iron straps, pipe hangers, U-bolt clamps and beam clamps.
- F. Support EMT using zinc coated steel straps, pipe hangers, U-bolt clamps and beam clamps.
- G. Group related conduits; support using conduit rack. Construct rack using support channel; provide space on each for 25 percent additional conduits.
- H. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
- I. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
- J. Do not attach conduit to ceiling support wires.
- K. Arrange conduit to maintain headroom and present neat appearance.
- L. Route exposed conduit parallel and perpendicular to walls.
- M. Route conduit installed above accessible ceilings parallel and perpendicular to walls.
- N. Route conduit in and under slab from point-to-point unless drawings indicate otherwise.
- O. Cross conduits in slab only with the Engineer's approval.
- P. Maintain adequate clearance between conduit and piping.
- Q. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104°F.
- R. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- S. Before installation of wires and cables, clean and dry inside of each conduit run.
- T. Provide conduit bushings on the end of each conduit to prevent insulation damage. Bushing shall be grounding type where applicable.
- U. For galvanized conduit, apply cold galvanizing compound to all field threads.
- V. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fittings. Allow joint to cure for 20 minutes, minimum.
- W. Connections to boxes/enclosures:
 - 1. Use conduit hubs with sealing gaskets on all boxes and enclosures, except those with NEMA 1 rating.
 - 2. Use conduit hubs with sealing gaskets to fasten conduit to boxes and enclosures in damp locations, wet locations, and locations below fluid piping. For wet and corrosive locations, use nonmetallic conduit hubs.
 - 3. Use two locknuts, one inside and one outside of each box and enclosure when enclosure rating is NEMA 1.

- X. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
- Y. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- Z. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints per Manufacturer's best practice and recommendations.
- AA. Provide 100-lb. test nylon pull string in each conduit 2 inch or larger except sleeves and nipples.
- BB. Use suitable caps (cast metal or thermoplastic) to protect installed conduit against entrance of dirt and moisture.
- CC. Ground and bond conduit in accordance with Section 260526.
- DD. Do not install exposed conduit in rooms with glazed tile or similar interior finish.
- EE. Do not penetrate waterproofing membranes in the structural floor slab or foundation walls without approval by, and in a manner acceptable to the Engineer.
- FF. Install rigid metal conduit using only threaded fittings.
- GG. Install a chromium plated, spun or split type escutcheon on all exposed conduits passing through walls or ceilings.
- HH. Extend pipe sleeves 3/4 inch above finished floors.
- II. Install a water and fire resistant caulking around all conduits passing through floors.
- JJ. Provide a separate conduit run for each 480V power circuit, unless otherwise shown on drawings.
- KK. Provide separate conduit runs for 480 and 120/208/240 volts systems. Install feed and control wiring in the same conduit only when shown on the Drawings or as approved by the Engineer.
- LL. Install all empty conduits in floor so finished installation is flush with finished floor. Use suitable coupling and pipe plug.
- MM. Arrange for all duct bank systems to drain away from buildings. Install duct bank systems to drain toward manholes or handholes.
- NN. Provide thru wall seals on all conduits passing through foundation walls.
- OO. Provide PVC coated rigid steel conduit at all galvanized rigid steel conduit floor penetrations in pump chambers, tunnels, cellars and other below grade high moisture areas. The PVC coated conduit shall extend at least 6" above and 6" below the floor surface.
- PP. Provide PVC coated rigid steel conduit, at least 6 inches in the concrete and 6 inches in the soil, at all galvanized rigid steel penetrations through floors or walls into soil.
- QQ. Use stainless steel or PVC coated steel hangers and straps to support PVC conduit.
- RR. Use PVC conduit fittings and bodies with PVC conduit.

- SS. Use PVC coated hangers and straps to support PVC coated steel conduit.
- TT. Use PVC coated conduit fittings and bodies with PVC coated steel conduit.
- UU. PVC coated conduit: Installer shall be Manufacturer-trained and certified for installation of the PVC coated conduit. If not certified, the Manufacturer shall provide an on-site installation training course by the company representative. Installer shall use proper installation tools that are intended for use with PVC coated rigid steel conduit.
- VV. Install underground warning tape 12 inches above all underground conduits.
- WW. Install underground conduit with minimum cover, in accordance with National Electric Code or utility requirements, but no less than 36 inches.
- XX. For non-concrete encased underground conduit installations, backfill the trench with sand borrow for the full width of the trench (at least 3-inches around sides and bottom of conduit) and extend the sand borrow 12-inches over the conduit.
- YY. For penetrations in existing walls, patch with mortar and touch up paint. Match existing paint color.
- ZZ. For penetrations in fire rated walls, use materials that maintain the fire rating of the wall.
- AAA. Conduit penetrations in the walls of wetwells, clearwells and other water or wastewater retaining structures shall be located above the maximum water elevation.
- BBB. Provide conduit expansion joints for underground conduits that enter a building through an exterior wall or connect to an exterior mounted disconnect switch, meter, or other equipment.
- CCC. Provide explosion proof sealing fittings where indicated on the Drawings and where required by code.

END OF SECTION

SECTION 260543

DUCT BANKS

PART I GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Nonmetallic conduit
 - 2. Handholes
 - 3. Installation of duct banks

4. Installation of handholes

- B. Related Sections
 - 1. Section 260533 - Conduit

1.2 REFERENCES

- A. AASHTO - Standard Specification for Highway Bridges
- B. ANSI/NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
- C. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
- D. ANSI/SCTE 77-2007 - Specification for Underground Enclosure Integrity

1.3 SUBMITTALS

- A. Manufacturer's shop drawings

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with a minimum of 5 years documented experience.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Accept conduit on site. Inspect for damage.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

PART 2 PRODUCTS**2.1 NONMETALLIC CONDUIT**

- A. Description: NEMA TC-2 Schedule 40 PVC.
- B. Fittings: NEMA TC-3.

2.2 PRECAST CONCRETE HANDHOLES

- A. Manufacturers
 - 1. Chase Precast Products
 - 2. Nashua Precast
 - 3. Arrow Concrete Products or equal
- B. Description
 - 1. Concrete Strength: Portland Cement Type I or II, air-entrained, 4500 psi compressive strength at 28 days; density 150 pcf
 - 2. Construction – bottomless, in modular sections with tongue and groove joints
 - 3. Inside dimensions – as required by NEC Article 314.28
 - 4. Knockouts for duct entry
- C. Handhole Frames and Covers:
 - 1. Material: Machined cast iron.
 - 2. Cover Type: Indented, solid top design, with two drop handles each.
 - 3. Cover Loading: AASHTO H-20.
 - 4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
 - a. Above 600 Volts: ELECTRIC HV.
 - b. 600 Volts and Below: ELECTRIC LV.
 - c. COMMUNICATIONS

2.3 POLYMER CONCRETE HANDHOLES

- A. Description
 - 1. Material shall be a polyester resin in combination with selectively graded aggregates.
 - 2. Material shall be resistant to ultraviolet light and unaffected by moisture and freezing.
 - 3. Loading – Designed to meet ANSI/SCTE 77-2007 requirements for Tier 8 (12,000 lbs) OR Tier 15 (22,500 lbs) applications.
 - 4. Dimensions – as required, or as indicated on the Drawings.
 - 5. Lid shall be provided by same manufacturer.

6. Any and all hardware required shall be stainless steel.
- B. Manufacturers
1. Quazite - Composolite
 2. Newbasis
 3. or equal

2.4 ACCESSORIES

- A. Duct Bank Spacers
1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
 2. Suitable for all types of conduit.
 3. Manufacturers
 - a. Underground Device, Inc.
 - b. Carlon.
- B. Identification Devices
1. Raceway Tags
 - a. Material: Permanent, nylon or polyethylene.
 - b. Shape: Round.
 - c. Raceway Designation: Pressure stamped, embossed, or engraved.
 - d. Tapes relying on adhesives or taped-on markers not permitted.

PART 3 EXECUTION

3.1 DUCT BANK INSTALLATION

- A. Use Schedule 40 PVC conduit for all underground duct banks.
- B. Install duct in accordance with manufacturer's instructions.
- C. Install duct to locate top of duct bank at depths as indicated on drawings (or at 36 inches below grade depths not indicated on drawings).
- D. Install duct with minimum slope of 1.5 inches per 100 feet. Slope duct away from building entrances.
- E. Cut duct square using saw or pipe cutter; de-burr cut ends.
- F. Insert duct to shoulder of fittings; fasten securely.
- G. Join nonmetallic duct using adhesive as recommended by manufacturer.
- H. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- I. Install no more than equivalent of three 90 degree bends between pull points.
- J. Provide suitable fittings to accommodate expansion and deflection where required.

- K. Terminate duct at manhole/handhole entries using end bell.
- L. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- M. Use suitable separators and chairs installed not greater than 4 feet on centers.
- N. Separate conduits by at least 7.5 inches center-to-center in duct banks.
- O. Band ducts together before placing concrete.
- P. Securely anchor duct to prevent movement during concrete placement.
- Q. For non-concrete encased conduits, backfill the trench with sand borrow for the full width of the trench (at least 3 inches around sides and bottom of conduit) and extend the sand borrow 12 inches over the conduit. For non-concrete encased ductbanks with stacked conduits, run a vibratory plate over top of sand to settle the sand between/under conduits.
- R. For concrete encased ductbanks, provide the following:
 - 1. Minimum 3 inch concrete cover at bottom, top, and sides of duct bank.
 - 2. Two No. 4 steel reinforcing bars in top of bank under paved areas.
 - 3. Connect to existing concrete encasement using dowels.
- S. Excavation, backfill and compaction of trenches shall be performed per the contract documents.
- T. Provide suitable pull string in each empty duct except sleeves and nipples.
- U. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- V. Handhole sizes shall be as required by code.
- W. Provide handholes where shown on the Drawings and provide additional handholes and where required to meet code, meet Utility requirements, and as required to pull wiring without damaging insulation. Coordinate locations of additional handholes with the Engineer.

3.2 PREPARATION FOR INSTALLATION HANDHOLES

- A. Contractor shall provide excavation, installation of base material, and compaction of base material in accordance with the contract documents.

3.3 INSTALLATION – PRECAST CONCRETE HANDHOLES

- A. Install and seal precast sections in accordance with manufacturer's instructions.
- B. Install handholes plumb.
- C. Set the top of each handhole to finished grade.

3.4 INSTALLATION – POLYMER CONCRETE HANDHOLES

- A. Install and seal sections in accordance with manufacturer's instructions.
- B. Install handholes plumb.
- C. Set the top of each handhole to finished grade.

3.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of exact routing of duct bank.
- B. Accurately record actual locations of each manhole and each handhole.

END OF SECTION

SECTION 260553

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Nameplates
 - 2. Wire and cable markers

1.2 REFERENCES

- A. NEMA WC5 - Thermoplastics - Insulated Wire and Cable for Transmission and Distribution of Electrical Energy

1.3 SUBMITTALS

- A. Provide schedule for nameplates.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Engraved two-layer plastic, white letters on a black background
- B. Nameplate Wording:
 - 1. Wording of the nameplates shall be in conformance with Drawings and acceptable to the Owner.
 - 2. Wording of the nameplates for each piece of equipment shall be based on the common name and tag number (when applicable) of the equipment.

2.2 WIRE AND CABLE MARKERS

- A. Wires up to AWG10: Split sleeve or tubing type waterproof markers (Thomas & Betts, Panduit, Burndy or equal).
- B. Wires AWG8 and larger: Plastic impregnated cloth markers, resistant to abrasion, moisture, dirt and oil (Ideal, Panduit, Brady or equal).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates.
- B. Install nameplates parallel to equipment lines.
- C. Secure nameplates to equipment fronts using ASA Type U drive screws, and water-resistant adhesive. Secure nameplate to face of panelboard doors one third of the way down from the top of the door. Embossed tape will not be permitted for any application.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each end of each conductor in panelboard gutters, pull boxes, outlet and junction boxes, switchgear, switchboards, motor control centers, control panels, at each load connection and at each terminal board connection. Identify wiring as following:
 - 1. Power and lighting circuit wires: Wire markers shall identify (a) power source/panelboard name and circuit ID number (e.g. "LP-1,2,3"), and (b) load/equipment name (e.g. "VFD 1").
 - 2. Control & signal wiring: The identification on wire markers shall match the ID tag number of the wire/terminal shown on the associated equipment shop drawings.
- B. Circuits passing through junction boxes shall be individually grouped and bound with Ty-raps.
- C. Include the following color coding of all conductors used for power or lighting circuits.
 - 1. 120/240 volt, single phase 3 wire
 - a. Black - Phase A
 - b. Red - Phase B
 - c. White - Neutral
 - d. Green - Equipment ground
 - 2. 120/208 volt, three phase 4 wire
 - a. Black - Phase A
 - b. Red - Phase B
 - c. Blue - Phase C
 - d. White - Neutral
 - e. Green - Equipment ground
- D. Color coding of multiconductor control cables shall be in accordance with NEMA Standard WC5.

3.3 NAMEPLATE ENGRAVING SCHEDULE

- A. Provide nameplates of minimum letter height as scheduled below.
- B. Panelboards and Switchboards - 1/4 inch to identify equipment designation, 1/8 inch to identify voltage rating and source.
- C. Switches in Panelboards and Switchboards- 1/4 inch to identify circuit and load served, including location.
- D. Motor Starters and VFDs - 1/4 inch to identify circuit and load served, including location.
- E. Individual Circuit Breakers, Enclosed Switches, Remote Operator Stations, Time Clocks, Control Devices, and Motor Starters – 1/8 inch to identify load served.

- F. Transformers - ¼ inch to identify equipment designation, 1/8 inch to identify primary and secondary voltages, primary source, and secondary load and location. Power transformer nameplates shall be in accordance with ANSI C57.
- G. Pumps, fans, and other electrical equipment - ¼ inch to identify circuit and equipment designation.
- H. Equipment with More Than One Power Source, Including Motors with Heaters - ¼ inch to identify power sources. Mount nameplate on motor disconnect switch, equipment enclosure, or other prominent location.
- I. Provide a red nameplate/marker stating "Fire Alarm" tag at the circuit breaker feeding fire alarm system equipment, ELOCK-FA circuit lockout kit by Space Age Electronics or equal.

END OF SECTION

SECTION 260800

ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Testing of Electrical Systems - General
 - 2. Electrical Test Equipment
 - 3. Electrical Test Procedures
 - 4. Specific Electrical Tests
 - 5. System Function Tests
- B. Related Sections
 - 1. Section 260526 – Grounding and Bonding
 - 2. Section 260553 – Electrical Identification

1.2 REFERENCES

- A. National Electrical Code with New Hampshire Amendments
- B. NFPA 79 – Electrical Standard for Industrial Machinery
- C. ANSI C37

1.3 SUBMITTALS

- A. General: Testing shall be performed, with satisfactory results, prior to connecting and energizing equipment. Problems discovered as a result of testing shall be corrected and retesting performed prior to connecting and energizing equipment.
- B. The following test reports shall be submitted
 - 1. Motor test results
 - 2. Megger test results
 - 3. Wire and cable continuity test results
 - 4. Grounding system test results
 - 5. System functional test reports

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 TESTING OF ELECTRICAL SYSTEMS - GENERAL

- A. Provide supervision, labor, materials, tools, test instruments and other equipment or services and expenses required to test, adjust, set, calibrate, and operationally check work and components of the various electrical and control systems and circuitry throughout the contract.
- B. Pay for all tests specified in Division 26, including expenses incident to re-tests occasioned by defects and failures of equipment to meet specifications. Unless otherwise specified, the Owner will supply the electric current necessary for tests.
- C. After completion of testing replace wiring and equipment found defective (defined as failing to meet specified requirements).
- D. Do not void equipment warranties or guarantees by testing and checkout work. Checks and tests shall be supplemental to and compatible with the manufacturer's installation instructions. Where deviations are apparent, obtain the manufacturer's approved review of procedure prior to testing. Where any repairs, modifications, adjustments, tests or checks are to be made, contact the Engineer to determine if the work should be performed by or with the manufacturer's representative. All checks and tests specified for proper operating and safety of equipment and personnel are to be performed concurrent with progression of the work, prior to final acceptance by the Owner.
- E. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, or faulty, is to be reported to the Engineer. Corrective action requires Engineer's approval prior to re-testing, and inspection.
- F. Prior to testing and start-up, equipment and wiring shall be properly and permanently identified with nameplates, and other identification as specified in Section 260553. Check and tighten terminals and connection points, remove shipping blocks and thoroughly clean equipment, repair damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions for delivery to the Engineer. Make routine checks and tests as the job progresses to ensure that wiring and equipment is properly installed.
- G. Testing and checkout work is to be performed with fully qualified personnel skilled in the particular tests being conducted. Personnel are to have at least 5 years of experience with tests of same type and size as specified.
- H. Make openings in circuits for test instruments and place and connect instruments, equipment, and devices, required for the tests. Upon completion of tests, remove instruments and instrument connections and restore circuits to permanent conditions.
- I. Identify test being performed, conductor or equipment the test is being performed on, date the test was performed, value of test results, person performing the test, the witness to the test, and the serial and model number and description of test instrument. Arrange information in tabular form and submit to the Engineer for approval.
- J. When the electrical tests and inspections specified or required within Division 26 are complete and results reported, reviewed, and approved, that portion of the electrical equipment system or installation may be considered electrically complete. Affix appropriate, approved, and dated completion or calibration labels to the tested equipment and notify the Engineer of electrical completion. If the Engineer finds completed work unacceptable, he will notify the Contractor in writing of unfinished or

deficient work, with the reason for his rejection, to be corrected by the Contractor. The Contractor will notify the Engineer in writing when exceptions have been corrected. The Contractor will prepare a "notification of Substantial Electrical Completion" for approval by the Engineer following the Engineer's acceptance of electrical completion. If later in-service operation or further testing identifies problems attributable to the Contractor, these will be corrected.

3.2 ELECTRICAL TEST EQUIPMENT

- A. Test equipment used is to be inspected and calibrated.
- B. Perform calibration and setting checks with calibrated test instruments of at least twice that of the accuracy of the equipment, device, relay or meter under test. Dated calibration labels shall be visible on test equipment. Calibrations over 6 months old are not acceptable on field test instruments. Inspect test instruments for proper operation prior to proceeding with the tests.
- C. Perform ground tests using a low resistance, Null balance type, ground testing ohmmeter, with test lead resistance compensated for. Use the type of test instrument which compensates for potential and current rod resistances.

3.3 TEST PROCEDURES

- A. Prepare procedures and schedules for the work specified herein. This work is to be coordinated and compatible with both the work and schedule of the other crafts. Sequence the tests and checks so that the equipment can be energized immediately after the completion of the application tests.
- B. The test procedures shall provide specific instructions for the checking and testing of each electrical component of each system. Schedule tests and inspections as the job progresses.
- C. Testing and checkout work shall be conducted in a safe manner. Provide the following special safety precautions, as appropriate:
 - 1. Locking and tagging procedures
 - 2. Barricades
 - 3. De-energization and/or isolation of equipment prior to testing
 - 4. Review of procedures with the Engineer and Resident Project Representative
 - 5. Erection of warning signs
 - 6. Stationing of guards and watchmen
 - 7. Maintenance of voice communications
 - 8. Personnel orientation
- D. Before energizing any machine, visually inspect for serviceability. Check manufacturer's instruction manual for correct lubrication and ventilation. Align motor with driven equipment. Check nameplate for electrical power requirements.
- E. Perform insulation tests at the following times and conditions:
 - 1. Prior to energization and/or placing into service.

2. When damage to the insulation is suspected or known to exist.
 3. After repairs or modifications to the equipment affecting the insulation.
 4. Where lightning or other surge conditions are known to have existed on the circuit.
- F. Where ground test results identify the need for additional grounding conductors or rods that are not indicated or specified, design changes will be initiated to obtain the acceptable values.
- G. If the insulation resistance between conductors and ground reads below ANSI C37 minimums with the breakers out, follow the manufacturer's recommendations to restore readings to acceptable levels and retest.

3.4 SPECIFIC ELECTRICAL TESTS

- A. Wire and Cable
1. For all 480 volt circuits, megger test the insulation of every external circuit wire to each other and to ground. Tests shall be conducted at voltages of 1,000 V DC and record results.
 2. Continuity test each control and/or low voltage (below 480 volts) wire and cable to verify the field applied tag per conductor and record results.
- B. Perform insulation tests on electrical equipment, apparatus, generators, transformers, power circuit breakers and switches, and similar electrical equipment.
- C. Relay Panels, Operator and Instrument Control Panels, Programmable Controllers, Micro-Processors, Battery Systems and Other Miscellaneous Equipment
1. Upon completion of equipment installation, visually and functionally test equipment and their control devices for tightness of connections and for proper operation. In the case of battery systems, static inverters and similar equipment, follow manufacturer's recommended test and installation manuals upon review and approval by the Engineer. In the case of operator, instrument, and relay panels and cabinets or devices used solely for control, functionally test each circuit for proper operation and compliance with the Drawings and Specifications. Where functional testing is deemed undesirable by the Engineer from a safety or plant operational standpoint, then continuity and terminal connection verification checks will be acceptable.
- D. Grounding Systems
1. Test in accordance with Section 260526.

3.5 SYSTEM FUNCTION TESTS

- A. It is the purpose of system function tests to prove the correct operation of systems/equipment and correct interaction of all sensing, processing, and action devices.
- B. Perform system function tests upon completion of the maintenance tests defined, as system conditions allow. Document results and submit a detailed report for all functional tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 2. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 3. Verify the correct operation of all sensing devices, alarms, and indicating devices.
 4. Verify communication assisted protection schemes via end-to-end testing.
 5. Measure latency of communication lines for pilot wire, line differential and transfer trip protection schemes.
 6. Function test bus restoration and/or transfer switches.
 7. Verify correct metering on protective relays and meters.
 8. Verify control circuits and current transfer circuits are restored to normal operation.
 9. Verify communication lines are operational for local and remote devices.
 10. Verify control annunciation systems are left with no alarms and any alarms present shall be investigated.
- C. Verify systems are left in normal operating mode or position, transfer and restoration schemes are enabled, and monitoring and protection devices are operational.

END OF SECTION

SECTION 262816

SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Circuit Breakers
 - 2. Switch Assemblies
- B. Related Sections
 - 1. Section 260529 – Electrical Hangers and Supports

1.2 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers.
- B. NEMA KS 1 – Enclosed Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

1.3 SUBMITTALS

- A. Shop drawings, product data, and reports.
- B. Circuit breaker trip current and let-through current curves, outline dimensions, and terminal lug sizes.

1.4 REGULATORY REQUIREMENTS

- A. Use circuit breakers and switch assemblies listed by Underwriter's Laboratories, Inc., and suitable for specific application.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton
- B. Square D
- C. Siemens
- D. Or equal

2.2 MOLDED CASE CIRCUIT BREAKER

- A. CIRCUIT BREAKER: NEMA AB-1. FS W-C-375.
- B. Service Conditions:
 - 1. Temperature: 40 C.
- C. Interrupting Rating: For circuit breakers that are part of a panelboard or other equipment, the interrupting rating shall be equal to or greater than that of the equipment. For stand-alone circuit breakers, the interrupting rating shall be a minimum of 35,000 AIC.

- D. Enclosure: NEMA 12 dust tight industrial indoor dry locations, NEMA 3R raintight (lockable) for outdoor locations, and NEMA 4X stainless steel for wet and damp locations
- E. Configuration: Inverse time automatic tripping. Instantaneous automatic tripping, for motor circuit protection.
- F. Field-Adjustable Trip Circuit Breaker: NEMA AB 1; provide circuit breakers with frame sizes 100 amperes and larger with mechanism for adjusting long time, short time continuous current, short time, long time pickup current, and instantaneous setting for automatic operation.
- G. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; zero sequence type ground fault sensor; instantaneous trip; and adjustable short time trip.
- H. Phase Failure Protection
 - 1. For the Main Circuit Breaker, provide with an adjustable three phase-sensing single phase failure protection relay, factory wired including required controls interface to the breaker's shunt trip mechanism. The equipment shall include a stored-energy device rated to power the shunt trip mechanism of the breaker. The relay shall be set to 85% nominal voltage for tripping and shall be resettable at 90% nominal voltage.
- I. Ratings: NEMA AB 1; as scheduled.
- J. Provide a lockable hasp with each circuit breaker.

2.3 SWITCH ASSEMBLIES

- A. Interrupting Rating: The interrupting rating shall be a minimum of 35,000 AIC.
- B. Nonfusible Switch Assemblies: NEMA KS 1; FS W-S-865; heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF and ON positions.
- C. Fusible Switch Assemblies: NEMA KS 1; FS W-S-865; heavy duty, quick-make, quick-break load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF and ON positions. Fuse Clips: FS W-F-870. Designed to accommodate Class R fuses unless otherwise indicated.
- D. The switch ampacity shall meet or exceed the circuit ampacity shown on the drawings.
- E. Accessories:
 - 1. Unless shown otherwise, provide all fusible disconnect switches with fuses rated for the full ampacity of the disconnect switch frame.
 - 2. Provide all disconnect switches downstream from VFDs or Soft-Starters with auxiliary contacts.
- F. Enclosure: NEMA 12 for indoor dry locations, NEMA 3R raintight (lockable) for outdoor locations, and NEMA 4X stainless steel for wet and damp locations.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on Drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.

3.2 INSTALLATION

- A. Install circuit breakers and switch assemblies where shown on Drawings, in accordance with manufacturer's instructions.
- B. Provide all necessary hardware and supports and make all wiring connections.
- C. Support equipment of this Section in accordance with Section 260529.
- D. Provide fuses in all fusible switch assemblies, whether fuses are shown on the drawings or not. For HVAC equipment, coordinate fuse size required with HVAC contractor.

3.3 ADJUSTING

- A. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in the circuit. Use trip settings provided by the Engineer. Coordinate with Engineer to request settings at least 2 weeks prior to starting up the equipment.

3.4 FIELD QUALITY CONTROL

- A. Inspect visually and perform several mechanical ON-OFF operations on each circuit breaker and switch assembly.
- B. Verify circuit continuity on each pole in closed position.

END OF SECTION

SECTION 263100

PHOTOVOLTAIC ENERGY EQUIPMENT - PERFORMANCE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This document supplies the performance specifications for a photovoltaic (PV) system to be installed on the roof of Building #12 in Center Strafford, NH. The energy produced via a photovoltaic array shall be connected to Building 12 main electrical distribution panel through grid-tied DC to AC inverters and DC coupled Battery Energy Storage System (BESS).
- B. The Contractor shall supply all components necessary to configure the specified PV system including, but not limited to, the PV modules and associated PV panel mounts, racking, flashing, combiner boxes, interconnection wiring and cabling, AC to DC inverter, BESS, panel, circuit breakers and disconnect switches. In addition, the Contractor shall provide design, operation, and maintenance documentation, and shall package all equipment for domestic overland shipment in a manner suitable to ensure the adequate protection of the equipment during transport.
- C. The PV System described in this document shall be of the utility-interactive type and shall include battery backup storage and no other secondary electrical generation devices. The PV System shall feed Alternating Current (AC) power into the distribution system when solar energy is available and shall immediately disconnect from the grid upon loss of grid power to the service as per IEEE, NEC, and local utility regulations.
- D. The PV System shall be interlocked with standby/portable generators to prevent inverter and generator parallel operation, synchronization, or backfeed to the system while the generator is operating.
- E. Related Sections
 - 1. Section 260526 – Grounding and Bonding
 - 2. Section 260529 – Hangers and Supports
 - 3. Section 260553 – Electrical Identification
 - 4. Section 260800 - Electrical Testing
 - 5. Section 260519 – Conductors and Cables
 - 6. Section 260533 - Conduit

1.2 REFERENCES

- A. National Fire Protection Association (NFPA) 70, National Electrical Code, 2020 including New Hampshire amendments.
- B. National Fire Protection Association (NFPA) 855, Standard for the Installation of Stationary Energy Storage Systems
- C. National Electrical Manufacturers Association (NEMA)
- D. American National Standards Institute (ANSI) / Underwriters Laboratories, Inc. (UL) 1703 Standard for Flat-Plate Photovoltaic Modules and Panels.

- E. ANSI/UL 1699B Photovoltaic (PV) DC Arc-Fault Circuit Protection
- F. ANSI/UL 1741 Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
- G. ANSI/UL 2703 Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels.
- H. ANSI/UL 3730 Photovoltaic Junction Boxes
- I. ANSI/UL 3741 Photovoltaic Hazard Control
- J. ANSI/UL 9540 Energy Storage System (ESS) Requirements
- K. ANSI/UL 9540A Battery Energy Storage System (ESS) Test Method
- L. Institute of Electrical and Electronics Engineers (IEEE) 1547-2018 Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electrical Power Systems Interfaces
- M. ASCE 7-16 – Minimum Design Loads for Buildings and Other Structures
- N. International Building Code – [IBC 2021]
- O. New Hampshire State Building Code

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components, profiles and finishes for PV panels.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. When manufacturer's cut sheets apply to more than one possible product, clearly indicate the data, and catalog numbers, including options, specifically applicable to this project.
 - 4. General catalogs are not acceptable as product data sheets.
- B. Shop Drawings: For Photovoltaic Energy Equipment.
 - 1. Submit system performance calculations to show that the components provided will produce the minimum required production of power in accordance with DESCRIPTION paragraph.
 - 2. Include plans, elevations, sections, and mounting details.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Detail fabrication and assembly.
 - 5. Include statement from manufacturer that racking equipment is compatible with the selected PV module.

6. Include diagrams for power, signal, and control wiring.
7. Include voltage drop calculations for DC circuits.
- C. In addition to Product Data, Shop Drawings, and other required submittals, submit a statement indicating compliance with performance requirements, including analysis, signed and sealed by the qualified Professional Engineer responsible for their preparation.
 1. System sizing analysis that meets the following parameters:
 - a. Nominal power of PV system: **30 kW** (+/- 0.5%)
 - b. Detailed description of test procedures and site commissioning test.
 - c. Electrical schematic diagram indicating proposed PV arrays and interconnection of all components.
 - d. System Operation & Maintenance Manual
 - e. All equipment installed indoors and outdoors shall be UL- or ETL-listed and/or NEMA rated accordingly.
- D. Design Calculations: Inverter manufacturer's string-sizing calculation showing satisfactory performance of the proposed module, MLPE, stringing, and inverter configuration. Calculations for the BESS shall be provided showing estimated runtime and charging/discharging information.
- E. All equipment and material to be supplied shall be designed to withstand the environmental conditions at the project site.
- F. Submit structural calculations/design for all foundations and structures required, including roof racking systems. Structural design shall be stamped by a Professional Engineer in the State of New Hampshire.
 1. Submit system mounting details and drawings.
- G. Submit complete external electrical interconnection diagrams for contractor wiring including electrical interlocks and connections shall be supplied within four weeks after approval and release for manufacturing to aid the Contractor in installation.
- H. Coordinate Utility interconnection with the Contractor. Allow adequate lead time for coordination with Eversource. Within thirty (30) days of the effective date of the Notice to Proceed, provide a schedule of the work indicating the following:
 1. Intended sequence of work items;
 2. Start dates of individual work items;
 3. Duration of individual work items;
 4. Planned delivery dates for major material and equipment and expected lead times;
 5. Milestones indicating possible restraints on work by other trades or situations.
- I. Complete, submit, and pay for solar interconnection agreement with Eversource.
 1. Contact the Owner for coordination on existing accounts and contracts with Eversource, including net metering per RSA 362-A.

- J. Each submitted piece of literature and drawing shall clearly reference the relevant equipment and/or system.
- K. Proof of North American Board of Certified Energy Practitioners (NABCEP) Certification, including the names of the certified installers that will be performing the work.

1.4 ENVIRONMENTAL SPECIFICATIONS

- A. All equipment and materials to be supplied shall be designed so as to withstand the environmental conditions at the project site:
 - 1. High/Low Record Temperatures:
 - 2. Average High Temperature:
 - 3. Relative Humidity:
 - 4. Wind Speed: 95 mph
 - 5. Exposure Category: C
 - 6. Seismic Exposure Category: C

1.5 STRUCTURAL SPECIFICATIONS

- A. The roof racking system and photovoltaic module weights, dimensions and installation shall be designed around the existing roof structural design criteria:
 - 1. 24 Ga. 'Corle "R" PBR' roof panel sections.
 - 2. Roof Dimensions: 60 ft. Width x 80 ft. Length
 - 3. Eave Height: 13 ft.
 - 4. Roof Slope (rise/12): 3.0 : 12
 - 5. Roof Live Load: 20.00 psf
 - 6. Roof Snow Load: 61.6 psf

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.
 - 1. Submit manuals that detail the step-by-step procedures required for system start-up, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and brief descriptions of all equipment and their basic operating features. List routine maintenance procedures, possible breakdowns, and repairs, recommended spare parts, troubleshooting guides, wiring and equipment layout, and simplified wiring and control diagrams.
- B. Field Test and Inspection Reports with the final Operation and Maintenance Manuals
- C. Upon acceptance of the completed installation, submit record (as-built) documents as follows:
 - 1. Project Record Drawings shall be as-built versions of the Contract Drawings, delivered in AutoCAD.

2. Keep accurate daily records of all deviations in the work from the original design by clearly marking up and noting them on the contract drawings.
 3. Certify the accuracy of each drawing by endorsing and signing each submitted drawing.
 4. When work is complete, furnish one complete Record Set of marked drawings.
- D. Any CAD drawings, including Record Drawings, shall be submitted in *.dwg format, AutoCAD Release 2017, or later version, electronically. All drawings shall be neat, clear, and well arranged.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable New Hampshire Building Code.
- B. Electrical - Conform to the state-adopted version of the National Electrical Code New Hampshire amendments. All references to the National Electrical Code or NEC in the project manual or on the drawings shall be construed as references to the New Hampshire Electrical Code.
- C. Conform to applicable Local Building Codes.
- D. Obtain and pay for all applicable permits.
- E. Schedule and pay for all inspections necessary for the electrical installation including but not necessarily limited to the general electrical inspection and fire department inspections.

1.8 WARRANTY

- A. Manufacturer's Warranty
- B. The Contractor shall obtain from the manufacturer its warranty that the PV energy equipment including panels will be free from defects in design, materials, and workmanship for a period of two years following substantial completion and shall provide a 25 year power performance warranty.

1.9 SEISMIC REQUIREMENTS

- A. Components, systems and their supports shall be designed by the contractor in accordance ASCE 7-16, Section 13.6 Mechanical and Electrical Components, the International Building Code (IBC 2021), and the New Hampshire Amendments to IBC.
- A. Submit details showing the seismic restraints.
- B. Submit stamped, signed certification from a New Hampshire licensed professional structural engineer that the design meets the seismic restraint requirements.

PART 2 PRODUCTS

2.1 GENERAL

- A. Products shall be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) recognized by OSHA if a listing for that product is available. NRTL shall be Underwriter's Laboratory (UL), Electrical Testing Laboratory (ETL), Factory Mutual (FM) or equal.

- B. Equipment Ampere Interrupting Capacity (AIC) and/or Short Circuit Current Rating (SCCR): Electrical equipment shall be labeled in accordance with NFPA 70 and have an Ampere Interrupting Capacity rating or Short Circuit Current Rating of equal to or greater than the following:
 - 1. 240 volt equipment: **35,000** amps
- C. Provide a PV array consisting of (84) eighty-four, Tier-I mono-crystalline PV panels arranged in strings. The overall output shall be; 30,000 STC Watts' +/- 0.5%.
- D. Photovoltaic array shall be installed on the roof of Building #12, as coordinated with the Owner. Maintain 5-foot clearance from the edge of roof at all locations. All support structures, and necessary appurtenances for mounting the array shall be provided.
- E. Connections between the modules and combiner box shall consist of series strings interconnected with pre-manufactured cables. Cables shall be USE-2 RHH/RHW-2 #10 AWG copper, rated 90°C and approved for use with PV systems. Connectors shall be UL-listed and rated for 90°C wet conditions, outdoor use.
- F. Provide all Balance of System (BOS) components required to accommodate the installation of the PV system to the existing electrical infrastructure. The main circuit breaker within the Building #12 main distribution panelboard shall be derated as required to accommodate the installation of the PV system.
- G. Provide all equipment required by the Utility provider including but not limited to a visible load-break gang-operated utility-accessible disconnect.

2.2 PHOTOVOLTAIC MODULES

- A. All components within this section shall be sourced to ensure compatibility with one another. Confirm the selected manufacturer is a Tier I manufacturer.
- B. Capacities and electrical characteristics listed on the manufacturer's datasheet shall be based on Standard Test Conditions of 1000W/m², cell temperature 25 degrees C, wind speed 1 m/s. Each module shall be rated at 350W and will include the following information:
 - 1. Module Dimensions
 - 2. Weight
 - 3. Maximum power per Module
 - 4. Voltage at Maximum Power
 - 5. Current at Maximum Power
 - 6. Short Circuit Current
 - 7. Open Voltage Current
 - 8. Power Tolerance
 - 9. Module Efficiency
 - 10. Maximum Static Load

- C. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and fire safety, Class A, according to UL 1703.

2.3 MODULE LEVEL POWER ELECTRONICS (MLPE)

- A. The module level power electronics in this section are for optimization of DC power for energy production. The MLPE are high efficiency DC-to-DC converters with custom application specific integrated circuit devices. In addition to providing Maximum Power Point Tracking (MPPT), the MLPE also provides safety functions that allow the system to meet specific requirements of the NEC.
- B. All components within this section shall be sourced from a single manufacturer to ensure compatibility with one another. Confirm the selected manufacturer has a manufacturing facility within the USA.
- C. The following MLPE electrical characteristics shall be provided:
 - 1. Module Rated Power DC
 - 2. Absolute Maximum Input Voltage DC
 - 3. MPPT Operating Range DC
 - 4. Maximum Short Circuit Current
 - 5. Maximum Output Current
 - 6. Maximum System Voltage DC
 - 7. Maximum Efficiency
 - 8. Safety Voltage
- D. The MLPE shall be capable of rapid shutdown of energized PV circuits and meet the requirements of NEC and UL 1741 for Photovoltaic Rapid Shutdown System (PVRSS).

2.4 UTILITY-INTERACTIVE INVERTER

- A. All components within this section shall be sourced from a single manufacturer to ensure compatibility with one another. Confirm the selected manufacturer has a manufacturing facility within the USA.
- B. The PV System contractor and inverter manufacturer shall be responsible for ensuring the manufacturers' inverter is capable of all the requirements herein for performance and design. The PV System Contractor shall be responsible for string configuration adjustments required and shall submit the configuration for review and approval. At a minimum, a single utility-interactive inverter, input 1,000 VDC maximum, output 240 Volt, single-phase shall be provided with the following electrical characteristics information provided:
 - 1. Maximum Recommended PV Input Power
 - 2. Operating Voltage Range DC
 - 3. Maximum Input Current
 - 4. Maximum Input Short Circuit Current

5. Maximum Number of DC Input Pairs
6. Maximum Rated AC Power Output
7. Maximum Continuous Output Current
8. Nominal Output Voltage
9. California Energy Commission (CEC) Weighted Efficiency
10. DC/AC Terminal Range (AWG)
11. Enclosure NEMA Rating
12. Physical Characteristics:
 - a. Inverter Dimensions
 - b. Inverter Weight
- C. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and safety according to UL 1741 and applicable UL standards.
- D. The inverter shall be capable of rapid shut down, arc fault protection and be compliant with IEEE-1547 and utility required parameters.
- E. The inverter shall employ maximum power point tracking (MPPT) technology and shall have a communication port capable of remote monitoring of inverter operation from a computer or from specialized monitoring equipment using RS-485 protocol.
- F. The inverter shall be capable of completely automatic, continuous, unattended, and stable operation over the voltages, currents, and power levels and temperatures for the size, type, and location of the array to which it is connected, including startup, synchronization with the utility provider and disconnect.
- G. The following protective functions shall be listed as part of the inverter:
 1. AC Over/Under Voltage
 2. AC Over/Under Frequency
 3. Overcurrent protection for DC input and AC output.
 4. AC & DC Surge Protection
 5. Anti-Islanding Protection
 6. Reverse-polarity protection
 7. A method for interlocking with a standby generator. The PV System contractor shall be responsible for coordination with the standby generator and inverter manufacturer's and producing the required documentation to demonstrate the compliance with utility requirements and prevention of parallel operation of the inverter and standby generator.
- H. In addition to the utility required disconnect, an AC and DC disconnect shall be supplied with the inverter or shall be integral to the inverter and rated for the continuous operation at the inverter's maximum capacity. Verify that the lugs are adequate to accept the cable sizes shown in the contract drawings.

- I. Total harmonic distortion shall be in compliance with the utility requirements and IEEE for interconnection of Distributed Energy Resources (DERs) and not require an external isolation transformer.
- J. The inverters operator interface shall consist of a multi-line LCD text display on the front. It shall have an automatic visual indicator showing whether the system is online or not. Provide at no charge, any inverter firmware upgrades that become available during the warranty period, and that resolve known software deficiencies as identified by the equipment manufacturer.
- K. Manufacturer shall be Solar Edge or approved equal.

2.5 BATTERY ENERGY STORAGE SYSTEM

- A. Wall mounted, DC coupled, battery energy storage system for outdoor installation and sized per the inverter manufacturers requirements and for the capacity restrictions of each inverter.
- B. The following electrical characteristics shall be provided for each BESS:
 - 1. Battery Information
 - a. Depth of Discharge
 - b. Battery Chemistry
 - c. Nominal Capacity
 - d. Voltage Range
 - e. C-Rate
 - f. Rated life
 - 2. Rated Continuous Output Power
 - 3. DC Voltage Range
 - 4. AC Voltage Range
 - 5. Efficiency
 - 6. Communication Protocols
 - 7. Operating Temperature
 - 8. Ventilation
 - 9. Enclosure Rating
- C. NRTL (Nationally Recognized Testing Laboratory) Listing: Entire assembly shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for electrical and safety according to UL 9540, 9540A and applicable UL standards.

2.6 PV WIRING

- A. All wiring shall be installed in accordance with the National and New Hampshire Electrical Codes.

- B. All wiring shall be new and copper conductors suitable for the location in which it is used, and rated for the conditions in which it is installed.
- C. All raceways containing PV wiring shall be labeled at every 10' and at entry and exits to separate spaces with the following: "PHOTOVOLTAIC POWER SOURCE" or "SOLAR PV DC CIRCUITS".
- D. All low voltage wiring shall be 1000V rated, UV resistant, labeled as such, and listed for the temperature rating of 90°C and shall be of the type permitted by the National and New Hampshire Electrical Code.
- E. Communication and interlocking cables shall conform to the requirements given by the inverter manufacturer.
- F. The use of any exposed conductors or cabling (excluding equipment bonding, and grounding conductor wiring) is not acceptable unless otherwise specified. String wiring beneath the modules shall be permitted to be run exposed beneath the modules. Provide supports and run in a neat and orderly fashion.
- G. All DC and AC wiring connected to the inverter shall conform to requirements given by the inverter manufacturer.
- H. Grounding and bonding methods shall be according to the requirements of the National Electrical Code.
- I. Grounded DC conductors shall be color coded in accordance with the National and New Hampshire Electrical Code 200.6(A)(5).

2.7 MOUNTING STRUCTURES

- A. Structural design calculations and fabrication drawings shall be prepared and stamped by a Professional Engineer registered in New Hampshire. The mounting system manufacturer shall include any field-testing including uplift as required to perform the complete design and determine spacing and means of attachment.
- B. The rooftop rack-mount system shall be fixed-tilt, portrait mounted modules, and shall be designed using local environmental (wind, snow, and seismic) information per the governing and/or local building codes.
- C. The rooftop rack-mount system frame and brackets shall be aluminum with stainless steel hardware and fasteners.
- D. It shall be the responsibility of the PV system contractor to furnish and install all necessary mounting hardware and to coordinate and comply with the manufacturer installation requirements.
- E. Mounting rack shall provide for each module to be individually removed for maintenance, repair, or replacement. The mounting rack shall ensure that the bonding of all modules is not broken if a module is removed.
- F. The system shall not violate the roof warranty and shall be listed and labeled to UL 2703.
- G. The racking system corrosion warranty shall be a minimum of 20 years. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Do not begin installation until mounting surfaces have been properly prepared.
- C. If preparation of mounting surfaces is the responsibility of another installer, notify the Engineer preparation before proceeding.
- D. Examine modules and array frame before installation. Reject modules and arrays that are damaged.
- E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- F. Proceed with installation only after unsatisfactory conditions have been corrected. The Contractor shall be responsible for providing all required components and work related to unsatisfactory conditions at no extra cost to the Owner.

3.2 INSTALLATION

- A. Complete all electrical work in accordance with NFPA 70.
- B. Coordinate PV Array installation with building envelope penetration and confirm roof area is capable of handling the designed array size with no overhanging edges except as per design.
- C. Provide all permanent and temporary shoring, anchoring, and bracing required by the nature of this work in order to make all parts absolutely stable and rigid, even when such shoring, anchoring, and bracing are not explicitly called for.
- D. All drawings, specifications, and component manuals are to be read and understood prior to installation of the PV System. The contractor shall designate a NABCEP certified Photovoltaic Installer as site supervisor.
- E. Install the solar PV system in accordance with this section, installation drawings, and the printed installation instructions of the manufacturer.
- F. Follow the manufacturer's installation recommendations to ensure no electricity is being fed to the grid and that all available disconnects are in the open position and fuses are not installed during wiring operations.
- G. Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections.
- H. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring. Ensure wires and conduit are not installed as a trip hazard.
- I. Attach solar PV modules to the mounting structure according to the manufacturer's instructions and approved plans.
- J. Inverter shall be located in a space that complies with the inverter's clearance and ambient temperature operating requirements.

- K. Install all wiring connections and terminations at PV modules, inverter, and standby generator in accordance with manufacturers' instructions. Coordinate connectors, contacts, and wiring required for installation with each manufacturer.
- L. Verify integrity of all wiring to ensure continuity and absence from electrical short circuits.
- M. Ensure installation meets local utility's interconnection requirements and connect PV system to the electrical distribution system.
- N. Install instrumentation according to the manufacturer's instructions, with control panels located as indicated
- O. Provide final and complete commissioning of the solar PV system in accordance with IEEE 1547.
- P. Verify that all electrical components are installed and connected according to the requirements of the PV electrical drawings, specifications, and manufacturer's written instructions.
- Q. Before starting or operating the system, check continuity of all conductors and grounding conductors to verify that there are no faults and that all equipment has been properly installed according to the manufacturer's recommendations. Check factory instructions to see that installations have been made accordingly. Check equipment for any damage that may have occurred during shipment, after delivery, or during installation. Replace damaged equipment.
- R. The PV System shall not be left operational without the permission from the local utility company. The Contractor shall notify the Owner in writing when the entire PV System is installed, and preliminary field-testing is successfully completed.
- S. Before starting or operating the system, obtain a final inspection approval and final inspection from the General Contractor. Be present on site for both of these inspections. Have final inspections certified by the Authority Having Jurisdiction (AHJ) and the utility company. Make final adjustments to all inverters and monitoring equipment so that they will be placed in an acceptable operating condition. Adjustable parameters must be set so that the PV system will produce the maximum possible amount of energy on an annual basis.

3.3 WIRING

- A. The visual appearance of all wiring shall be to satisfaction of the authority having jurisdiction.
- B. All wiring shall meet the installation and product standards for the interior and exterior environment in which it is installed. All wiring and raceway shall be installed in accordance with National and New Hampshire Electrical Codes.
- C. Wiring shall be continuous for each wiring run. Splices shall only be allowed in approved enclosures.
- D. All wire-to-equipment connections shall be made at a terminal block or terminal strip when supplied with the equipment and shall be neatly bundled and anchored within enclosures to permit easy access to devices and terminals.
- E. Label all circuits and any terminal strips in junction boxes for polarity and string number (both positive and negative). Label all other wiring for polarity and/or phase.

- F. Any building envelope penetrations shall be sealed to prevent moisture and movement into the envelope from the exterior or the interior using industry-approved sealing methods according to standard building practices.
- G. For roof mounted wiring provide roof top support blocks with integral mounting strut.
- H. Seal roof penetrations with materials compatible with the roofing system including flashing, pipe penetrations and mastics to building code requirements. Include approved fire stops in all building envelope penetrations. Coordinate any roof warranty requirements prior to the commencement of any roof work.
- I. Properly size all wiring penetrations of the building envelope.
- J. Ensure corrosion resistance and durability of all mechanical hardware.

3.4 IDENTIFICATION OF COMPONENTS

- A. Provide permanent as-built drawings including those required by the Utility.
- B. Clearly identify all control devices (i.e., circuit breakers, switches, AC and DC disconnects) as to their function and the equipment controlled.
- C. Furnish and install all nameplates and warning signs as per the requirements of the National and New Hampshire Electrical Codes and the utility.
- D. All equipment labels and warning signs shall be permanently fastened engraved phenolic (lamacoid-type) legend plates with standard engraver's letter style, using a standard size appropriate for the application.

3.5 FIELD QUALITY CONTROL

- A. Upon receipt of PV energy equipment and modules, visually inspect for signs of damage. Field-test each PV energy equipment and module prior to installation to verify electrical integrity and specified performance in accordance with manufacturer's specifications to ensure modules are within manufacturers' specified tolerances.
- B. Field-test each PV Array (including each PV string individually) to verify electrical integrity and specified performance.
- C. Follow the manufacturer's inverter commissioning procedures.
- D. The utility may require that a representative be on-site at the time of the initial system connection and energizing. Provide sufficient notice and coordinate the work accordingly.
- E. Perform tests and inspections with the assistance of a factory-authorized service representative.
- F. PV module will be considered defective if it does not pass tests and inspections. Defective modules are not to be installed.
- G. Correct all installation defects identified by the field testing.
- H. Prepare test and inspection reports.

3.6 FIELD TRAINING & WARRANTY SERVICE

- A. Engage an authorized service representative to train owner's maintenance personnel to adjust, operate, and monitor equipment.

- B. Provide 2 years of basic annual maintenance and warranty service from a factory authorized technician for the entire PV system. For this time period the owner's maintenance personnel shall provide "hands-off" monitoring only and report all issues to the factory technician for adjustment or repair. Only actions considered emergency measures, as approved by the factory technician, shall be performed on the PV system by maintenance personnel.
- C. Include an option to extend maintenance and warranty service beyond the 2-year period if desired by the owner at the end of this period.
- D. All PV equipment to have the manufacturer's standard warranty.

END OF SECTION

SECTION 265600

EXTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Exterior luminaires and accessories
 - 2. Poles

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. ANSI/IES RP-8 - Recommended Practice for Roadway Lighting.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate dimensions and components for each luminaire and pole.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 3 year's experience.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. and testing firm acceptable to authority having jurisdiction.

1.6 COORDINATION

- A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.7 SPARE PARTS

- A. Provide 1 of each lamp type and wattage installed.

PART 2 PRODUCTS

2.1 LUMINAIRES SCHEDULE

- A. Refer to the luminaire schedule on the contract drawings. Electrical Contractor shall be responsible for providing all accessories including but not limited to, pole and pole bases matching anchor layout, integral controls, light pollution guards, and all mounting hardware

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine excavation and concrete foundation for lighting poles.
- B. Examine each luminaire to determine suitability for lamps specified.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install lighting poles at locations indicated.
- C. Install poles plumb. Double nuts to adjust plumb. Grout around each base.
- D. Install lamps in each luminaire.
- E. Bond luminaires, metal accessories and metal poles to branch circuit equipment grounding conductor.

3.3 FIELD QUALITY CONTROL

- A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- B. Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.4 ADJUSTING

- A. Aim and adjust luminaires to provide illumination levels and distribution as directed. Exterior luminaires adjacent to other properties shall be provided with provisions for limiting light pollution outside project area and per the local governing codes.
- B. Relamp luminaires which have failed lamps at Date of Substantial Completion.

3.5 CLEANING

- A. Clean electrical parts to remove conductive and deleterious metals.
- B. Remove dirt and debris from enclosure.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

END OF SECTION

**STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS AND VETERANS SERVICES**

**EXHIBIT B – APPENDIX 2
Authorized Construction Drawings, Documents, and Clarification Sketches**

SUBJECT: Center Strafford MEP Upgrades

STATEMENT OF UNDERSTANDING

By initialing and dating the following pages, The Contractor clearly understands the following Center Strafford MEP Upgrades - Authorized Construction Drawings, Documents, and Clarification Sketches (Pages 1-9) and will meet all requirements specified herein.

Initials: an
Date: 7/27/26

DEPARTMENT OF MILITARY AFFAIRS AND VETERANS SERVICES

NEW HAMPSHIRE ARMY NATIONAL GUARD CENTER STRAFFORD MEP UPGRADES

1 AUSTIN CATE DRIVE
CENTER STRAFFORD, NH 03815

LIST OF DRAWINGS		
SHEET NO.	DRAWING NO.	DRAWING TITLE
GENERAL		
1	G-001	COVER SHEET
HVAC		
2	H-001	HVAC BMS PLAN
3	H-002	HVAC DEMOLITION PLANS - BUILDINGS 1
4	H-003	HVAC PLANS - BUILDINGS 2
ELECTRICAL		
5	E-001	ELECTRICAL LEGEND & GENERAL NOTES
6	E-002	ELECTRICAL SITE PLAN - 1
7	E-003	ELECTRICAL SITE PLAN - 2
8	E-004	ELECTRICAL PLANS - BUILDINGS 1
9	E-005	ELECTRICAL SCHEDULES & DETAILS



REVISIONS
DATE
DESCRIPTION
DATE
DESCRIPTION
DATE
DESCRIPTION

PROJECT NAME
CENTER STRAFFORD
MEP UPGRADES

ISSUE DATE
1/23/2026

SHEET NUMBER
G-001

MECHANICAL



Tighe & Bond, Inc.
177 Corporate Drive
Portsmouth, NH 03801
P. 603-433-0100
F. 603-433-0100

ELECTRICAL



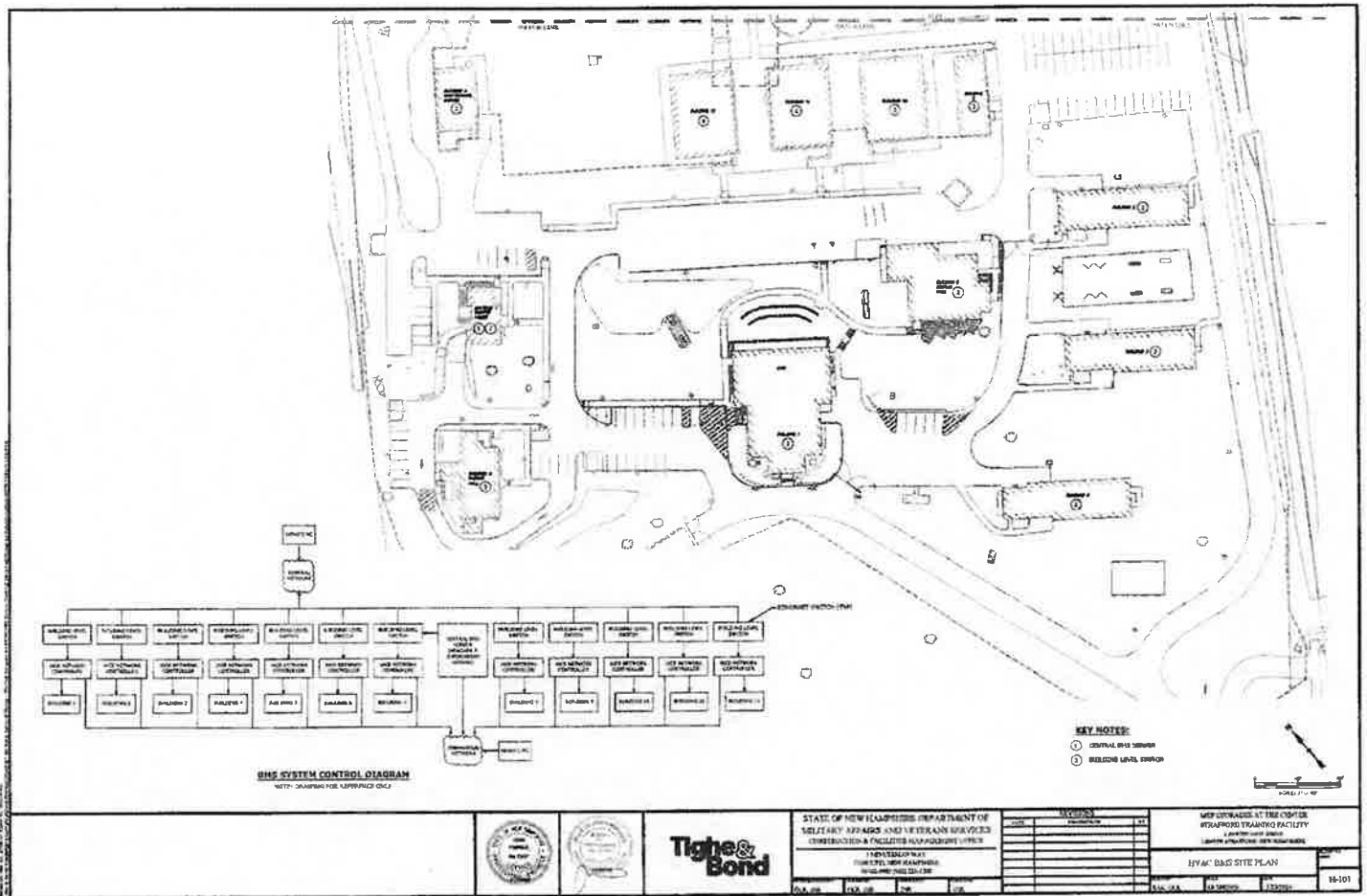
Tighe & Bond, Inc.
177 Corporate Drive
Portsmouth, NH 03801
P. 603-433-0100
F. 603-433-0100

CIVIL



Tighe & Bond, Inc.
177 Corporate Drive
Portsmouth, NH 03801
P. 603-433-0100
F. 603-433-0100

De
7/27/26



Handwritten signature and date:
 7/27/20



EXISTING CONCRETE FOUNDATION

EXISTING EQUIPMENT ROOMS

EXISTING GENERAL CONSTRUCTION TO BE REMOVED

1. ALL EXISTING DUCTWORK TO BE CLEANED PRIOR TO INSTALLATION OF WORK.
REFER TO SPECIFICATION 231000 FOR REQUIREMENTS.

[illegible]**Tighe & Bond**

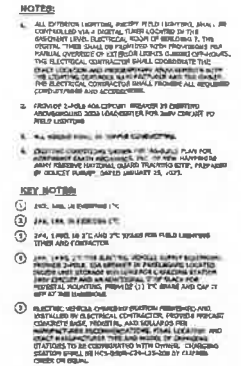
STATE OF NEW HAMPSHIRE DEPARTMENT OF
MILITARY AFFAIRS AND VETERANS SERVICES
COMMISSIONER OF THE DEPARTMENT OF THE ARMY
1 MEDUSA MAN PLAZA
CONCORD, NEW HAMPSHIRE
(603) 281-1234

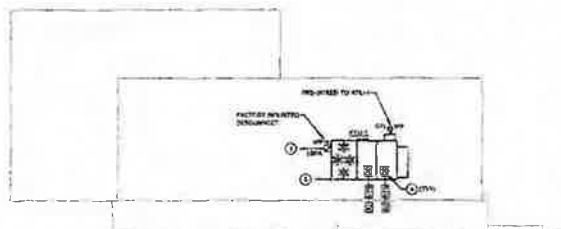
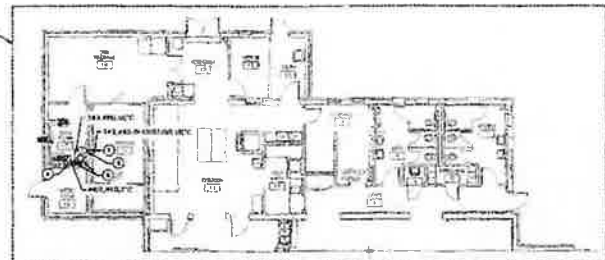
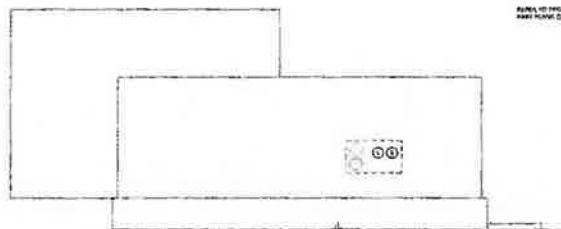
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REPAIRS TO THE TANK
AT THE TANK TRAINING FACILITY
A BOMB EXPLOSION
DURING A TRAINING EXERCISE
WAS DISCUSSION PLANNED -
EASTERN NEWS

H-203

7/27/26





7/27/26

7/27/26

STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS & VETERANS SERVICES
NEW HAMPSHIRE ARMY NATIONAL GUARD

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EXHIBIT C
CONTRACT PRICE



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SECTION 3 – METHOD OF PAYMENT	5

SECTION 1 – CONTRACT PRICE

The Department of Military Affairs and Veterans Services will pay the Contractor a maximum total of \$827,250.00. This amount shall not be exceeded without issuance of an amendment to this agreement and approval by the Governor and Executive Council of the State of New Hampshire.

The undersigned, having carefully examined the specifications for the referenced services, hereby proposes to furnish all materials and to perform all work for the above-captioned project in strict accordance with said specifications for the following price amount.

Contract price:	<u>\$ 767,250.00</u>
Allowance for unforeseen conditions and/or owner-initiated changes:	<u>\$ 60,000.00</u>
Total contract price:	<u>\$ 827,250.00</u>

SECTION 2 – TERMS OF PAYMENT

- A. The Department will manifest payments to the Contractor each calendar month on the basis of duly certified and approved estimate of the work performed during the preceding period. In preparing estimates, the material delivered on the site and any preparatory work done may be taken into consideration.
- B. At least ten (10) days before the end of the billing period, the Contractor shall submit to the Department an itemized Requisition for Payment, supported by such data substantiating the Contractor's right to payment as the Department may require. If payment is to be made on account of materials or equipment not incorporated in the work, but delivered and suitably stored at the site, such payment shall be conditional upon submission by the Contractor of bills of sale or such other procedure satisfactory to the Department to establish the State's title to such materials or equipment or otherwise protect the State's interest including applicable insurance.
- C. Immediately upon receipt of the Department Approved Monthly Requisition for Payment, the Contractor shall post same at the Contractor's Field Office or project site in a location where Subcontractors and Suppliers have clear access.
- D. A 5% retainage of the value of the work performed on each partial estimate will be deducted and retained by the Department until after completion of the entire Contract in an acceptable manner. The balance remaining after the specified percentage has been retained, less all previous payments, will be certified for payment on each partial estimate.
- E. Retainage will be released at Final Payment:
 - a. After the Certificate of Substantial Completion has been issued, upon written application by the Contractor and with the approval of the Surety, the Department may release a portion of the retained amount.


7/27/26

F. Payment for Material on Hand:

- a. Partial payments are made for materials to be incorporated in the Work, provided the materials meet the requirements of the Contract and are delivered on, or in the vicinity of, the Project site and stored in acceptable places. Partial payments will not exceed 90% of the Contract unit price for the item, or the amount supported by copies of paid invoices, freight bills, or other supporting documents required by the Department. The quantity paid will not exceed the corresponding quantity estimate in the Contract. No partial payment will be made on living or perishable materials until incorporated in the Work.
- b. When material payments exceed \$100,000.00 or 10% of the total contract amount, whichever is less, notarized copies of paid invoices or copies of canceled checks for all such materials must be submitted to the Department within forty-five (45) days of the end date of the estimate on which the material allowance was paid. Failure to provide such documentation will result in the deduction of such material allowance from future estimates until documentation is provided.
- c. All material and work covered by partial payments made shall thereupon become the sole property of the Department, but this provision shall not be construed as relieving the Contractor of the sole responsibility of all materials and work upon which payments have been made or the restoration of any damaged work or as a waiver of the right of the State to require the fulfillment of all the terms of the Contract.

G. Payment for Material not on hand:

- a. The Department will not pay for products and or materials that have not been delivered and stored properly on the construction site.

H. Release of Claims:

- a. Neither the final payment nor any part of the retained percentage shall become due until the Contractor shall deliver a complete release of all claims arising under and by virtue of this Contract, including claims for all Subcontractors and suppliers of either materials or labor, plus a release of the Contract Bond and a statement that all Subcontractors and suppliers have been paid. The Department may pay any and all such claims, in whole or in part, and deduct the amount or amounts so paid from any partial or final payment.

I. Final Payment:

- a. Within thirty (30) days after acceptance, the Department shall pay to the Contractor the amount of the Contract less all prior payments. All prior payments and estimates, including those relative to extra work, shall be subject to correction by this payment, which is throughout this Contract called the Final Payment.
- b. Application for Final Payment received from the Contractor will be processed for payment not less than 60 days after project acceptance and final completion unless accompanied by a release of the Contract Bond. This payment shall be the amount

of the Contract, amended by approved change orders, less previous payments minus liquidated damages, additional penalties, or holdbacks. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

J. Acceptance of Final Payment Constitutes Release:

- a. The acceptance of the Final Payment by the Contractor shall be and shall operate as a release to the Contractor of all claims and of all liability to the Department for all things done or furnished in connection with this work. No payment, however final or otherwise, shall operate to release the Contractor and its Sureties from any obligations under this Contract or the Contract Bond. Acceptance of Final Payment shall not impact any warranties provided by the Contractor with respect to this project.

Invoices will be submitted to:

Department of Military Affairs and Veterans Services

Attn: State Business Office

1 Minuteman Way, Bldg. 1

Concord, NH 03301-5652

SECTION 3 – METHOD OF PAYMENT

- A. Payment shall be made by mailing a bank draft or electronic funds transfer as established by submitting or updating an Alternate W-9 Form to the State of New Hampshire.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF MILITARY AFFAIRS & VETERANS SERVICES
NEW HAMPSHIRE ARMY NATIONAL GUARD

Center Strafford MEP Upgrades
RFB-DMAVS-2027-01

EXHIBIT D
ENVIRONMENTAL MANAGEMENT SYSTEM



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4. CONTACT INFORMATION.....	4
5. RESOURCES PROVIDED UPON CONTRACTOR REQUEST	4

SECTION 1 – NOTICE FOR CONTRACTORS AND CONTRACTOR EMPLOYEES

1. OVERVIEW

The New Hampshire Army National Guard (NHARNG) has implemented an environmental Management System (eMS), in accordance with Executive Orders 13423 and 13514, to guide its operations in an environmentally sound manner. Under its eMS, the NHARNG has identified significant activities, products or services that can interact with the environment (known as aspects) and potential environmental impacts from its operations.

- A. The significant environmental aspects are listed below:
 - a. Energy Use
 - b. Vehicle Travel (fleet) Between Workstations
- B. These significant aspects and their associated impacts are closely monitored by the NHARNG. Further, the NHARNG is tracking the success of the implementation plans established to achieve the NHARNG's objectives. For the purposes of this notice, applicability is limited to those actions that the contractor or subsequent employees are likely to perform on NHARNG properties.
- C. The primary purpose of this notice is to communicate the three basic tenets of the NHARNG's eMS policy:
 - a. eMS (ISO 14001) is the management system the NHARNG uses to implement the Adjutant General's Environmental Policy.
 - b. The eMS Environmental Policy commits the NHARNG to comply with environmental laws and regulations, to prevent pollution and to promote continual improvement of the eMS.
 - c. Contractors are responsible for knowing the environmental impacts of their services and must understand the management requirements for any activities that could affect any of NHARNG's significant aspects, or that could result in potential environmental impacts.

2. ENERGY USE

The NHARNG is committed to reducing its consumption of energy. Reducing energy consumption may be realized by turning off electrical equipment when not in use, or reducing heating temperatures/increasing cooling temperatures, using alternative fuels (if available, such as E85 or biodiesel), etc. Contracts that include the use or installation of equipment will seek the most energy-efficient technology within the scope of the contract.

3. VEHICLE TRAVEL (FLEET) BETWEEN WORKSTATIONS

The NHARNG is committed to preventing pollution through monitoring of Federal GSA Fleet vehicle usage. Usage of fleet vehicles by contractors is prohibited.

4. CONTACT INFORMATION

The Department of Military Affairs and Veterans Services Environmental Staff (603) 227-1439

5. RESOURCES PROVIDED UPON CONTRACTOR REQUEST

NHARNG Integrated Cultural Resources Management Plan (ICRMP)

NHNG Green Procurement Plan

Facility Specific Integrated Contingency Plans (ICPs); established for the State Military Reservation, Manchester RC / FMS, Army Aviation Support Facility (AASF)

NHARNG Hazardous Waste Management Plan

State of New Hampshire

Department of State

CERTIFICATE

I, David M. Scanlan, Secretary of State of the State of New Hampshire, do hereby certify that JBC CONSTRUCTION LLC is a New Hampshire Limited Liability Company registered to transact business in New Hampshire on June 07, 2018. I further certify that all fees and documents required by the Secretary of State's office have been received and is in good standing as far as this office is concerned.

Business ID: 796577

Certificate Number: 0007987911



IN TESTIMONY WHEREOF,

I hereto set my hand and cause to be affixed
the Seal of the State of New Hampshire,
this 27th day of July A.D. 2026.

A handwritten signature in black ink, appearing to read "David M. Scanlan", is written over a circular stamp that partially overlaps the seal.

David M. Scanlan
Secretary of State

Certificate of Authority #7 *(Sole Limited partnership, Limited liability professional partnership, or LLC)*

Sole Limited Partnership or LLC Certification of Authority

I, Dan Callahan, hereby certify that I am the sole Partner, Member or
(Name of Attestor)
Manager and the sole officer of JBC Construction LLC a limited liability partnership
(Name of Partnership or LLC)
under RSA 304-B, a limited liability professional partnership under RSA 304-D, or a limited liability company
under RSA 304-C.

I certify that I am authorized to bind the partnership or LLC. I further certify that it is understood that the State of New Hampshire will rely on this certificate as evidence that the person listed above currently occupies the position indicated and that they have full authority to bind the partnership or LLC and that this authorization **shall remain valid for thirty (30) days** from the date of this certificate.

DATED: 7/21/26 ATTESTOR: 

NAME: Dan Callahan

TITLE: Member / Construction Manager



CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

07/26/2026

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER Cross Insurance-Manchester 1100 Elm Street Manchester NH 03101		CONTACT NAME: Jennifer Landry PHONE (A/C, No, Ext): (603) 669-3218 E-MAIL ADDRESS: manch.certs@crossagency.com FAX (A/C, No): (603) 645-4331													
INSURED JBC Construction LLC PO Box 107 Londonderry NH 03053		INSURER(S) AFFORDING COVERAGE <table border="1"><tr><td>INSURER A: Ohio Security Ins Co</td><td>NAIC # 24082</td></tr><tr><td>INSURER B: American Fire & Casualty</td><td>24066</td></tr><tr><td>INSURER C: Ohio Casualty Ins. Co.</td><td>24074</td></tr><tr><td>INSURER D: Hartford Underwriters Ins. Co.</td><td></td></tr><tr><td>INSURER E:</td><td></td></tr><tr><td>INSURER F:</td><td></td></tr></table>		INSURER A: Ohio Security Ins Co	NAIC # 24082	INSURER B: American Fire & Casualty	24066	INSURER C: Ohio Casualty Ins. Co.	24074	INSURER D: Hartford Underwriters Ins. Co.		INSURER E:		INSURER F:	
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INSURER B: American Fire & Casualty	24066														
INSURER C: Ohio Casualty Ins. Co.	24074														
INSURER D: Hartford Underwriters Ins. Co.															
INSURER E:															
INSURER F:															

COVERAGES**CERTIFICATE NUMBER:** 26-27 All Lines**REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS														
A	☒ COMMERCIAL GENERAL LIABILITY ☐ CLAIMS-MADE ☒ OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: ☒ POLICY ☐ PROJECT ☐ LOC OTHER:			BKS58953246	07/13/2026	07/13/2027	<table border="1"><tr><td>EACH OCCURRENCE</td><td>\$ 1,000,000</td></tr><tr><td>DAMAGE TO RENTED PREMISES (Ea occurrence)</td><td>\$ 300,000</td></tr><tr><td>MED EXP (Any one person)</td><td>\$ 15,000</td></tr><tr><td>PERSONAL & ADV INJURY</td><td>\$ 1,000,000</td></tr><tr><td>GENERAL AGGREGATE</td><td>\$ 2,000,000</td></tr><tr><td>PRODUCTS - COMP/OP AGG</td><td>\$ 2,000,000</td></tr><tr><td></td><td>\$</td></tr></table>	EACH OCCURRENCE	\$ 1,000,000	DAMAGE TO RENTED PREMISES (Ea occurrence)	\$ 300,000	MED EXP (Any one person)	\$ 15,000	PERSONAL & ADV INJURY	\$ 1,000,000	GENERAL AGGREGATE	\$ 2,000,000	PRODUCTS - COMP/OP AGG	\$ 2,000,000		\$
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C	☒ UMBRELLA LIAB ☒ OCCUR ☐ EXCESS LIAB ☐ CLAIMS-MADE DED ☒ RETENTION \$ 10,000			USO58953246	07/13/2026	07/13/2027	<table border="1"><tr><td>EACH OCCURRENCE</td><td>\$ 1,000,000</td></tr><tr><td>AGGREGATE</td><td>\$ 1,000,000</td></tr><tr><td></td><td>\$</td></tr></table>	EACH OCCURRENCE	\$ 1,000,000	AGGREGATE	\$ 1,000,000		\$								
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AGGREGATE	\$ 1,000,000																				
	\$																				
D	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below Y/N ☒ Y N/A			6S60UB6R47788726 (3a.) NH	07/14/2026	07/14/2027	<table border="1"><tr><td>☒ PER STATUTE ☐ OTHER</td><td></td></tr><tr><td>E.L. EACH ACCIDENT</td><td>\$ 1,000,000</td></tr><tr><td>E.L. DISEASE - EA EMPLOYEE</td><td>\$ 1,000,000</td></tr><tr><td>E.L. DISEASE - POLICY LIMIT</td><td>\$ 1,000,000</td></tr></table>	☒ PER STATUTE ☐ OTHER		E.L. EACH ACCIDENT	\$ 1,000,000	E.L. DISEASE - EA EMPLOYEE	\$ 1,000,000	E.L. DISEASE - POLICY LIMIT	\$ 1,000,000						
☒ PER STATUTE ☐ OTHER																					
E.L. EACH ACCIDENT	\$ 1,000,000																				
E.L. DISEASE - EA EMPLOYEE	\$ 1,000,000																				
E.L. DISEASE - POLICY LIMIT	\$ 1,000,000																				
D	Daniel Callahan is excluded from workers compensation coverage.																				

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

Re: Work to be performed at the NHARNG MEP Upgrades Strafford, NH. The State of New Hampshire and the New Hampshire Army National Guard are included as additional insured with respects to the CGL as required by executed written contract with the above named insured. Refer to attached policy forms.

CERTIFICATE HOLDER**CANCELLATION**

Department of Military Affairs & Veteran's Services 1 Minuteman Way Building 1 Concord NH 03301-5652	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE
---	---

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Document A312™ – 2010

Conforms with The American Institute of Architects AIA Document 312

Bond #32S619856

Performance Bond

CONTRACTOR:

(Name, legal status and address)

JBC Construction LLC

PO Box 107
Londonderry NH 03053

OWNER:

(Name, legal status and address)

NH Dept. of Military Affairs & Veteran's Services

1 Minuteman Way, Bldg. 1
Concord NH 03301-5652

CONSTRUCTION CONTRACT

Date: July 21, 2026

Amount: \$827,250.00

Description:

(Name and location)

NHARNG - Center Strafford MEP Upgrade

SURETY:

(Name, legal status and principal place of business)

The Ohio Casualty Insurance Company

62 Maple Avenue, Keene, New Hampshire
03431

Mailing Address for Notices

The Ohio Casualty Insurance Company

Attention: Surety Claims Department
1001 4th Avenue, Suite 1700
Seattle, WA 98154

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

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable

BOND

Date: July 27, 2026

(Not earlier than Construction Contract Date)

Amount: \$827,250.00

Modifications to this Bond:

☒ None

☐ See Section 16

CONTRACTOR AS PRINCIPAL

Company:

(Corporate Seal)

JBC Construction LLC

Signature:

Name

DAN CAELAHAN

and Title:

MEMBER

SURETY

Company:

(Corporate Seal)

The Ohio Casualty Insurance Company

Signature:

Name

and Title:

Gary T. Eastman, Attorney-in-Fact



(Any additional signatures appear on the last page of this Performance Bond.)

(FOR INFORMATION ONLY — Name, address and telephone)

AGENT or BROKER:

Swiftbonds LLC

4901 W 136th Street
Leawood KS 66224

913.214.8344

OWNER'S REPRESENTATIVE:

(Architect, Engineer or other party:)

§ 1 The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

§ 2 If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Section 3.

§ 3 If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond shall arise after

- .1 the Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice shall indicate whether the Owner is requesting a conference among the Owner, Contractor and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Section 3.1 shall be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement shall not waive the Owner's right, if any, subsequently to declare a Contractor Default;
- .2 the Owner declares .2 a Contractor Default, terminates the Construction Contract and notifies the Surety; and
- .3 the Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

§ 4 Failure on the part of the Owner to comply with the notice requirement in Section 3.1 shall not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

§ 5 When the Owner has satisfied the conditions of Section 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

§ 5.1 Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

§ 5.2 Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

§ 5.3 Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Section 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

§ 5.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

- .1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
- .2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

§ 6 If the Surety does not proceed as provided in Section 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Section 5.4, and the Owner refuses the payment or the Surety has denied liability, in whole or in part, without further notice the Owner shall be entitled to enforce any remedy available to the Owner.

§ 7 If the Surety elects to act under Section 5.1, 5.2 or 5.3, then the responsibilities of the Surety to the Owner shall not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety shall not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication, for

- .1 the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
- .2 additional legal, design professional and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Section 5; and
- .3 liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

§ 8 If the Surety elects to act under Section 5.1, 5.3 or 5.4, the Surety's liability is limited to the amount of this Bond.

§ 9 The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors and assigns.

§ 10 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

§ 11 Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and shall be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

§ 12 Notice to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears.

§ 13 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

§ 14 Definitions

§ 14.1 **Balance of the Contract Price.** The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made, including allowance to the Contractor of any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

§ 14.2 **Construction Contract.** The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

§ 14.3 **Contractor Default.** Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

§ 14.4 **Owner Default.** Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

§ 14.5 **Contract Documents.** All the documents that comprise the agreement between the Owner and Contractor.

§ 15 If this Bond is issued for an agreement between a Contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

§ 16 Modifications to this bond are as follows:

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL

Company: _____
(Corporate Seal)

Signature: _____

Name and Title: _____

Address _____

SURETY

Company: _____
(Corporate Seal)

Signature: _____

Name and Title: _____

Address _____



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Conforms with The American Institute of Architects AIA Document 312

Payment Bond

Bond #32S619856

CONTRACTOR:

(Name, legal status and address)

JBC Construction LLC

PO Box 107

Londonderry NH 03053

OWNER:

(Name, legal status and address)

NH Dept. of Military Affairs & Veteran's Services

1 Minuteman Way, Bldg. 1

Concord NH 03301-5652

CONSTRUCTION CONTRACT

Date: July 15, 2026

Amount: \$827,250.00

Description:

(Name and location)

NHARNG - Center Strafford MEP Upgrade

SURETY:

(Name, legal status and principal place of business)

The Ohio Casualty Insurance Company

62 Maple Avenue, Keene, New Hampshire
03431

Mailing Address for Notices

The Ohio Casualty Insurance Company

Attention: Surety Claims Department
1001 4th Avenue, Suite 1700
Seattle, WA 98154

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

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable

BOND

Date: July 27, 2026

(Not earlier than Construction Contract Date)

Amount: \$827,250.00

Modifications to this Bond:

☒ None

☐ See Section 18

CONTRACTOR AS PRINCIPAL

Company:

(Corporate Seal)

JBC Construction LLC

Signature:

Name

and Title:

Dan Callahan
DAN CALLAHAN
MEMBER

SURETY

Company:

(Corporate Seal)

The Ohio Casualty Insurance Company

Signature:

Name

and Title:

Gary T. Eastman, Attorney-in-Fact



(Any additional signatures appear on the last page of this Payment Bond)

(FOR INFORMATION ONLY --- Name, address and telephone)

AGENT or BROKER:

Swiftbonds LLC

4901 W 136th Street

Leawood KS 66224

913.214.8344

OWNER'S REPRESENTATIVE:

(Architect, Engineer or other party:)

§ 1 The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to the Owner to pay for labor, materials and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

§ 2 If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies and holds harmless the Owner from claims, demands, liens or suits by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

§ 3 If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond shall arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Section 13) of claims, demands, liens or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials or equipment furnished for use in the performance of the Construction Contract and tendered defense of such claims, demands, liens or suits to the Contractor and the Surety.

§ 4 When the Owner has satisfied the conditions in Section 3, the Surety shall promptly and at the Surety's expense defend, indemnify and hold harmless the Owner against a duly tendered claim, demand, lien or suit.

§ 5 The Surety's obligations to a Claimant under this Bond shall arise after the following:

§ 5.1 Claimants, who do not have a direct contract with the Contractor,

- .1 have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
- .2 have sent a Claim to the Surety (at the address described in Section 13).

§ 5.2 Claimants, who are employed by or have a direct contract with the Contractor, have sent a Claim to the Surety (at the address described in Section 13).

§ 6 If a notice of non-payment required by Section 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Section 5.1.1.

§ 7 When a Claimant has satisfied the conditions of Sections 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

§ 7.1 Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

§ 7.2 Pay or arrange for payment of any undisputed amounts.

§ 7.3 The Surety's failure to discharge its obligations under Section 7.1 or Section 7.2 shall not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Section 7.1 or Section 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

§ 8 The Surety's total obligation shall not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Section 7.3, and the amount of this Bond shall be credited for any payments made in good faith by the Surety.

§ 9 Amounts owed by the Owner to the Contractor under the Construction Contract shall be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfy obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

§ 10 The Surety shall not be liable to the Owner, Claimants or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to, or give notice on behalf of, Claimants or otherwise have any obligations to Claimants under this Bond.

§ 11 The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders and other obligations.

§ 12 No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Section 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this Paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

§ 13 Notice and Claims to the Surety, the Owner or the Contractor shall be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, shall be sufficient compliance as of the date received.

§ 14 When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

§ 15 Upon request by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

§ 16 Definitions

§ 16.1 Claim. A written statement by the Claimant including at a minimum:

- .1 the name of the Claimant;
- .2 the name of the person for whom the labor was done, or materials or equipment furnished;
- .3 a copy of the agreement or purchase order pursuant to which labor, materials or equipment was furnished for use in the performance of the Construction Contract;
- .4 a brief description of the labor, materials or equipment furnished;
- .5 the date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
- .6 the total amount earned by the Claimant for labor, materials or equipment furnished as of the date of the Claim;
- .7 the total amount of previous payments received by the Claimant; and
- .8 the total amount due and unpaid to the Claimant for labor, materials or equipment furnished as of the date of the Claim.

§ 16.2 Claimant. An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials or equipment were furnished.

§ 16.3 Construction Contract. The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

§ 16.4 Owner Default. Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

§ 16.5 Contract Documents. All the documents that comprise the agreement between the Owner and Contractor.

§ 17 If this Bond is issued for an agreement between a Contractor and subcontractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

§ 18 Modifications to this bond are as follows:

(Space is provided below for additional signatures of added parties, other than those appearing on the cover page.)

CONTRACTOR AS PRINCIPAL

Company: _____
(Corporate Seal)

SURETY

Company: _____
(Corporate Seal)

Signature: _____

Name and Title:

Address

Signature: _____

Name and Title:

Address



This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

Certificate No: 8201592 - 988568

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, _____

Gary T. Eastman

all of the city of Leawood state of KS each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents and shall be as binding upon the Companies as if they have been duly signed by the president and attested by the secretary of the Companies in their own proper persons.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 18th day of July, 2019.



Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

By: David M. Carey
David M. Carey, Assistant Secretary

State of PENNSYLVANIA
County of MONTGOMERY ss

On this 18th day of July, 2019 before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at King of Prussia, Pennsylvania, on the day and year first above written.



COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Teresa Pastella, Notary Public
Upper Merion Twp., Montgomery County
My Commission Expires March 28, 2021
Member, Pennsylvania Association of Notaries

By: Teresa Pastella
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV - OFFICERS: Section 12. Power of Attorney.

Any officer or other official of the Corporation authorized for that purpose in writing by the Chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.

Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation - The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization - By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

I, Renee C. Llewellyn, the undersigned, Assistant Secretary, The Ohio Casualty Insurance Company, Liberty Mutual Insurance Company, and West American Insurance Company do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy of the Power of Attorney executed by said Companies, is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 27th day of July, 2026.



By: Renee C. Llewellyn
Renee C. Llewellyn, Assistant Secretary

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Jul 24, 2026

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Jul 15, 2026

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e.g. 1606N020Q02

"JBC Construction"**"New Hampshire"****Federal Organizations**

Enter Code or Name



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WARNING

This is a U.S. General Services Administration Federal Government computer system that is **"FOR OFFICIAL USE ONLY."** This system is subject to monitoring. Individuals found performing unauthorized