MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

CONTRACT DOCUMENTS

CONTRACT 2026.13

AIR HANDLER REPLACEMENTS
YORK AND GARDINER MAINTENANCE FACILITIES
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NOTICE TO CONTRACTORS

PROPOSAL

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CONTRACT BOND

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SPECIFICATIONS

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

The Specifications are divided into two parts:
Part I, Supplemental Specifications and Part II, Special Provisions.

The Maine Turnpike Supplemental Specifications are additions and alterations to the 2014 Maine Department of Transportation Standard Specifications. See Subsection 100.1.

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MAINE TURNPIKE AUTHORITY

NOTICE TO CONTRACTORS

Sealed Proposals will be received by the Maine Turnpike Authority for:

CONTRACT 2026.13

AIR HANDLER REPLACEMENTS
YORK AND GARDINER MAINTENANCE FACILITIES

at the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, ME, until 11:00 a.m., prevailing time as determined by the Authority on October 23, 2025 at which time and place the Proposals will be publicly opened and read. Bids will be accepted from Contractors **prequalified** by the Maine Department of Transportation for Building Construction Projects. All other bids may be rejected. This Project includes a wage determination developed by the State of Maine Department of Labor.

The work consists of the following:

a. Replace the central split system Dx air handling unit, LP gas fired duct furnace, and two exterior condensing units serving the Gardiner Maintenance Facility complete with controls.
b. Add an electric resistance duct coil for the Supervisor's Office at the Gardiner Maintenance Facility.
c. Replace two air handlers with LP gas furnaces, two duct mounted Dx cooling coils, and two exterior condensing units complete with controls at the York Maintenance Facility.
d. Duct revisions at both the York and Gardiner Maintenance Facilities to create a complete ducted return system.

The work includes all mechanical, electrical, and plumbing, as well as all cutting, patching, finish work incidental thereto in accordance with the Plans and Specifications.

Plans and Contract Documents may be examined by prospective Bidders weekdays between 8:00 a.m. and 4:30 p.m. at the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine. **The full size Plans** and Contract Documents may be obtained from the Authority upon payment of One Hundred ($100.00) Dollars for each set, which payment will not be returned. **The half size Plans** and Contract Documents may be obtained from the Authority upon payment of Fifty ($50.00) Dollars for each set, which payment will not be returned. Checks shall be made payable to: Maine Turnpike Authority. The Plans and Contract Documents may also be downloaded from a link on our website at http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx.

For general information regarding Bidding and Contracting procedures, contact Nate Carll, Purchasing Manager, at (207)482-8115. For information regarding Schedule of Items, plan holders

list and bid results, visit our website at **http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx** . For Project specific information, email all questions to Nate Carll, Purchasing Manager, ncarll@maineturnpike.com. Responses will not be prepared for questions received by telephone. Bidders shall not contact any other Authority staff or Consultants for clarification of Contract provisions, and the Authority will not be responsible for any interpretations so obtained.

All work shall be governed by the Specifications entitled "State of Maine, Department of Transportation, Standard Specifications, Revision of November 2014", "Standard Details, Revision of November 2014" and "Best Management Practices for Erosion and Sediment Control", latest issue. Copies and recent updates to these publications can be downloaded at: http://www.maine.gov/mdot/contractors/publications/ .

Proposals must be accompanied by an original bid bond, certified or cashier's check payable to the Maine Turnpike Authority in an amount not less than Five (5%) Percent of the Total Amount in the Proposal, but not less than $500.00. The Bidder to whom a Contract is awarded will be required to furnish a Surety Corporation Bond, satisfactory to the Authority, on the standard Contract Bond form of the Authority, for a sum not less than the Total Amount of the Proposal.

Proposals must be made upon the Proposal Forms furnished by the Authority separately with the Contract Documents, and must be enclosed in the sealed special addressed envelope provided therefore bearing the name and address of the Bidder, the name of the Contract, and the date and time of Proposal opening on the outside.

A pre-bid conference will be held on October 07, 2025 at 10:00 a.m. at the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

The Authority reserves the unqualified right to reject any or all Proposals and to accept that Proposal which in its sole judgment will under all circumstances serve its best interest.

MAINE TURNPIKE AUTHORITY

Nate Carll
Purchasing Manager
Maine Turnpike Authority

Portland, Maine

Maine Turnpike Authority

MAINE TURNPIKE

PROPOSAL

CONTRACT 2026.13

AIR HANDLER REPLACEMENTS
YORK AND GARDINER MAINTENANCE FACILITIES

MAINE TURNPIKE AUTHORITY

PROPOSAL

CONTRACT 2026.13

AIR HANDLER REPLACEMENTS
YORK AND GARDINER MAINTENANCE FACILITIES

TO MAINE TURNPIKE AUTHORITY:

The work consists of the following:

a. Replace the central split system Dx air handling unit, LP gas fired duct furnace, and two exterior condensing units serving the Gardiner Maintenance Facility complete with controls.
b. Add an electric resistance duct coil for the Supervisor's Office at the Gardiner Maintenance Facility.
c. Replace two air handlers with LP gas furnaces, two duct mounted Dx cooling coils, and two exterior condensing units complete with controls at the York Maintenance Facility.
d. Duct revisions at both the York and Gardiner Maintenance Facilities to create a complete ducted return system.

The work includes all mechanical, electrical, and plumbing, as well as all cutting, patching, finish work incidental thereto in accordance with the Plans and Specifications.

This Work will be done under a Contract known as Contract 2026.13, Air Handler Replacements – York and Gardiner Maintenance Facilities according to the Plans and Specifications which are on file in the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

On the acceptance of this Proposal for said Work, the undersigned will give the required bond with good security conditioned for the faithful performance of said Work, according to said Plans and Specifications, and the doing of all other work required by said Specifications for the consideration herein named and with the further condition that the Maine Turnpike Authority shall be saved harmless from any and all damages that might accrue to any person, persons or property by reason of the carrying out of said Work, or any part thereof, or by reason of negligence of the undersigned, or any person or persons under his employment and engaged in said Work.

The undersigned hereby declares that he/she has carefully examined the Plans, Specifications and other Contract Documents, and that he/she will contract to carry out and complete the said Work as specified and delineated at the price per unit of measure for each scheduled item of Work stated in the Schedule of Prices as follows:

It is understood that the TOTAL AMOUNT stated by the undersigned in the following Schedule of Prices is based on approximate quantities and will be used solely for the comparison of

bids, and that the quantities stated in the Schedule of Prices for the various items are estimates only and may be increased or decreased all as provided in the Specifications.

Item No	**Item Description**	**Units**	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
Item No	**Item Description**	**Units**	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
659.10	MOBILIZATION	LUMP SUM	1				
800.01	AIR HANDLER REPLACEMENTS	LUMP SUM	1				
					TOTAL:		

Acknowledgment is hereby made of the following Addenda received since issuance of the Plans and Specifications: _____

_____

_____

Accompanying this Proposal is an original bid bond, cashiers or certified check on _____ Bank, for _____, payable to the Maine Turnpike Authority. In case this Proposal shall be accepted by the Maine Turnpike Authority and the undersigned should fail to execute a Contract with, and furnish the security required by the Maine Turnpike Authority as set forth in the Specifications, within the time fixed therein, an amount of money equal to Five (5%) Percent of the Total Amount of the Proposal for the Contract awarded to the undersigned, but not less than $500.00, obtained out of the original bid bond, cashier's or certified check, shall become the property of the Maine Turnpike Authority; otherwise the check will be returned to the undersigned.

The performance of said Work under this Contract will be completed during the time specified in Subsection 107.1.

It is agreed that time is of the essence of this Contract and that I (we) will, in the event of my (our) failure to complete the Work within the time limit named above, pay to Maine Turnpike Authority liquidated damages in the amount or amounts stated in the Specifications.

The undersigned is an Individual/Partnership/Corporation under the laws of the State of _____, having principal office at _____, thereunto duly authorized.

_____ *(SEAL)*

_____ *(SEAL)*

Affix Corporate Seal
or Power of Attorney
Where Applicable

_____ *(SEAL)*

By: _____

Its: _____

Information below to be typed or printed where applicable:

INDIVIDUAL:

_____	_____
(Name)	(Address)

PARTNERSHIP - Name and Address of General Partners:

_____	_____
(Name)	(Address)
_____	_____
(Name)	(Address)
_____	_____
(Name)	(Address)
_____	_____
(Name)	(Address)

INCORPORATED COMPANY:

_____	_____
(President)	(Address)
_____	_____
(Vice-President)	(Address)
_____	_____
(Secretary)	(Address)
_____	_____
(Treasurer)	(Address)

MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

YORK TO AUGUSTA

CONTRACT AGREEMENT

This Agreement made and entered into between the Maine Turnpike Authority, and sometimes termed the "Authority", and _____

_____

herein termed the "Contractor":

WITNESSETH: That the Authority and the Contractor, in consideration of the premises and of the mutual covenants, considerations and agreements herein contained, agree as follows:

FIRST: The parties hereto mutually agree that the documents attached hereto and herein incorporated and made a part hereof collectively evidencing and constituting the entire Contract to the same extent as if herein written in full, are the Notice to Contractors, the Accepted Proposal, the Specifications, the Plans, this Agreement, the Contract Bond and all Addenda to the Contract Documents duly issued and herewith enumerated:

_____

_____

SECOND: The Contractor for and in consideration of certain payments to be made as hereafter specified, hereby covenants and agrees to perform and execute all of the provisions of this Contract and of all documents and parts attached hereto and made a part thereof, and at his own cost and expense to furnish and perform everything necessary and required to construct and complete, ready for its intended purpose, in accordance with the Contract and such instructions as the Engineer may give, acceptable to the Authority, in the times provided, all of the Work covered and included under Contract No. _____ covering _____ as herein described.

THIRD: In consideration of the performance by the Contractor of his covenants and agreements as herein set forth, the Authority hereby covenants and agrees to pay the Contractor according to the Schedule of Prices set forth in the Proposal with additions and deductions as elsewhere herein provided in the times and in the manner stated in the Specifications. This Agreement shall insure to the benefit of, and shall be binding upon the parties hereto, and upon their respective successors and assigns; but neither party hereto shall assign or transfer his interest herein in whole or in part without the consent of the other, except as herein provided.

IN WITNESS WHEREOF the parties to this Agreement have executed the same in quintuplicate.

AUTHORITY -

MAINE TURNPIKE AUTHORITY

By: _____

Title: CHAIRMAN

Date of Signature: _____

ATTEST:

_____
Secretary

CONTRACTOR -

_____
CONTRACTOR

By: _____

Title: _____

Date of Signature: _____

WITNESS:

_____

CONTRACT BOND

KNOW ALL MEN BY THESE PRESENTS that _____

of _____ in the County of _____ and State of _____

as Principal, and _____ a Corporation duly organized under the

laws of the State of _____ and having a usual place of business in _____

_____

As Surety, are held and firmly bound unto the Maine Turnpike Authority in the sum of _____Dollars ($_____.___), to be paid to said Maine Turnpike Authority, or its successors, for which payment, well and truly to be made, we bind ourselves, our heirs, executors, successors and assigns jointly and severally by these presents.

The condition of this obligation is such that the Principal, designated as Contractor in the foregoing Contract No. _____ shall faithfully perform the Contract on his part and satisfy all claims and demands incurred for the same and shall pay all bills for labor, material, equipment and all other items contracted for, or used by him, in connection with the Work contemplated by said Contract, and shall fully reimburse the Obligee for all outlay and expense which the Obligee may incur in making good any default of said Principal, then this Obligation shall be null and void; otherwise it shall remain in full force and effect.

Signed and sealed this _____ day of _____, A.D., 201___

Witnesses: CONTRACTOR

_____ _____ *(SEAL)*

_____ _____ *(SEAL)*

_____ _____ *(SEAL)*

SURETY

_____ _____ *(SEAL)*

_____ _____ *(SEAL)*

_____ _____ *(SEAL)*

(Surety must attach copy of Power of Attorney showing authority of Office or Agent to execute bonds)

FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT

Upon receipt of the sum of _____, which sum represents the total amount paid, including the current payment for work done and materials supplied for Project No. _____, in _____, Maine, under the undersigned's Contract with the Maine Turnpike Authority.

The undersigned, on oath, states that the Final Payment of _____ is the final payment for all work, labor, materials, services and miscellaneous (all of which are hereinafter referred to as "Work Items") supplied to the said Project through _____and that no additional sum is claimed by the undersigned respecting said Project.

The undersigned, on oath, states that all persons and firms who supplied Work Items to the undersigned in connection with said Project have been fully paid by the undersigned for such Work Items or that such payment will be fully effected immediately upon receipt of this payment.

In consideration of the payment herewith made, the undersigned does fully and finally release and hold harmless the Maine Turnpike Authority, and its Surety, if any, from any and all claims, liens or right to claim or lien, arising out of this Project under any applicable bond, law or statute.

It is understood that this Affidavit is submitted to assure the Owner and others that all liens and claims relating to the Work Items furnished by the undersigned are paid.

_____
(Contractor)

By: _____

Title: _____

State of MAINE

County of _____

I, _____, hereby certify on behalf of _____
(Company Officer) *(Company Name)*

its _____, being first duly sworn and stated that the foregoing representations are
(Title)

are true and correct upon his own knowledge and that the foregoing is his free act and deed in said capacity and the free act and deed of the above-named

_____

.

(Company Name)

The above-named, _____, personally appeared before me this ____ day of _____ and swears that this is his free act and deed.

(SEAL)

_____
Notary Public

My Commission Expires: _____

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART I – SUPPLEMENTAL SPECIFICATIONS

(Rev. November 10, 2016)

The Supplemental Specifications are not included in these contract documents but are available at MaineTurnpike.com for download.

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART II – SPECIAL PROVISIONS

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART II - SPECIAL PROVISIONS

All work shall be governed by the Maine Department of Transportation Standard Specifications, Revision of November 2014, except for that work which applies to sections of the Maine Department of Transportation Standard Specifications which are amended by the Maine Turnpike Supplemental Specifications and the following modifications, additions and deletions.

General Description of Work

The work consists of the following:

a. Replace the central split system Dx air handling unit, LP gas fired duct furnace, and two exterior condensing units serving the Gardiner Maintenance Facility complete with controls.
b. Add an electric resistance duct coil for the Supervisor's Office at the Gardiner Maintenance Facility.
c. Replace two air handlers with LP gas furnaces, two duct mounted Dx cooling coils, and two exterior condensing units complete with controls at the York Maintenance Facility.
d. Duct revisions at both the York and Gardiner Maintenance Facilities to create a complete ducted return system.

The work includes all mechanical, electrical, and plumbing, as well as all cutting, patching, finish work incidental thereto in accordance with the Plans and Specifications.

Plans

The drawings included in these Contract Documents, and referred to as the Plans, show the general character of the work to be done under this Contract. They bear the general title "Maine Turnpike – Contract 2026.13 – Air Handler Replacements – York and Gardiner Maintenance Facilities". The right is reserved by the Resident to make such minor corrections or alterations in the Plans as he deems necessary without change in the unit prices on the Schedule of Prices of the Proposal.

101.2 Definition

Holidays

The following is added after Memorial Day in the Supplemental Specifications:

Christmas 2025	12:01 PM (noon) preceding Wednesday to 6:00 AM the following Monday
New Years 2026	12:01 PM (noon) preceding Wednesday to 6:00 AM the following Monday
Memorial Day 2026	12:01 p.m. (noon) preceding Friday to 6:00 a.m. the following Tuesday.

103.4 Notice of Award

The following sentence is added:

The Maine Turnpike Authority Board is scheduled to consider the Contract Award on November 20, 2025.

104.3.8 Wage Rates and Labor Laws

Section 104.3.8 Wage Rates and Labor Laws has been amended as follows:

The fair minimum hourly rates determined by the State of Maine Department of Labor for this Contract are as follows:

THIS DOCUMENT MUST BE CLEARLY POSTED AT ALL CONSTRUCTION SITES FUNDED IN PART WITH STATE FUNDS

State of Maine
Department of Labor
Bureau of Labor Standards
Augusta, Maine 04333-0045
Telephone (207) 623-7906

Wage Determination - In accordance with 26 MRS §1301 et. seq., this is a determination by the Bureau of Labor Standards, of the fair minimum wage rate to be paid to laborers and workers employed on the below titled project.

2025 Fair Minimum Wage Rates – Building 2 Kennebec County (other than 1 or 2 family homes)

Occupational Title	Minimum Wage	Minimum Benefit	Total
Brickmasons And Blockmasons	$42.55	$28.02	$70.57
Bulldozer Operator	$34.44	$2.26	$36.70
Carpenter	$32.59	$11.94	$44.53
Cement Masons And Concrete Finisher	$26.50	$0.00	$26.50
Construction And Maintenance Painters	$28.00	$1.53	$29.53
Construction Laborer	$24.00	$1.80	$25.80
Crane And Tower Operators	$37.50	$11.94	$49.44
Crushing Grinding And Polishing Machine Operators	$27.50	$5.64	$33.14
Earth Drillers - Except Oil And Gas	$22.05	$1.19	$23.24
Electrical Power - Line Installer And Repairers	$43.26	$16.55	$59.81
Electricians	$34.70	$10.93	$45.63
Elevator Installers And Repairers	$71.21	$43.75	$114.96
Excavator Operator	$32.00	$5.91	$37.91
Fence Erectors	$26.00	$2.63	$28.63
Flaggers	$20.50	$0.40	$20.90
Floor Layers - Except Carpet/Wood/Hard Tiles	$26.50	$3.83	$30.33
Glaziers	$46.26	$22.61	$68.87
Grader/Scraper Operator	$31.00	$6.86	$37.86
Hazardous Materials Removal Workers	$21.13	$1.14	$22.27
Heating And Air Conditioning And Refrigeration Mechanics And Installers	$35.00	$5.56	$40.56
Heavy And Tractor - Trailer Truck Drivers	$25.00	$1.13	$26.13
Highway Maintenance Workers	$22.85	$4.79	$27.64
Industrial Machinery Mechanics	$30.00	$4.60	$34.60
Industrial Truck And Tractor Operators	$26.17	$3.49	$29.66
Insulation Worker - Mechanical	$24.00	$4.71	$28.71
Ironworker - Ornamental	$31.37	$25.82	$57.19
Light Truck Or Delivery Services Drivers	$27.99	$1.97	$29.96
Loading Machine And Dragline Operators	$25.50	$4.99	$30.49
Millwrights	$35.95	$13.84	$49.79
Mobile Heavy Equipment Mechanics - Except Engines	$30.00	$5.67	$35.67
Operating Engineers And Other Equipment Operators	$28.50	$3.54	$32.04
Paving Surfacing And Tamping Equipment Operators	$28.60	$12.03	$40.63
Pile-Driver Operators	$36.00	$2.87	$38.87
Pipe/Steam/Sprinkler Fitter	$30.75	$7.19	$37.94
Pipelayers	$27.48	$4.72	$32.20
Plumbers	$34.50	$5.74	$40.24
Pump Operators - Except Wellhead Pumpers	$56.03	$34.76	$90.79
Radio Cellular And Tower Equipment Installers	$30.00	$4.85	$34.85
Reinforcing Iron And Rebar Workers	$56.69	$2.27	$58.96
Riggers	$30.50	$8.25	$38.75
Roofers	$24.67	$3.60	$28.27
Sheet Metal Workers	$28.46	$6.44	$34.90
Structural Iron And Steel Workers	$31.37	$4.16	$35.53
Tapers	$29.00	$2.40	$31.40
Telecommunications Equipment Installers And Repairers - Except Line Installers	$30.42	$9.75	$40.17
Telecommunications Line Installers And Repairers	$30.00	$2.30	$32.30

Welders are classified as the trade to which welding is incidental (e.g. welding structural steel is Structural Iron and Steel Worker)

Apprentices – The minimum wage rates for registered apprentices are the rates recognized in the sponsorship agreement for registered apprentices working in the pertinent classification.

For any other specific trade on this project not listed above, contact the Bureau of Labor Standards for further clarification.

Title 26 §1310 requires that a clearly legible statement of all fair minimum wage and benefits rates to be paid the several classes of laborers, workers and mechanics employed on the construction on the public work must be kept posted in a prominent and easily accessible place at the site by each contractor and subcontractor subject to sections 1304 to 1313.

Appeal – Any person affected by the determination of these rates may appeal to the Commissioner of Labor by filing a written notice with the Commissioner stating the specific grounds of the objection within ten (10) days from the filing of these rates.

A true copy

Attest: Scott R. Cotnoir
Scott R. Cotnoir
Wage & Hour Director
Bureau of Labor Standards

Expiration Date: 12-31-2025
Revision Date: 2-3-2025

THIS DOCUMENT MUST BE CLEARLY POSTED AT ALL CONSTRUCTION SITES FUNDED IN PART WITH STATE FUNDS

State of Maine
Department of Labor
Bureau of Labor Standards
Augusta, Maine 04333-0045
Telephone (207) 623-7906

Wage Determination - In accordance with 26 MRS §1301 et. seq., this is a determination by the Bureau of Labor Standards, of the fair minimum wage rate to be paid to laborers and workers employed on the below titled project.

2025 Fair Minimum Wage Rates – Building 2 York County (other than 1 & 2 family homes)

Occupational Title	Minimum Wage	Minimum Benefit	Total
Brickmasons And Blockmasons	$33.00	$11.13	$44.13
Bulldozer Operator	$34.90	$2.24	$37.14
Carpenter	$28.72	$19.38	$48.10
Cement Masons And Concrete Finisher	$26.00	$1.67	$27.67
Construction And Maintenance Painters	$27.00	$1.29	$28.29
Construction Laborer	$21.90	$19.72	$41.62
Crane And Tower Operators	$35.00	$11.15	$46.15
Crushing Grinding And Polishing Machine Operators	$27.50	$5.64	$33.14
Earth Drillers - Except Oil And Gas	$23.30	$0.99	$24.29
Electrical Power - Line Installer And Repairers	$43.26	$16.55	$59.81
Electricians	$37.43	$20.07	$57.50
Elevator Installers And Repairers	$71.21	$44.32	$115.53
Excavator Operator	$32.79	$4.40	$37.19
Fence Erectors	$26.00	$2.63	$28.63
Flaggers	$20.50	$0.40	$20.90
Floor Layers - Except Carpet/Wood/Hard Tiles	$25.75	$3.73	$29.48
Glaziers	$46.26	$22.61	$68.87
Grader/Scraper Operator	$31.00	$6.86	$37.86
Hazardous Materials Removal Workers	$22.25	$1.55	$23.80
Heating And Air Conditioning And Refrigeration Mechanics And Installers	$35.00	$5.30	$40.30
Heavy And Tractor - Trailer Truck Drivers	$25.25	$3.96	$29.21
Highway Maintenance Workers	$22.85	$4.79	$27.64
Industrial Machinery Mechanics	$30.00	$4.60	$34.60
Industrial Truck And Tractor Operators	$26.17	$3.49	$29.66
Insulation Worker - Mechanical	$27.00	$6.49	$33.49
Ironworker - Ornamental	$31.37	$25.82	$57.19
Light Truck Or Delivery Services Drivers	$27.99	$1.90	$29.89
Loading Machine And Dragline Operators	$27.50	$6.43	$33.93
Millwrights	$31.45	$15.17	$46.62
Mobile Heavy Equipment Mechanics - Except Engines	$30.00	$5.67	$35.67
Operating Engineers And Other Equipment Operators	$28.50	$3.54	$32.04
Paving Surfacing And Tamping Equipment Operators	$28.60	$12.03	$40.63
Pile-Driver Operators	$36.00	$2.87	$38.87
Pipe/Steam/Sprinkler Fitter	$43.76	$25.44	$69.20
Pipelayers	$27.48	$4.72	$32.20
Plumbers	$38.75	$22.96	$61.71
Pump Operators - Except Wellhead Pumpers	$56.03	$34.76	$90.79
Radio Cellular And Tower Equipment Installers	$30.00	$4.85	$34.85
Reinforcing Iron And Rebar Workers	$56.69	$2.27	$58.96
Riggers	$31.95	$25.00	$56.95
Roofers	$28.50	$4.40	$32.90
Sheet Metal Workers	$29.00	$5.92	$34.92
Structural Iron And Steel Workers	$31.95	$25.00	$56.95
Tapers	$29.00	$4.75	$33.75
Telecommunications Equipment Installers And Repairers - Except Line Installers	$32.47	$9.82	$42.29
Telecommunications Line Installers And Repairers	$31.00	$2.79	$33.79

Welders are classified as the trade to which welding is incidental (e.g. welding structural steel is Structural Iron and Steel Worker)

Apprentices – The minimum wage rates for registered apprentices are the rates recognized in the sponsorship agreement for registered apprentices working in the pertinent classification.

For any other specific trade on this project not listed above, contact the Bureau of Labor Standards for further clarification.

Title 26 §1310 requires that a clearly legible statement of all fair minimum wage and benefits rates to be paid the several classes of laborers, workers and mechanics employed on the construction on the public work must be kept posted in a prominent and easily accessible place at the site by each contractor and subcontractor subject to sections 1304 to 1313.

Appeal – Any person affected by the determination of these rates may appeal to the Commissioner of Labor by filing a written notice with the Commissioner stating the specific grounds of the objection within ten (10) days from the filing of these rates.

A true copy

Attest: Scott R. Cotnoir
Scott R. Cotnoir
Wage & Hour Director
Bureau of Labor Standards

Expiration Date: 12-31-2025
Revision Date: 2-3-2025

104.4.6 Utility Coordination

This Subsection is amended by the addition of the following:

These Special Provisions outline the arrangements which have been established by the Authority for coordination of the work to be accomplished by the utilities. The scope and schedule of utility relocation work is noted herein. The Contractor shall plan and conduct the work accordingly.

General

Utility working days are Monday through Friday, conditions permitting. Times are estimated on the basis of a single crew for each utility. Any times and dates mentioned are estimates only and are dependent upon favorable weather, working conditions, and freedom from emergencies. The Contractor shall have no claim against the Authority if they are exceeded.

The Contractor shall plan and conduct his operations in accordance with the following utility schedule. The Contractor must comply with all OSHA regulations pertaining to work adjacent to utility wires. The Contractor shall plan and conduct his work accordingly.

The following utilities are located within the Project limits. The Contractor shall ascertain the location of the existing utilities and any other necessary information by direct inquiry at the office of the following utility owners:

AERIAL AND UNDERGROUND UTILITIES

No utility services are known to exist within the specified work area.

104.4.6.1 Temporary Utilities

The Contractor will be required to maintain access and all services/utilities, including backup power systems, to the existing buildings on site throughout construction. Existing services and utilities include, but are not necessarily limited to, permanent and backup power, telephone, internet, water, sewer, propane, heat, and site/roadway lighting.

The Contractor shall be responsible for all temporary connections, service runs, relocations, disconnections, reconnections, temporary holding tanks, coordination with the MTA’s propane supplier, coordination with the MTA’s maintenance supervisors, etc. as required to complete the work while maintaining utility services to existing buildings.

104.4.7 Cooperation With Other Contractors

This Subsection is amended by the addition of the following:

A number of adjacent contracts may be scheduled for the 2026 construction season. These contracts may utilize the York and Gardiner Maintenance Yards for the location of field trailers, material and equipment storage and parking, or for other purposes approved by the Maine Turnpike Authority. The Contractor for Contract 2026.13 shall be responsible for working cooperatively with the Resident Engineer, Site Foreman and Supervisor, and Contractors to reasonably accommodate and allow all approved operations on site.

The following Subsection is added:

105.2.4.3 Asbestos

The Contractor shall note that the existing structure(s) has/have tested negative for asbestos containing materials. A copy of the Asbestos Determination Report is attached as **Appendix A**.

Whereas no Asbestos Containing Material Determination Survey is 100 percent accurate, building demolition activities shall be accomplished under the supervision of a "competent person", as defined by OSHA, to evaluate whether materials uncovered/exposed are asbestos containing materials. If the "competent person" observes, or believes he has observed, asbestos containing materials while demolition is underway, the “competent person” shall immediately stop the demolition, secure the site and notify the Project Resident/Inspector.

The Owner shall have the area tested for asbestos containing materials. No work will be permitted in the area until samples show that no asbestos containing materials exists, or if asbestos containing materials are present, the conditions are abated. Compensation for delays resulting from stopping the demolition, testing for asbestos containing materials, and abating asbestos containing materials, if they exist, shall be limited to a time extension.

105.11 As-Built Plans

The Contractor shall provide the Authority with as-built plans in PDF and MicroStation or AutoCAD. The as-built plans shall note changes to the bid documents. Submittal of Draft and 100% as-built plans to the Resident shall be conditions of Mobilization Payment, Retainage Reduction, and Final Payment as noted in Special Provision 108.

105.11.1 As-Built Plan Submittals

The Contractor shall make the following submittals of as-built plans to the Resident as part of the conditions of Mobilization Payment, Retainage Reduction, and Final Payment as noted in Special Provision 108:

a. Draft As-Built Plans for review and approval by the Resident
b. Final As-Built Plans

105.11.2 As Built Plan Requirements

As-built plans and CADD files shall conform to the following requirements as they pertain to this project:

a. Include legend of line weights and styles
b. Project stationing shall be on its own layer and be color white
c. Electric cable, conduit, and lighting cables shall be on their own layer and be color red
d. Gas or gaseous materials shall be on their own layer and be color yellow

The following Subsection is added:

107.1 Contract Time and Contract Completion Date

The Maintenance Facilities at York and Gardiner shall be fully operational and available for use by Maine Turnpike staff between October 15th and April 15th annually. The Contractor shall schedule and conduct the work accordingly. An early start date may be considered by the Authority if winter maintenance activities end early for the season.

All work for Contract 20263.13 shall be completed in accordance with the following dates:

- Earliest Construction Start Date: April 16, 2026
- Substantial Completion: June 19, 2026
- Final Completion: June 26, 2026

The MTA will entertain a start date for this work that fits within the Contractor's schedule beginning after MTA Board Approval and completed within the date limitations noted above. Liquidated damages will occur for each day after the above noted dates.

107.1.1 Substantial Completion

This subsection is amended by the addition of the following:

Substantial Completion is defined as having the air handling systems at both the York and Gardiner Maintenance Facilities completely operational and balanced.

107.1.2 Limitations of Operations

Construction of the air handler replacements shall not, in the opinion of the Resident, prohibit the safe and reasonable operations of MTA maintenance crews. The Contractor shall provide clear access for all areas of the facilities throughout the construction project. The facility shall remain open and occupied by MTA throughout the construction duration. All work shall

be completed as expeditiously as reasonably possible and in a manner that minimizes disruptions to MTA operations to the extent possible.

The Contractor shall submit their proposed staging, storage and construction areas for approval to the Resident. The Contractor shall be responsible for minimizing the footprint of the project, and resulting impacts to the MTA, to the extent practical. The Authority will allow the contractor to store materials in the tool room while construction is ongoing.

The Contractor shall be responsible for maintaining all utility services at all times during construction, except as noted herein. Outages will be allowed between 4:00 p.m. and 6:00 a.m. daily and shall be scheduled and approved by the MTA at least one business day prior to the beginning of any outage.

107.4.6 Prosecution of Work

The Contractor shall submit to the Authority a construction schedule which shall document that the Contractor has the necessary labor and equipment to work immediately and continuously at the project site. The facility shall remain open and occupied by MTA throughout the construction duration. The intent of this specification is to minimize disruption to the facility to the extent possible. Then contractor shall strictly schedule required shutdowns for the HVAC systems with MTA and shall limit those shut downs to the time required to decommission the existing systems and install/commission the replacement systems. The contractor shall schedule the work such that the duration for the shut down of HVAC does not create untenable living conditions during normal business hours.

108.2.1 Generation of Progress Payments

The Authority will estimate the amount of Work performed at least monthly and make payment based upon such estimates. Estimates may be paid bimonthly (twice-a-month) if the bimonthly (twice-a-month) invoices exceed $100,000. No such estimates or payment will be made if, in the judgment of the Authority, the Work is not proceeding in accordance with the provisions of the Contract~~,~~. The Contractor agrees to waive all claims related to the timing and amount of such estimates.

108.3 Retainage

The seventh paragraph is deleted in its entirety and replaced with the following:

When requested by the Contractor, an 80 percent reduction of retainage will be considered by the Authority when the Project is substantially complete and the Contractor has submitted a Draft (98%) as-built submittal of all work, in accordance with Special Provision 105. When requesting a reduction, the Contractor shall include an explanation of the outstanding Work, an estimate of the cost to complete the Work, and a schedule for completing the Work. Seasonal limitations as well as warranty and establishment periods (for vegetation) shall be addressed.

MAINE TURNPIKE AUTHORITY
SPECIFICATIONS
PART III – DIVISION 800 SPECIFICATIONS

Division	Section Title

SPECIFICATIONS GROUP

General Requirements Subgroup

Facility Services Subgroup

END OF TABLE OF CONTENTS

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work by Owner.
4. Specification and drawing conventions.

1.2 PROJECT INFORMATION

A. Project Identification: **Air Handler Replacements – York and Gardiner Maintenance Facilities**

1. Project Location: York and Gardiner, ME

B. Owner: Maine Turnpike Authority

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of the Project is defined by the Contract Documents and consists of the following:

1. The project consists of:
   a. Replace the central split system Dx air handling unit, LP gas fired duct furnace, and two exterior condensing units serving the Gardiner Maintenance Facility complete with controls.
   b. Add an electric resistance duct coil for the Supervisor's Office at the Gardiner Maintenance Facility.
   c. Replace two air handlers with LP gas furnaces, two duct mounted Dx cooling coils, and two exterior condensing units complete with controls at the York Maintenance Facility.
   d. Duct revisions at both the Gardiner and York Maintenance Facilities to create a complete ducted return system.

1.4 PROJECT SCHEDULE

A. The work at both facilities shall be completed as a single project. The Contractor shall complete the work on or before dates scheduled below:

1. Scope shall be substantially completed by **June 19, 2026**
2. Scope shall achieve Final completion by **June 26, 2026**

1.5 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 230700 for plumbing insulation.

END OF SECTION 220700

SECTION 221123 – FACILITY FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 22 Section: “Common Work Results”

1.2 SUMMARY

A. This Section includes fuel gas piping, specialties, and accessories.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Specialty valves
2. Pressure regulators.
3. Meters

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For fuel gas specialties and accessories to include in maintenance manuals specified in Division 1.

D. Seismic Delegated-Design Submittal:

1. For piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

a. Determine seismic restraint sizes and locations.
b. Provide seismic restraints as scheduled or specified.
c. Provide calculations and materials if required for restraint of un-isolated equipment.
d. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

2. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.

    a. Applicable Code: IBC
    b. Seismic Design Category: See structural plans.
    c. Design Spectral Response at Short Periods (SDS): See structural plans.
    d. Short Period Spectral Response Acceleration (SS): See structural plans.
    e. Building Use Group or Occupancy Category: See structural plans.

1.4 QUALITY ASSURANCE

A. All work shall be performed by fuel gas licensed technicians.

B. Installations of fuel gas shall comply with the local fuel gas code: Maine Fuel Board Laws & Rules NFPA 58.

C. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Valves:

    a. American Valve.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Crane Valves.
    d. Grinnell Corp.
    e. Honeywell, Inc.
    f. McDonald: A. Y. McDonald Mfg. Co.
    g. Milwaukee Valve Co., Inc.
    h. Nibco, Inc.
    i. Mueller Co.; Mueller Gas Products Div.
    j. Watts Industries, Inc.

2. Meters:

    a. American Meter Co.
    b. Badger Meter, Inc.; Utility Products Div.
    c. Equimeter, Inc.
    d. National Meter.
    e. Schlumberger Industries; Gas Div.

3. Pressure Regulators:

    a. American Meter Co.
    b. Equimeter, Inc.
    c. Fisher Controls International, Inc.
    d. Maxitrol Co.
    e. National Meter.
    f. Richards Industries, Inc.; Jordan Valve Div.
    g. Schlumberger Industries; Gas Div.

2.2 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or flanged or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

C. Transition Fittings: Type, material, and end connections to match piping being joined.

D. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed

with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

E. Common Joining Materials: Refer to Division 23 Section "Common Work Results" for joining materials not in this Section.

2.3 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating. Tamperproof Feature: Include design for locking.

2.4 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

D. Pressure gages shall conform to ASME B40.100, Type I, Class 1. Pressure-gage size shall be 3-1/2-inch nominal diameter. Case shall be corrosion-resistant steel conforming to any of the AISI 300 series of

ASTM A 666, with a No. 4 standard commercial polish or better. All gages shall be equipped with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.5 PRESSURE REGULATORS

A. Provide service, line, and appliance pressure regulators as indicated and as required by fuel code. Regulators may include vent limiting device, instead of vent connection to outside, if approved by authorities having jurisdiction. Provide venting as required by fuel code.

B. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.

C. Appliance Pressure Regulators: ANSI Z21.18.

D. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

2.6 SEISMIC RESTRAINTS

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

B. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.

C. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint.

D. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required.

E. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section. Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Inspect gas piping according to fuel gas code to determine that gas utilization devices are turned off in piping section affected.

D. Comply with fuel gas code requirements for prevention of accidental ignition.

E. Make arrangements with local utility for gas service to the Owner’s distribution system. Provide service to the building as required by the gas supplier. Coordinate all activities between the Owner and gas supplier. The installation of the gas service shall comply with the published gas supplier standards. Pay all utility company charges; include charges in the base bid.

3.3 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping: Use the following:

1. NPS 2 and Smaller: steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
3. Gas Service Piping at Meters and Regulators: Steel pipe, steel welding fittings, and welded joints.

C. Concealed (gas piping that, when in place in a finished building, would require removal of permanent construction to gain access to the piping) Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Floors: Not permitted.

3. Concealed piping shall not be installed in solid partitions.
4. Prohibited Locations: Do not install gas piping where not allowed by fuel gas code.
5. In-slab (within building) Fuel Gas Piping: Not permitted.

3.4 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Piping Line Valves, NPS 2 and Smaller: Gas valve.

D. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

E. Valves at Service Meter, NPS 2 and Smaller: Gas valve.

F. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

3.5 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Results" for installation of:

1. Basic piping requirements.
2. Joint construction requirements.
3. Hanger, support, and anchor devices.
4. Firestopping
5. Sleeves and Escutcheons
6. Wall penetration system at each service pipe penetration through foundation wall.
7. Dielectric fittings
8. Valves
9. Mechanical Identification

B. Drips and Sediment Traps: Provide drips at points where condensate may collect. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Provide with space between bottom of drip and floor for removal of plug or cap.

C. Provide fuel gas piping at uniform grade of ¼” per 15 feet.

D. Use eccentric reducer fittings to make reductions in pipe sizes. Provide fittings with level side down.

E. Connect branch piping from top or side of horizontal piping.

F. Provide strainer on inlet of each line pressure regulator.

G. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

3.6 SEISMIC RESTRAINT OF PIPING

A. Seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.

C. Coordinate work with other trades to avoid rigid contact with the building.

D. Overstressing of the building structure must not occur because of overhead support of equipment. Generally bracing may occur from flanges of structural beams, upper truss cords in bar joist construction, or cast in place inserts or wedge type drill-in concrete anchors.

E. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit. Cable assemblies shall be installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

1. The support rods must be braced when necessary to accept compressive loads with steel angles and rod clamp assemblies.
2. At all locations where restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with pipe clevis cross bolt braces.
3. Seismically restrain the following piping: Fuel gas piping that is 1" I.D. or larger.
4. Piping exclusions:

    a. Gas piping less than 1" inside diameter.
    b. All piping suspended by individual hangers 12" or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" limit is exceeded by any hanger in the run, seismic bracing is required for the run.
    c. The 12" exemption applies for trapeze-supported systems if the top of each item supported by the trapeze qualifies.

5. Transverse piping restraints shall be at 20' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
6. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
7. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or tee or combined stresses are within allowable limits at longer distances.
8. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
9. Branch lines may not be used to restrain main lines.

F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

3.7 CONNECTIONS

A. Connect piping to appliances using appliance flexible connectors, shutoff valves, and unions. Provide valve upstream from and within 72 inches of each appliance. Provide union downstream from valve.

B. Sediment Traps: Provide tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 PAINTING

A. Paint exposed, exterior metal piping, valves, regulators, service meters and meter bars, and piping specialties, except components with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel
d. Color: As selected by Architect

B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to fuel gas code and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

G. Verify that the gas piping has been grounded by Division 26 in accordance with NFPA requirements.

H. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

END OF SECTION 221123

SECTION 221316 – PLUMBING SANITARY AND STORM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 22 Section: “Common Work Results”

1.2 SUMMARY

A. This Section includes piping and specialties.
1. HVAC condensate waste.

B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.

C. General layout shown, provide piping to fixtures as required by the local plumbing code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 PERFORMANCE REQUIREMENTS

A. Comply with the utility requirements for the connection of to the municipal utility services. Obtain and pay for all necessary permits from the applicable municipal department. Obtain authority to connect to their existing mains.

B. Provide components and installation capable of producing piping systems with working-pressure ratings per local plumbing code.

1.4 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with the local building and plumbing codes.

PART 2 - PRODUCTS

2.1 PVC DRAINAGE PIPING

A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D-1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D-1785 and ASTM D-2665. Fittings shall conform to ASTM D-2665.

B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D-2564, primer shall conform to ASTM F-656. The system to be manufactured by Charlotte Pipe and Foundry Co. or approved equal; and shall be intended for non-pressure drainage applications where the temperature will not exceed 140°F.

C. Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil and other foreign material, apply primer in accordance with ASTM F656.

2.2 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. HVAC Unit Condensate Indirect Waste: Drain Lines: ¾" minimum diameter; PVC or DWV Copper Tubing: ASTM B 306, Type DWV. PVC drain lines shall not be used in return air plenums.

3.2 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Results" for installation of:

1. Basic piping requirements.
2. Joint construction requirements.
3. Hanger, support, and anchor devices.
4. Firestopping
5. Sleeves and Escutcheons
6. Wall penetration system at each service pipe penetration through foundation wall.
7. Dielectric fittings
8. Valves
9. Mechanical Identification

B. Provide PVC soil and waste drainage and vent piping according to ASTM D 2665.

C. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. Aboveground Pressure Piping: Pipe fitting.

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

E. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Provide drainage piping beginning at low point of each system. Provide true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Provide required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Provide drainage and vent piping at the minimum slopes as required by the local plumbing code.

H. Provide cleanouts at grade and extend to where building drains connect to site piping. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

3.3 SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for drain piping and tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.
6. Piping shall be equal to or larger than the drain pan connection size.
7. If required by manufacturer for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with manufacturer's requirements.
8. Route indoor unit condensate drains to sink traps, floor drains, plumbing code compliant, or other locations as indicated.

B. Gravity Drains:

1. Piping shall be provided with a 1/8” foot minimum slope.
2. Height of unit must be carefully coordinated to provide for proper condensate drainage.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.
2. Provide units for collecting condensate and extend to open drain, floor drain, mop sink, or other approved location.
3. Mount pump level, secured to wall.

    a. Condensate supply hose must be routed with a downward slope to the pump.
    b. Secure the hose using hose clamps.
    c. After securing hose on the non-return valve, lock non- return valve by rotating valve one quarter turn clockwise.

4. After installing the condensate pump, test it to ensure that it functions correctly. To test the function, pour water into the tank until the activation level is reached and the pump starts. If air in the pump causes the integrated dry-run protection to actuate (pump deactivates, green and red operating lamp flash), add additional water and re-test.
5. Shutoff Valves: Provide full-port ball valve on each pump discharge.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior drainage piping to exterior drainage piping.

C. Connect drainage and vent piping to fixtures and equipment as shown on the plans.

D. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

E. Provide traps on plumbing specialty drain outlets.

F. Provide expansion joints on vertical risers, stacks, and conductors as required by code.

G. Cleanouts:

1. Provide cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated: Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated. Locate at each change in direction of piping greater than 45 degrees. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping. Locate at base of each vertical soil and waste stack.
2. Provide cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
3. Provide cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
4. Provide flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

3.5 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Test piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head

of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch w.g. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

D. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

E. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.6 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 230500 – COMMON WORK RESULTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This section applies to Plumbing Division 22 & and HVAC Division 23 sections.

1.2 GENERAL

A. Section 230500 includes items common to all the division specification sections.

B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.

C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for a decision before start of any related work.

D. Consistency and Completeness: The contract documents are intended to include all components; however, the contract documents may not be perfect. Repetitive, common components (such as volume dampers, thermostats, condensate drains, trap primers, vent pipes, valves, etc.) are shown throughout. If a common component is missing in from the drawings, provide as similar per other areas. There will be no change orders for missing such components, the contractor shall provide consistent, complete, functioning systems.

E. Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.

F. Materials or work described in words, which so applied, have a well-known technical or trade meaning shall be held to refer to such recognized standards. Since the plans and specifications cover the dimensions and features of the work and do not set forth the analysis of the design, it is the duty of the Contractor fulfilling them to ascertain the true intent in any case where it is doubtful.

1.3 MANUFACTURERS INSTRUCTIONS

A. Provide equipment and components to comply with manufacturer's written installation instructions and published drawings.

B. Follow manufacturer's instructions for inspection, start-up, calibration, commissioning, and testing.

1.4 DEFINITIONS

A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

B. "Provide": Furnish and install, complete and ready for the intended use.

C. "Shall": The word "shall" is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and attics.

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

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

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

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

I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

1.5 SUBMITTALS

A. Provide in accordance with Division 1 of the specifications.

B. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials, and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only.

1.6 SUBSTITUTIONS

A. Provide in accordance with Division 1 of the specifications.

B. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2. Requested substitution does not require revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work and shall be acceptable to all contractors involved.
8. Equipment electrical characteristics different than scheduled may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost.
9. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
10. Requested substitution has been coordinated with other portions of the Work.
11. Requested substitution provides specified warranty.

1.7 QUALITY ASSURANCE

A. Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

C. Installer Qualifications: Work shall be done by skilled mechanics shall have successfully completed an apprenticeship program or another craft training program.

D. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.

1.8 COORDINATION

A. Coordinate use of project space and sequence of installation of work, which is indicated diagrammatically on drawings. Follow routings shown, as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

B. Coordinate use of project space and sequence of installation of work.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels shall be provided for any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

1. Access panels and doors shall be provided by the trade responsible for the equipment that needs access. Access door shall be an Acudor UF-5000 or approved equal; finish color shall match wall. Fire-rated wall access panels shall have a UL - 1-1/2 hour "B" label.

1.9 TEST ADJUST AND BALANCE READINESS

A. The Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers and personnel as required to correct, repair, and/or replace deficient items or conditions found during this project, including the testing, adjusting, and balancing period.

B. In order that systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

C. The Drawings and Specifications indicate adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to provide these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

D. Complete operational readiness of the HVAC systems also requires that the following be accomplished:

1. Distribution Systems:

a. Verify installation for conformity to design. Ducts shall be terminated and tested as required by the Specification.
b. Dampers shall be properly located and functional. Dampers shall have tight closure and open fully with smooth and free operation.
c. RGD’S and terminal devices shall be provided and secured in a fully open position.
d. Air handling systems and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. Clean filters shall be in place, coils shall be clean with fins straightened, bearings properly greased, and the system shall be completely operational.

The Contractor shall verify that systems are operating within the design pressure limits of the piping and ductwork.

e. Under normal operating conditions, check condensate drains for proper connections and functioning. Cooling coil drain pans have a positive slope to drain. Cooling coil condensate drain trap maintains an air seal.
f. Fans shall be operating and verified for freedom from vibration, proper fan rotation.
g. Bearings shall be greased.
h. Terminal units shall be provided and functional (i.e., controls functioning).

1.10 RENOVATION PROJECT REQUIREMENTS

A. The Contractor shall cooperate with the Owner to minimize conflicts with the Owner's operations.

B. The Contractor shall study drawings and specifications, visit the site, and get acquainted with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to be familiarized with the conditions and extent of the proposed work. The Contractor shall execute alterations, additions, removals, relocations, or new work, etc., as indicated, or required to provide a complete installation in accordance with the intent of the drawing and specifications.

C. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated. Keep driveways and entrances serving premises clear and available to Owner. Schedule deliveries to minimize use of driveways and entrances and minimize space and time requirements for storage of materials and equipment on-site.

D. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.

E. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within rooms of building. Schedules for various phases of contract work shall be coordinated with other trades and with Owner’s Representative. Provide, as part of the contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

F. Cutting And Patching: Provide temporary support of Work to be cut. Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

1. Where existing services/systems are required to be removed relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
2. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. Cut in-place construction to provide for installation of other components or performance of other construction and subsequently patch as required to restore surfaces to their original condition.

3. Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original installer; comply with original installer's written recommendations.
4. Patch construction by filling, repairing, refinishing, closing, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. Clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
5. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced to be left in safe structural condition in accordance with the local building code requirements.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
7. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

A. Any costs incurred due to deviations from basis of design unit shall be responsibility of the contractor.

B. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 5 years.

C. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.

D. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

E. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

F. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

G. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 IDENTIFICATION

A. Equipment:

1. Terminology: Match schedules as closely as possible.
2. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

   a. Lettering Size: Minimum letter height of 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.
   b. Stencil Material: Fiberboard or metal.
   c. Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

B. In addition to the equipment tag, equipment located above the ceiling that requires servicing shall be labeled on the ceiling grid using a labeling machine.

C. Piping Identification Devices

1. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.
2. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow. Length of color field and size of letters shall be proportional to pipe OD.
4. Types: Self-adhesive type: Seton Opti-Code; Snap-around type: Seton Setmark; Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

D. Valve Tags & Schedules

1. Valve Tags: Stamped or engraved 1-1/2 round with 1/4-inch letters for piping system legend and 1/2-inch black-filled numbers, with numbering scheme; 3/16” hole for fastener; Material: 19-gauge brass; Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
2. Valve Schedules: For each piping system, on standard-size bond paper. Also save in PDF format. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws. Frame: aluminum. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

E. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing. Size: 3 by 5-1/4 inches minimum. Large-size primary caption such as “DANGER”. Color: Yellow background with black lettering.

2.3 PIPE JOINING MATERIALS

A. Provide per local code.

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

C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Press Connections

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC; ProPress, Apollo, or approved equal.
2. Press ends shall have Viega Smart Connect, Apollo Leak Before Press, or similar technology designed into the fitting itself, allowing identification of an un-pressed fitting during pressure testing. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
3. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed, or an alternative supplied by the fitting manufacturer.
4. Steel: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI/CSA LC4. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed, or an alternative supplied by the fitting manufacturer. Piping and fittings shall comply with CSA LC-4 and local codes.

E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.

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

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

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

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

J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Provide dielectric isolation at the connection of dissimilar metals. Provide brass ball valves or fittings; or Watts Series LF3000 (lead free) or approved equal.

2.4 SLEEVES & ESCUTCHEONS

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

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

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Provide penetration system where service pipes penetrate through foundation wall or floor. Make installation watertight. Mechanical Sleeve Seals: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, Advanced Product & Systems, LLC, Garlock, or approved equal.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Glass-reinforced nylon.
3. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements.

G. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers the opening. Escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.5 HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

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

1. B-Line Systems, Inc.
2. Carpenter & Patterson, Inc.
3. Grinnell Corp.
4. Hubbard Enterprises/Holdrite
5. National Pipe Hanger Corp.
6. Piping Technology & Products, Inc.
7. Unistrut
8. Anvil International, Inc.
9. Empire

B. Provide in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped on the part itself for identification.

C. The materials of pipe hanging and supporting elements shall be in accordance with MSS SP-58. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Do not allow dissimilar metals to come into contact.

D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel." Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. Delegated-Design Submittal: For hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Show fabrication and installation details and include calculations. Provide for the following: trapeze pipe hangers, metal framing systems, pipe stands, equipment supports.

F. Hangers:

1. Uninsulated pipes 2 inch and smaller: Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170; Adjustable steel swivel J-hanger, Type 5, B-Line B3690; Malleable iron ring hanger, Type 12, B-Line B3198R or hinged ring hanger, B3198H.Adjustable steel clevis hanger, Type 1, B-Line B3100.
2. Uninsulated pipes 2-1/2 inch and larger: Adjustable steel clevis hanger, Type 1, B-Line B3100.
3. Insulated Hot piping: 2 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield. 2-1/2 inch and larger pipes: Type 41 or Type 43 with Type 39A/39B, B3160-B3165 series pipe covering protection saddle.
4. Insulated Cold piping: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield.
5. Copper Tubing Supports Hangers shall be sized to fit copper tubing outside diameters. Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170CT. Malleable iron ring hanger, Type 12, B-Line B3198RCT or hinged ring hanger B3198HCT. Adjustable steel clevis hanger, Type 1, B-Line B3104CT. For supporting copper tube to strut use plastic inserted vibration isolation clamps, B-Line BVT series.

6. Plastic Pipe Supports: V-Bottom clevis hanger with galvanized 18-gauge continuous support channel, Type 1, B-Line B3106 and B3106V plastic pipe support channel, to form a continuous support system for plastic pipe or flexible tubing.

G. Pipe Clamps: When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weldless eye nuts, Type 4, B-Line B3140. For insulated lines use double bolted pipe clamps, Type 3, B-Line B3144.

H. Multiple or Trapeze Hanger: Trapeze hangers shall be constructed from 12-gauge roll formed ASTM A1011 SS Grade 33 structural steel channel, 1-5/8 inch by 1-5/8-inch minimum, B-Line B22 strut or stronger as required. Mount pipes to trapeze with 2-piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.

I. Wall Supports: Pipes 4” and smaller: Carbon steel J-hanger, B-Line B3690. Pipes larger than 4”: Welded strut bracket and pipe straps, Type 31 light welded steel bracket, B-Line B3064. Provide Type 32 or Type 33 for heavier loads.

J. Floor Supports: Hot piping under 6 inch and cold piping: Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Type 38 adjustable pipe saddle, B-Line B3093 and B3088T base stand; or Type 39, B3090 and B3088 base stand. Pipe saddle shall be screwed or welded to appropriate base stand. Hot piping 6 inch and larger: Adjustable Roller stand with base plate, Type 46, B3118SL. Adjustable roller support and steel support sized for elevation, B-Line B3124.

K. Vertical Supports: Steel riser clamp sized to fit OD of pipe, Type 8, B-Line B3373.

L. Supplementary Structural Supports: Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12-gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the strut system.

M. Beam Clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected based on load to be supported, and load configuration. C-Clamps shall have locknuts and cup point set screws, Type 23, B-Line B351L. Refer to manufacturer’s recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.

N. Concrete Inserts: Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, Type 18, B-Line B2500 or B3014. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, B-Line N2500 or B3014N series. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 SS Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs./ft. in concrete, B-Line B22I, 32I, or 52I. Select channel nuts suitable for strut and rod sizes.

O. For air conditioning and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT-Series Vibraclamps. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.

P. Accessories

1. Hanger Rods shall be threaded both ends or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
2. Shields shall be 180-degree galvanized sheet metal, 12-inch minimum length, 18-gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.
3. Pipe protection saddles shall be formed from carbon steel, 1/8-inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

Q. Indoor Finishes: Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633; or shall have an electro-deposited green epoxy finish, B-Line Dura-Green®. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.

R. Unistrut (MFMA) Manufacturer Metal Framing System:

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

   a. Unistrut Corporation
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. Thomas & Betts Corporation.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with in-turned lips. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
5. Coating: Unistrut Perma-green or similar.

2.6 MISCELLANEOUS

A. Equipment shall be vibration isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

A. Refer to Division 1 for general demolition requirements and procedures.

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

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap and seal remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap and seal ducts with same or compatible ductwork material.
5. Equipment to be Removed: Disconnect and cap services and remove equipment.
6. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

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

3.2 COMMON REQUIREMENTS

A. Work shall be conducted, installed, and completed in a neat and professional manner reflecting a minimum level of competent workmanship.

B. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by the contractor where necessary to avoid interferences and clearance difficulties.

C. Fabricate based on field measurements.

D. Corrections or comments made on the shop or coordination drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades; and performing work in a safe and satisfactory manner.

E. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect finished parts of equipment. Close duct and pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of work thoroughly clean fixtures, exposed materials, and equipment.

F. Provide piping, ductwork, and equipment to allow maximum headroom unless specific mounting heights are indicated. Provide equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

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

H. Coordinate location of piping, ductwork, sleeves, inserts, hangers, and equipment. Locate to clear other construction, services, and utilities.

I. Provide piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

J. Provide systems above accessible ceilings to allow sufficient space for ceiling panel removal.

K. Verify final equipment locations for roughing-in.

L. Do not enclose, cover, or put into operation until inspected and approved by authorities having jurisdiction.

M. The contract documents indicate required valves, fittings, and accessories. If additional materials are required by code or manufacturer's instructions, they shall be provided at no cost to the owner.

N. Any hot work operations that are performed during this project shall be permitted by use of the FM Global Hot Work Permit System. The FM Global Hot Work Permit System shall be used to supervise all hot work operations (cutting, welding, brazing, grinding, soldering, etc.,) performed outside of any designated welding areas. A written policy statement shall specify who has the authority to issue permits on all shifts. In addition, a constant fire watch shall be continued for 1 hr. after work is completed and the area shall be monitored for an additional 3 hrs. after that.

3.3 PIPING INSTALLATIONS

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

1. Provide piping to permit valve servicing.
2. Provide equipment and other components to allow right of way for piping installed at required slope.
3. Provide free of sags and bends.
4. Provide unions or flanges at connections to equipment.
5. Provide fittings for changes in direction and branch connections.
6. Make allowances for application of insulation.

B. Provide piping adjacent to equipment and machines to allow service and maintenance.

C. Use transition fitting to join dissimilar piping materials. Connect piping in sizes indicated, but not smaller than sizes of unit connections.

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

E. Plastic piping: Piping shall be installed to avoid damage from adjacent light fixtures. In certain construction situations, these plastic pipes may be installed near recessed light fixtures in ceilings. Light fixtures may have exterior temperatures as high as 194°F.

F. Plumbing: General layout shown, provide piping and components as required by the local plumbing code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

3.4 PIPING JOINT CONSTRUCTION

A. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied endcaps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor. Protect fittings, flanges, and piping specialties from moisture and dirt. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

B. Joints shall be fabricated, joined, and tested per the piping and fitting manufacturer’s instructions. Joint preparation, setting and alignment, joining process, timing, hanger spacing, and working pressure shall be in accordance with the pipe and fitting manufacturer’s specifications.

C. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.

D. Ream ends of pipes and tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

E. Installer Qualifications

1. Pipe fitters shall be qualified in the procedure used to perform the pipe joining.
2. The contractor is responsible for documenting the qualification and training records of each pipe fitter. Pipe fitters shall have current, formal training on the pipe jointing method.
3. Contractor must submit documentation that lists personnel assigned to this project prior to beginning construction who have successfully completed formal training conducted by an authorized manufacturer’s representative. The Contractor Training documentation shall be specific to the manufacturer of the pipe and fittings.
4. Personnel’s training documentation must be current and have been updated within the past two (2) years. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.
5. Piping Warranty: Contractor shall provide, and document required training and required by the piping system manufacturer to maintain the piping manufacturer’s warranty.

F. Provide dielectric isolation at the connection of the dissimilar piping (copper and steel).

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

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

I. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

J. Press connections:

1. The joints shall be pressed using the tools approved by the manufacturer.
2. Always examine the pipe to ensure it is fully inserted into the fitting prior to pressing the joint.
3. Pipe ends shall be cut on a right angle (square) to the pipe.
4. Copper: The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tools approved by the manufacturer.
5. Steel: Pipe ends shall be reamed chamfered, and paint, lacquer, grease, oil, or dirt shall be removed from the pipe end with an abrasive cloth, or with the Rigid MegaPress pipe end prep tool. Sealing elements shall be verified for the intended use. Visually examine the fitting sealing element to ensure there is no damage. Utilizing a Viega insertion depth inspection gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.

K. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators. Bevel plain ends of steel pipe. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

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

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix. PVC Piping: Join according to ASTM D 2855.

3.5 PIPE PENETRATIONS, SLEEVES, & ESCUTCHEONS

A. Pipe penetrations shall be sealed, provide sealants for pipe penetrations

B. Provide allowance for thermal expansion and contraction of copper tubing passing through a wall, floor, ceiling, or partition by wrapping with an approved tape or pipe insulation or by installing through an appropriately sized sleeve.

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beams shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.

D. Provide sleeves for pipes passing through concrete and masonry construction. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. Cut sleeves to length for mounting flush with both surfaces. Provide sleeves in new walls and slabs as new walls and slabs are constructed. Provide steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Piping through concrete or masonry shall not be subject to any load from the building construction.

1. Sleeves are not required in drywall construction.
2. Sleeves are not required for core-drilled holes. Provide core drilling as required.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 7.

F. Escutcheons:

1. Provide escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork.
2. Provide escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
3. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

G. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5” beyond the OD of the pipe or tubing.

3.6 PIPE HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Provide hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or provide intermediate supports for smaller diameter pipes as specified for individual pipe hangers. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Provide per manufactures recommendations and calculations.

D. Thermal-Hanger Shield Installation: Provide in pipe hanger or shield for insulated piping.

E. Fastener System Installation: Provide powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Provide fasteners according to

powder-actuated tool manufacturer's operating manual. Provide mechanical-expansion anchors in concrete after concrete is placed and completely cured. Provide fasteners according to manufacturer's written instructions.

F. Provide hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Provide hangers and supports to allow controlled thermal or seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Provide lateral bracing with pipe hangers and supports to prevent swaying.

J. Provide building attachments within concrete slabs or attach to structural steel. Provide additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Provide concrete inserts before concrete is placed; fasten inserts to forms and provide reinforcing bars through openings at top of inserts.

K. Provide for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement

L. Pipe Slopes: Provide hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping. Piping shall be supported in such a manner as to maintain its alignment and prevent sagging.

M. Equipment Supports: Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Grouting: Place grout under supports for equipment and make bearing surface smooth. Provide lateral bracing, to prevent swaying, for equipment supports.

N. Metal Fabrications: Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

O. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

P. Hanger and Support Schedule

1. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
2. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

3. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Hanger Spacing

1. Support piping and tubing not listed below according to MSS SP-69 and manufacturer's written instructions.
2. Load Distribution: Provide hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading.
3. Space and provide hangers with the fewest practical rigid anchor points.
4. Piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal.
5. Pipe shall be supported at branch ends and at changes of direction.
6. Provide hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:

    a. NPS ¾ to 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
    b. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    c. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    d. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
    e. NPS 2-1/2 to 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
    f. NPS 4 to 5: Maximum span, 10 feet; minimum rod size, 5/8 inch.
    g. NPS 6 to 8: Maximum span, 10 feet; minimum rod size, 3/4 inch.
    h. NPS 10 to 12: Maximum span, 10 feet; minimum rod size, 7/8 inch.

7. Provide hangers for copper piping with the following maximum horizontal spacing and minimum rod sizes:

    a. NPS ½ and 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
    b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
    c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
    d. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    e. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    f. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
    g. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
    h. Maximum vertical steel and copper pipe attachment spacing: 10 feet.

8. Piping Hangers for Plastic Piping:
    a. Hangers shall not compress, distort, cut, or abrade the piping.
    b. Hangers shall be placed next to the pipe joint not more than 18” from the point joint.
    c. Maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).
    d. Solvent cemented PVC

        1) NPS 2 and smaller: 48” with 3/8-inch rod.
        2) NPS 2-1/2: 48” with 1/2-inch rod.
        3) NPS 3: 48” with 1/2-inch rod.
        4) NPS 4: 48” with 5/8-inch rod.
        5) NPS 6: 48” with 3/4-inch rod.
        6) NPS 8: 48” with 7/8-inch rod.

7) NPS 10: 48” with 7/8-inch rod.
8) NPS 12: 48” with 7/8-inch rod.

R. Support vertical piping independently of connected horizontal piping. Support vertical pipes at base and at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

S. Place a hanger within 12 inches of each horizontal elbow.

3.7 VALVE INSTALLATION

A. Valves shall be installed in accordance with the manufacturer’s recommendations.

B. Provide valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary.

C. Provide valves in horizontal piping with stem at or above center of pipe.

D. Provide valves in position to allow full stem movement.

E. Provide strainers on supply side of each control valve and elsewhere as indicated or recommended by component manufacturer to have strainer protection. Provide valved drain and hose connection on strainer blow down connection.

1. Provide with provisions for service clearance.
2. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

F. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at connections to screw-type control valves.

3.8 IDENTIFICATION

A. Provide equipment markers on each item of scheduled equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated. Locate markers where accessible and visible. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

1. Letters shall be ¼” high, black.
2. Label equipment above ceiling that requires servicing or access. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.

B. Piping Identification:

1. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts and plenums; and exterior exposed locations as follows:

a. Near each valve and control device.

b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
c. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
d. At access doors and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

2. Directional Flow Arrows: Arrows shall be provided to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
3. Apply “Electric Traced” labels to the outside of heat-traced insulation.

C. Provide tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules in digital format.

D. Relocate mechanical identification materials and devices that have become visually blocked by other work. Clean faces of mechanical identification devices.

3.9 ERECTION OF SUPPORTS AND ANCHORAGES

A. Fasten wall-hanging items securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated. Fasten recessed-type items to reinforcement built into walls.

B. Wood: Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Provide fasteners without splitting wood members. Attach to substrates as required to support applied loads.

C. Metal: Provide in accordance with Division 5. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment. Field Welding: Comply with AWS D1.1.

D. Grouting: Provide per manufacturer’s instructions. Mix and provide grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will encounter grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout.

3.10 FIRESTOPPING

A. Provide through-penetration firestop systems. Refer to Division 7 for materials. Seal penetrations through fire-or smoke-rated wall, partition, ceiling, or roof assemblies with firestopping systems. Refer to Architectural plans for location of rated assemblies.

B. Provide through-penetration firestop systems to comply with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

C. UL-Classified Systems shall be provided for rated walls and floors.

D. Engage an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to provide firestop products per specified requirements.

E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are provided according to specified requirements.

F. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

G. Provide components for each through-penetration firestop system that are needed to provide fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

H. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance. Keep areas of work accessible until inspection by authorities having jurisdiction.

I. Inspecting Agency: Owner may engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

J. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and provide new materials to produce systems complying with specified requirements.

3.11 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 PROJECT CLOSEOUT

A. Starting and Adjusting

1. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace them with new units, and retest.
2. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
3. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Provide commissioning per manufacturer's instructions. This start-up shall include verification of proper installation, system initiation, adjustment, and fine tuning.
5. Start-up shall not be considered complete until the sequence of operation, including alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

B. Follow Closeout procedures as per Division 1.

C. Provide Demonstration and Training in accordance Division 1.

D. Provide Project Record Documents in accordance with Division 1. In addition, per ASHRAE 90.1-2016: Provide record drawings of the actual installation to the building owner. Record drawings shall include, as a minimum, the location and performance data on each piece of equipment; general configuration of the duct and pipe distribution system, including sizes; and the terminal air or water design flow rates.

E. Provide Operation and Maintenance information in accordance with Division 1. In addition, per ASHRAE 90.1: Provide an operating manual and a maintenance manual to the building owner. Manuals shall include, at a minimum, the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Operation manuals and maintenance manuals for each piece of equipment and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of at least one service agency.
4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined set points shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.

END OF SECTION 230500

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division Section: “Common Work Results”

1.2 SUMMARY

A. Testing, Adjusting, and Balancing

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Reports:

1. Deficiency Report: Following examination of installed system, prior to balancing, submit report indicating system deficiencies that would prevent proper testing, adjusting, and balancing of systems and equipment to meet specified performance.
2. TAB Report: Submit the complete testing, adjusting, and balancing report, including any drawings indicating air outlets, thermostats, and equipment identified to correspond with data sheets.
3. Reports shall be on TABB/SMACNA, AABC, or NEBB forms that indicate information addressing each of the testing methods, readings, and adjustments.

C. Closeout Submittals: Provide complete copy of TAB report. Include report in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

A. An independent entity shall perform the TAB work.

B. Special Warranty

1. Provide warranty for period of 90 days following submission of completed report, during which time Owner may request a recheck of up to 10% of total number of terminals, or resetting of any outlet, coil, or device listed in the test report.
2. Warranty shall meet the requirements of the following programs:

    a. TABB – Quality Assurance Program
    b. AABC – National Project Performance Guarantee
    c. NEBB – Conformance Certification

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed, complete, and operable.
3. Verify HVAC control system is operating within the design limitations.
4. Confirm that the sequences of operation comply with Contract Documents.
5. Automatic and manual dampers are operable and fully open.
6. Verify that controllers are calibrated and function as intended.
7. Verify that controller set points are as indicated.
8. Verify the operation of lockout or interlock systems.
9. Verify the operation of valve and damper actuators.
10. Verify that controlled devices are properly installed and connected to correct controller.
11. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
12. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
13. Suitable access to balancing devices and equipment is provided.
14. Thermal overload protection is in place for equipment.
15. Start-up air filters are removed.
16. Final filters are clean and properly installed.
17. Duct and fan systems are clean.
18. Fans are rotating correctly.
19. Life safety and volume dampers are in place and open.

20. Air coil fins are cleaned and combed.
21. Access doors are closed, and duct end caps are in place.
22. Air outlets are installed and connected.
23. Hydronic systems are pressure tested, flushed, filled, and properly vented.
24. Leak testing on duct system has been performed.
25. Pumps are rotating correctly.
26. Start-up/construction strainers have been removed and all permanent strainers are clean and in place.
27. Gauges and/or test ports are properly located for balancing.
28. Service and balance valves are fully open.

B. If deficiencies are evident, submit Deficiency Report to Architect. Do not begin testing, adjusting, and balancing of environmental systems until deficiencies have been remedied.

C. Existing Systems Pre-balance: Existing conditions and operations shall be documented prior to initiation of the project. This shall include measurement and documentation of existing airflows and water flows. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fans.
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check bearings and other lubricated parts for proper lubrication.
7. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

3.2 AIR SYSTEMS PROCEDURES

A. Adhere to the follow procedure:

1. TABB – SMACNA TAB Procedural Guide, with particular focus on the following chapters: Preliminary TAB Procedures, General Air System TAB Procedures, & TABB Procedures for Specific Air Systems.
2. AABC – National Standards for Total System Balance.
3. NEBB – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

B. Minimum air procedures shall include the following:

1. Provide TAB for all air systems and components.
2. Test and adjust fan RPM to design requirements.
3. Test and record motor full load nameplate rating and actual ampere draw.
4. Test and record system static pressures, fan suction, and discharge.
5. Adjust all main supply and return air duct to within tolerances of proper design CFM.
6. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design velocity (FPM) and adjusted velocity, design CFM, and adjusted CFM.
7. Test and record outside air, mixed air, and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).

8. In coordination with the BAS contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
9. Test and adjust air handling and distribution systems to provide required supply, return, outside, and exhaust air quantities within design tolerance.
10. Make air velocity measurements in ducts by Pitot tube traverse across entire cross-sectional area of duct in accordance with SMACNA equal area method or Log Linear method.
11. Measure air quantities at all air inlets and outlets.
12. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels.
13. Vary total system air quantities by adjustment of fan speeds. Provide drive changes recommendations. Vary branch air quantities by damper regulation.
14. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for loading of filters and coils.
15. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances.
16. Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and 100% outside air mode of operation.

C. Set system's airflow rates within the following tolerances:
1. Air Handling Systems: Adjust to within plus 10 percent of outlet total plus allowable leakage rate.
2. Air Outlets and Inlets: Adjust total to within plus or minus 10 percent of design for the space.
3. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.3 ADJUSTING

A. Recorded data shall represent actual measured or observed conditions.

B. Permanently mark the setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.

C. Final report to include identification of all key outlets, key branches, and key trunks in each air system that shows a critical path of no dampening from the fan to terminal device.

D. Final report to include identification of all key terminal devices, key branches, and key trunks in each hydronic system that shows a critical path of no throttling of valves from the pump to terminal device.

E. Leave systems in proper working order by replacing guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

END OF SECTION 230593

SECTION 230700 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

A. This Section includes insulation and related components for Division 22 & Division 23.

1.3 ACTION SUBMITTALS

A. Product Data: Identify thermal conductivity, Greenguard Certification, thickness, and jackets (both factory and field applied, if any), for each type of product indicated. For adhesives and sealants, provide documentation including printed a statement of VOC content.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

C. Indoors: Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.

D. Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Provide accessory materials as part of insulation work under his section shall include closure materials, adhesives, mastics, and support materials; shall be as recommended by insulation material manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.

D. Follow manufacturer's recommended handling practices.

E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.

F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with other trades for insulation application.

B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Certainteed
2. Knauf
3. Owens-Corning
4. John Mansville
5. Armstrong
6. Aeroflex USA
7. Nomaco K-Flex
8. Pabco.

2.2 DUCTWORK INSULATION MATERIALS

A. Flexible Fiber Glass Blanket: Glass Mineral Wool Blanket Insulation: Glass Mineral Wool bonded with a bio-based thermosetting resin. Comply with ASTM C 553, Types I, II, and III, ASTM C 1136 Type II, and ASTM C 1290, Type III. UL/ULC Classified per UL 723 for FSK, FHC 25/50 per ASTM E 84 for PSK only.

1. Factory-applied jacket: ASJ: White, Kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
2. Basis-of-Design Product: Subject to compliance with requirements, provide Knauf Insulation; Atmosphere Duct Wrap.
3. Density: 1.5 PCF
4. R-Value: R6.0 minimum for 1-1/2" thick blanket (k=0.25).

B. Rigid Fiber Glass Board: Johns Manville's 817 Series Spin-Glass® or Knauf Insulation Board with ECOSE Technology meeting ASTM C 612 Type IA and IB; rigid. Maximum Service Temperature: 450°. Density: Minimum 3.0 PCF; R4.2 per inch. Vapor Retarder Jacket: ASJ conforming to ASTM C1136 Type I, or FSK or PSK conforming to ASTM C1136 Type II in combination with protective jacket where necessary. R-Value: R6.0 minimum for 1-1/2" thick blanket (k=0.25).

PART 3 - EXECUTION

3.1 GENERAL APPLICATION REQUIREMENTS

A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer. Follow manufacturer's recommended handling practices. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades. Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

B. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry. Proceed with installation only after unsatisfactory conditions have been corrected. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin. Ensure that pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

C. Installer Qualifications: Skilled mechanics shall have successfully completed an apprenticeship program or another craft training program.

D. Provide insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout, including the length of ducts and fittings, valves, and specialties. Provide per "National Commercial & Industrial Insulation Standards" – MICA Manual.

E. Provide insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each system as specified in insulation system schedules.

F. Provide accessories compatible with insulation materials and suitable for the service.

G. Provide insulation with longitudinal seams at top and bottom of horizontal pipe runs and equipment. Provide multiple layers of insulation with longitudinal and end seams staggered.

H. There shall be no glass fibers exposed to the air. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

I. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

J. Jackets And Finishes: Draw jacket tight and smooth. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c. For below ambient services, apply vapor-barrier mastic over staples. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

K. Keep insulation materials dry during application and finishing.

L. Provide insulation over fittings, valves, and specialties, with continuous thermal and the least number of joints practical.

M. Provide removable insulation covers at fittings and equipment that require servicing and locations with service requirements.

N. Locate seams in the least visible location.

O. Cold surfaces that may “sweat” must be insulated. Vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal.

1. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
2. Hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.
3. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

4. Provide insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity.
5. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic. Provide insert materials and provide insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

P. For above-ambient services, do not install insulation to the following: testing agency labels and stamps, nameplates, and cleanouts.

Q. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance. If piping type is omitted from list below, provide insulation per energy code or as per similar duty.

R. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

S. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

T. Insulate instrument connections for specialties (examples: thermometers, sensors, etc.) on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

U. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

V. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

W. Penetrations

1. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Provide insulation continuously through walls and partitions.
2. Insulation Installation at Fire-Rated Penetrations:

    a. Fire Dampers: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
    b. Pipe or duct penetrations (no fire damper): Provide insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.2 INSTALLATION OF DUCTWORK INSULATION

A. Flexible Fiberglass Blanket Insulation Installation:

1. Secure with adhesive and insulation pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces. Apply adhesive to entire circumference of ducts and to surfaces of fittings and transitions.
2. Firmly butt joints.
3. Provide either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts.
4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
5. Provide insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Provide insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces. Apply adhesive to entire circumference of ducts and to surfaces of fittings and transitions.
2. Provide either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts.
3. Provide insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Provide insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. For ducts and plenums with surface temperatures below ambient, provide a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Provide vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal. Provide vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

D. Fire-rated insulation system installation: Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating. Insulate duct access panels and doors to achieve the same fire rating as duct.

3.3 DUCTWORK APPLICATION SCHEDULE

A. For duct systems not indicated, insulate to with a similar thickness and type as those specified. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance.

B. Application schedules identify ductwork thickness, and jacket requirements. For duct systems not indicated, insulate to with a similar thickness and type as those specified. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance.

C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment: Flex connectors, metal ducts with duct liner, factory-insulated flexible ducts, factory-insulated plenums, casings, and access doors.

D. Supply Ducts:

1. Concealed or Unconditioned: Flexible Fiber Glass Blanket; 1.5” thickness, R6 minimum.
2. Exposed to heated or non-air conditioned spaces: Flexible Fiber Glass Blanket; 1.5” thickness R6 minimum.
3. Exposed to Air-Conditioned Space: None
4. Indirectly conditioned spaces (plenum returns, crawl spaces,): R1.9 minimum.
5. Ventilated Attic, exterior, or unconditioned spaces: R-12, 3” thickness.

E. Relief, outside air, or exhaust plenums at louvers: Flexible Rigid Fiberglass Board; 2” thickness.

F. OA ducts between the intake plenum and the air handling unit: Flexible Fiber Glass Blanket; 1.5” thickness, R6 minimum.

G. Relief or exhaust ducts within 20 feet of the exterior: Flexible Fiber Glass Blanket; 1.5” thickness, R6 minimum.

H. Return ducts within conditioned space: None required.

END OF SECTION 230700

SECTION 230900 – DIRECT DIGITAL CONTROL (DDC) SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. There is no central building automation system (BAS), see Paragraph 2.1.

B. Provide labor, materials, special tools, equipment, enclosures, power supplies, interfaces, wiring, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items that are required for the functional turn-key operation of the controls.

C. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software, and configurations to be provided for this Project.

PART 2 - PRODUCTS

2.1 CONTROLS

A. Split Dx Gas Furnaces and DX Air Handling Unit with Duct Mounted Gas Furnace

1. The systems shall be controlled via factory installed unit controller and space temperature sensor provided with the air handling units by the unit manufacturer (refer to Sections 235400, 237314, and 236200).

B. New Electric Resistance Duct Coil:

1. Space temperature controller provided with the coil shall modulate SCR heating coil output to maintain space temperature setpoint.
2. Coil manufacturer provided air proving switch shall prevent heater operation when the air handler is not operating.

PART 3 - INSTALLATION

3.1 INSTALLATION

A. Provide a complete, neat, and workmanlike installation.

B. Provide all components in accordance with the manufacturer’s recommendations. Perform the installation under the supervision of competent technicians.

C. Provide equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

E. Provide hydronic instrument wells, valves, and other accessories.

F. All wiring shall comply with national and local electrical codes, and Division 26 of this specification.

G. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, calibrate, and adjust field-assembled components and equipment installation, including connections.

H. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC controls.

END OF SECTION 230900

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 23 Section “Common Work Results”
2. Division 23 Section – “Packaged Condensing Units”

1.2 SUMMARY

A. Section includes refrigerant pipes, fittings, valves, & specialties for HVAC units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

B. Delegated-Design Submittals: Refrigerant piping layout and design shall be by HVAC unit manufacturer. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Include calculations showing that system travel distance for refrigerant piping is within horizontal and vertical travel distances set by HVAC unit manufacturer.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding, Brazing, and Fusing Qualifications."

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

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

1.6 PRODUCT STORAGE AND HANDLING

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

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use the following precautions during storage:

1. Maintain valve and specialty end protection.
2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.

C. Brazing Filler Metals: AWS A5.8/A5.8M.

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

E. Brazing Filler Metals: AWS A5.8/A5.8M.

2.2 VALVES AND SPECIALTIES

A. Working Pressure Ratings and Temperatures shall be compatible with the system and refrigerant. Provide system components with pressure rating equal to or greater than system operating pressure.

B. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.

C. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

D. Thermostatic Expansion Valves: Comply with AHRI 750.

E. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.

F. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 microns, pleated with integral end rings; stainless-steel support.
3. Desiccant Media.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

2.3 SLEEVE SEAL SYSTEMS (WALL OUTLET)

A. Airex Manufacturing Inc.; AIREX TITAN OUTLET, or equal Wall Outlet seal. Provided and installed with its compression gasket mounting method and must be fastened to wall surface with supplied ICC-ES listed and approved non-corrosive screws with pre-loaded neoprene washers. Wall Outlet must also integrate an over-molded, flexible, elastomeric sleeve for sealing, supporting and isolating refrigerant pipes to also control vibration. The Wall Outlet shall also feature outdoor-rated durability and shall provide wall expansion and contraction protection features achieved by gaskets and seals as per energy code requirements. A stainless-steel clamp must be utilized to create a “Mechanical Connection” between wall seal and pipe insulation protector as intended per energy codes to allow removable/reusable maintenance capabilities and designed to co-act with a pipe insulation jacketing. Wall Outlet seal and insulation protector must both be sustainably and securely installed, mechanically fastened together as one, due to piping vibration, and shall be assembled without the use of adhesives or adhesive tapes as per energy code requirements. Wall Outlet tested in accordance with: ASTM E 331 (Water Penetration), ASTM E 283 (Air Leakage), and ASTM E 2178 - Air Permeance of Building Materials.

B. Provide the appropriate Wall Outlet type/size for construction type and pipe/insulation sizes, multiple variations are available from the manufacturer.

C. Provide a Wall Outlet at each refrigerant piping envelope penetration.

2.4 REFRIGERANT

A. Provide full refrigerant charge in accordance with HVAC unit manufacturers instructions.

PART 3 - EXECUTION

3.1 VALVE AND SPECIALTY APPLICATIONS

A. Provide refrigerant specialties in accordance with HVAC unit manufacturers requirements.

B. Provide thermostatic expansion valves as close as possible to distributors on evaporators.

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

3.2 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Results" for installation of:

1. Basic piping requirements.
2. Joint construction requirements.
3. Hanger, support, and anchor devices.
4. Firestopping
5. Sleeves and Escutcheons
6. Mechanical Identification

B. Provide piping layout, fittings, valves, and specialties in accordance with the HVAC unit manufacturer’s instruction.

C. Provide insulated refrigerant piping per Section 230700 and HVAC unit manufacturer’s recommendations.

D. Provide refrigerant piping according to ASHRAE 15 and governing codes.

E. Provide piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

1. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance. Provide piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
2. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings. Provide piping above accessible ceilings to allow sufficient space for ceiling panel removal. Diagonal runs are allowed to reduce refrigerant pipe length.

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

G. Provide fittings for changes in direction and branch connections.

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

I. Arrange piping to allow inspection and service of refrigeration equipment. Provide valves and specialties in accessible locations to allow for service and inspection.

J. Provide piping free of sags and bends. Unless otherwise required by HVAC unit manufacturer, slope refrigerant piping and tubing as follows:

1. Provide horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Provide horizontal suction lines with a uniform slope downward to compressor.
3. Provide traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

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

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

M. Provide and connect pre-charged refrigerant tubing to component's quick-connect fittings. Provide tubing to allow access to unit.

3.3 PIPE JOINT CONSTRUCTION

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

B. Before installation, clean piping, tubing, and fittings to cleanliness level required by HVAC unit manufacturer.

C. Ream ends of tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Joining method shall be approved by HVAC unit manufacturer.

1. Brazed Joints:

a. Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.
c. The piping being brazed shall be purged of air to remove the oxygen and filled with one of the following inert gases: oxygen-free nitrogen, helium or argon. The piping system shall be purged with an inert gas for a minimum time corresponding to five volume changes through the piping system prior to brazing. The pre-purge rate shall be at a minimum velocity of 100 feet per minute (0.508 m/s). The inert gas shall be directly connected to the tube system being brazed to prevent the entrainment of ambient air. After the pre-purge, the inert gas supply shall be maintained through the piping during the brazing operation at a minimum pressure

of 1.0 psi and a maximum pressure of 3.0 psi. The joint shall be brazed with a filler metal conforming to AWS A5.8.

2. Mechanically Pressed Joints

   a. The installing contractor shall be fully trained and qualified by the manufacturer of the mechanically pressed joints to install the selected piping connections.
   b. Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

3. Flared Joints: Flared fittings shall be installed in accordance with the manufacturer’s instructions. The flared fitting shall be used with the tube material specified by the fitting manufacturer. The flared tube end shall be made by a tool designed for that operation.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

B. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of HVAC unit manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:

   a. Name of person starting test, company name, phone number, and e-mail address.
   b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
   c. Detailed description of extent of tubing tested.
   d. Date and time at start of test.
   e. Test pressure at start of test.
   f. Outdoor temperature at start of test.
   g. Name of person ending test, company name, phone number, and e-mail address.
   h. Date and time at end of test.
   i. Test pressure at end of test.
   j. Outdoor temperature at end of test.
   k. Remarks:

5. Submit test reports for Project record.

C. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of HVAC unit manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of HVAC unit manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

D. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult HVAC unit manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following HVAC unit manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by HVAC unit manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

3.5 ADJUSTING

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

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

C. Adjust set-point temperature of controllers to the system design temperature.

END OF SECTION 232300

SECTION 233113 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results"
2. Division 23 Control Section
3. Division 23 Section "Testing, Adjusting, and Balancing".

1.2 SUMMARY

A. This Section includes ductwork and accessories.

1.3 SYSTEM DESCRIPTION

A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which may be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor’s expense.

C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify duct construction is in compliance.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", 4th Editon (SMACNA); and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1. Exception: Sheet metal surfaces and fasteners.

1.5 ACTION SUBMITTALS

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

1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Fittings.
4. Reinforcement and spacing.
5. Seam and joint construction.
6. Penetrations through fire-rated and other partitions.
7. Equipment installation based on equipment being used on Project.
8. Hangers and supports, including methods for duct and building attachment.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Ductwork Specialties Product Data; provide for the following:

1. Sealant
2. Duct-mounted access doors and panels.
3. Flexible ducts.
4. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.
5. Life Safety dampers: Provide complete submittal information (including installation instructions) and the manufacturer's certification of compliance with these specifications for approval prior to bidding. Contractor shall include damper manufacturer’s Installation Instructions as part of the submittal. These instructions shall describe the applicable requirements for damper sleeve thickness, retaining angles, and methods of attachment, duct-to-sleeve connections, preparation of wall or floor openings, and all other requirements to provide an installation equivalent to that tested by the damper manufacturer during the UL Standard 555 qualification procedures. Contractor shall detail any proposed installations that deviate from these manufacturer’s instructions and explain the needed deviations.
6. Louvers: Provide data describing design characteristics, maximum recommended air velocity, design free area, AMCA seals, materials and finishes. Provide independent agency reports showing compliance with specified performance criteria. For units with factory-applied color finishes, provide color chart.

1.6 INFORMATIONAL SUBMITTALS

A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

B. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.8 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. IMC-2021

D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. 4th Edition: 2020 HVAC Duct Construction Standards, Metal and Flexible (SMACNA)
2. 1st Edition: 2012 ANSI/SMACNA 016-2012 HVAC Air Duct Leakage Test Manual

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Deliver, store and handle materials according to manufacturer's written recommendations.

C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M. Galvanized Coating Designation: G60 or G90 as indicated. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A-1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A-480/A-480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A-36/A-36M, steel plates, shapes, and bars; black and galvanized.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius (1.5W minimum), or Type RE5 dual radius. Square throat is not allowed.
2. Vane support in elbows: Fig 2-4. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of SMACNA Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer’s instructions.
3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
5. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.
6. Fig 2-9 Duct Coils: Duct coils with transitions and upstream access door.

2.3 ROUND DUCT FABRICATION

A. Fabricate supply ducts of galvanized steel according to SMACNA.

B. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

1. Exposed Round Ducts: Shall be Spiral Seam (RL-1 seam) at 2-inch wg construction.
2. Concealed Round Ducts: Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
3. Snap lock seams shall not be used for this project.

C. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Outdoor Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A-603. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

G. Supports For Roof Mounted Items:

1. Equipment rails shall be galvanized steel, minimum 18-gauge, with integral baseplate, continuous welded corner seams, factory installed 2x4 treated wood nailer, 18-gauge galvanized steel counter flashing cap with screws, built-in cant-strip; minimum height 11 inches. Provide raised cant strip to start at the upper surface of the insulation.
2. Roof Duct Supports: Portable Pipe Hanger Model number PPH-D - Enclosed style.

a. Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane.
b. Hot dip galvanize in accordance with ASTM A 123 after fabrication.
c. Factory fabricated to support exact duct sizes and equipment to be installed.
d. Provide SS or galvanized clamps, bolts, nuts, washers, and other devices as required for a complete system.

2.5 SEALANT MATERIALS

A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 listed; UL 181A-M or 181B-M listed; and meet NFPA 90A requirements. Pressure sensitive tape shall not be used as a sealing mechanism.

1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
2. Generally, provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
3. Resistance to mold, mildew and water: Excellent
4. Color: Gray
5. Duct sealant/mastic shall meet requirements for LEED. ITW TACC Miracle Kingco water-based sealants, or approved equal.

B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

C. Round Duct Joint O-Ring Seals: Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. static-pressure class, positive or negative. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 FITTINGS

A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.

D. Low-point drains: Ductmate moisture drain with funnel collection design; ¾” connection with drain fitting and cap.

2.7 DUCT-MOUNTED ACCESS DOORS

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

1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation.
3. McGill Air Flow LLC.
4. Nailor Industries Inc.
5. Durodyne
6. Cesco
7. Buckley

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door: Double wall, rated for up to 4.5” static pressure. Door panel filled with 1" fiberglass insulation; ¾ lb. density. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs.
3. Provide 1/8” thick neoprene gaskets.
4. Locks: Access doors less than 12 sq. inches: One cam lock. Doors over 12 sq. inches shall have two locks.

2.8 FLEXIBLE CONNECTORS

A. Provide for all air moving equipment. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with NFPA 90A. Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts. Duro-Dyne, Ductmate, Hardcast, or approved equal.

B. Indoor Flexible Connector Fabric: Glass fabric double coated with polychloroprene or neoprene. Minimum Weight: 26 oz. /sq. yd. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.

2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 0 0r 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.

B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC’s), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.

C. Rated Positive Pressure: 10" w.g. per UL-181. Maximum negative pressure: ¾”.

D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.

1. R6 insulation, Basis of Design: Atco #86
2. Reinforcement: Steel-wire helix encapsulated in inner liner.
3. Jacket (inner and outer): Polyethylene film.

E. Exhaust/Return Flexible Ducts, not insulated: Atco#50 Factory-fabricated, round duct. Reinforcement: Triple lamination of tough metallized polyester, aluminum foil and polyester encapsulates a steel wire helix. Rated for ¾" w.g. negative pressure.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

G. Hangers shall be band type, 1" wide minimum.

2.10 MANUAL-VOLUME DAMPERS

A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.

B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. diameter axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.

C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; ½ in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.

D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

2.11 LOUVERS

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

1. Ruskin Company
2. American Warming and Ventilating, Inc.
3. Greenheck.
4. Arrow United Industries.
5. Cesco Products.
6. Construction Specialties, Inc.

B. Louvers shall be AMCA Licensed. Louvers shall comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

C. Louvers shall be AMCA Certified in accordance with AMCA 511.

D. Louvers shall exceed ASHRAE 62.1-2022 requirements:

1. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft. water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
2. Wind-Driven Rain Performance: Not less than 99.0% effectiveness when subjected to a rainfall of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 583 fpm.

E. American Warming & Ventilating Louvers Model LE-53: Drainable Wind-Driven Rain Blade: Aluminum outer frames, louver perimeter frame, non-thermally broken, air ventilator with overlapping louvers; free area: 44.3%, minimum. Wind-Driven Rain Performance: Not less than 99.0% effectiveness when subjected to a rainfall of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 583 fpm. Blades: Horizontal Sight proof, Wind-driven rain. Frame: 5 inch deep, extruded aluminum.

F. Superior Performing Organic Coatings System: Manufacturer's standard multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent polyvinylidene fluoride (PVDF) resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch. Primer: Zinc chromate, alkyd type.

G. Accessories

1. Insulated Blank-Off Panels: 0.040 aluminum sheet, 2 inches thick, aluminum skin insulated core, factory installed with removable fasteners and neoprene gaskets.
2. Aluminum Insect Screen - 18-16 mesh, mill finish, .011-inch wire.
3. Bird Screen: aluminum, 1/2” mesh, removable frame, re-wireable.
4. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Provide volume dampers at branch ducts to RGD’s. If volume dampers are inadvertently not shown, contractor shall provide, the intent is to provide volume dampers at branches.

B. Provide ducts and accessories according to SMACNA unless otherwise indicated.

C. Construct and install each duct system for the specific duct pressure classification indicated.

D. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.

E. Provide ducts in lengths not less than 12 feet, unless interrupted by fittings. Provide ducts with fewest possible joints.

F. Provide fabricated fittings for changes in directions, changes in size and shape, and connections.

G. Provide couplings tight to duct wall surface with a minimum of projections into duct.

H. Provide ductwork to allow maximum headroom. Provide ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Provide ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Provide ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

K. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.

L. Electrical Equipment Spaces: Ductwork not allowed.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Hangers Exposed to View: Threaded rod and angle or channel supports.

C. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system. Seal duct joints to prevent dirt marks.

D. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

E. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

F. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 MATERIALS

A. Hangers, accessories, and dampers shall be same material as parent duct.

B. Ducts shall be G60 galvanized steel except as follows:

1. Plenums at outside louvers: G90 galvanized steel; horizontal ducts connected to louver shall be water-tight and pitch to drain into the louver plenum. Louver plenum shall be water-tight, pitched to drain to exterior. Provide low-point drain fittings at low points.

3.4 DUCT CLASSIFICATIONS AND SEALING

A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:

1. Supply Ducts: 2-inch w.g.
2. Return Ducts: 2-inch w.g, negative pressure.
3. Exhaust Ducts: 2-inch w.g, negative pressure.

B. Seam And Joint Sealing:

1. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
2. Pressure-sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory, and the tape is used in accordance with that certification.
3. Connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required.
4. Spiral lock seams need not be sealed.
5. Seal externally insulated ducts before insulation installation.

3.5 DUCT PENETRATIONS

A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall be provided in accordance with the UL listing of the penetration. Provide firestopping per Section 230500.

B. Fire or Smoke Rated Penetrations: Provide fire and/or smoke damper.

C. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

D. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.

E. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.

F. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA Chapter 5, "Hangers and Supports."

B. Building Attachments: Comply with SMACNA Chapter 5, "Hangers and Supports". Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

C. Hanger Spacing: Comply with SMACNA Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

E. Provide upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.7 FLEXIBLE DUCT

A. Provide in accordance with manufacturer’s and SMACNA recommendations.

B. Flexible ducts hall be supported at manufacturer’s recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is ½” per foot of spacing between supports.

C. Provide duct fully extended; do not install in the compressed state or use excess lengths.

D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment.

E. Bends shall be made with not less than 1 duct diameter centerline radius. Ducts shall extend a few inches beyond the end of a sheet metal connection before bending.

F. Hanger or saddle material in contact with the duct shall be at least 1” wide.

G. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

3.8 DUCT ACCESSORIES INSTALLATION

A. Provide duct accessories according to applicable details shown in SMACNA.

B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards

C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.

D. Adjust operable devices for proper action.

E. Manual dampers shall be visible outside the insulation and marked with a 12" orange ribbon.

F. Locate each duct smoke detector in a serviceable location, in accordance with its listing.

G. Perform the following as directed by the controls contractor: Installation of control devices. Access doors where indicated and as required.

H. Provide duct access panels for access components that require servicing.

1. Provide duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers' requirements.
2. Provide access panels on side of duct where adequate clearance is available.
3. Locate panel upstream and/or downstream as recommended by manufacturer.
4. Locations:

    a. Upstream side of duct coils.
    b. At outdoor-air intakes.
    c. Adjacent to and close enough to life safety dampers, to reset or reinstall fusible links.
    d. Control devices requiring inspection.
    e. Elsewhere as indicated or required by duct accessory manufacturer

5. Inspect locations of access doors and verify that purpose of access door can be performed.

I. Control Damper Installation

1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
3. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
4. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct opening to prevent leakage around perimeter of damper.

3.9 LOUVER INSTALLATION

A. Louvers to be furnished by Division 23; mounted and installed by the contractor responsible for the outside wall construction. Ductwork shall be connected to the louvers by Division 23.

B. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. For new construction, or where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

C. Installation

1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
2. Pitch horizontal ducts and plenums connected to louvers downward toward louvers not less than 1 inch in 10 feet. Connect to louver to allow drainage to exterior. Seal ducts water-tight.
3. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
4. Form closely fitted joints with exposed connections accurately located and secured.
5. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
6. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
7. Provide concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather tight louver joints are required.

D. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.10 PROTECTION

A. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

1. The HVAC system and ductwork shall be provided with protective coverings. The HVAC system includes any interior surface of the facility’s air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.
2. The duct system shall be free of construction debris.
3. The working area shall be clean, dry and the ductwork protected from dust.
4. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.

B. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation

C. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.

3.11 FIELD QUALITY CONTROL

3.12 DUCT CLEANING

A. Ducts shall be kept clean. If the contractor fails to maintain cleanliness, duct cleaning will be required, using duct cleaning methodology as indicated in NADCA ACR.

B. If the contractor fails to maintain cleanliness, duct system cleanliness tests shall be performed:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

3. Duct system will be considered defective if it does not pass tests and inspections.

4. Prepare test and inspection reports.

END OF SECTION 233113

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results"
2. Division 23 Section "Ductwork"
3. Division 23 Section "Testing, Adjusting, and Balancing"

1.2 SUMMARY

A. This Section includes diffusers, registers (combination grille & damper), and grilles.

1.3 SUBMITTALS

A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner’s representative of problems prior to shop drawing submittal.

B. Pressure drop, airflow and noise criteria selection are based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.

C. Product Data: For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

D. Coordinate locations with reflected ceiling plans and wall elevations as applicable.

E. Coordinate mounting frame with associated mounting surface.

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A.

B. Sound pressure levels shall be determined by using AHRI Standard 885-2008 “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Outlets”.

C. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 2 - PRODUCTS

2.1 GENERAL

A. Diffusers, registers, and grilles are scheduled on Drawings.

B. Border and mounting type shall match the mounting surface. Coordinate with mounting conditions.

C. Material shall match the specified ductwork. Coordinate with Section 233113 “Ductwork”.

D. Provide with a White Powder Coat finish, unless noted otherwise.

E. Grille blade orientation: Vertical rectangle (wall grille with height longer than width): The blades shall run parallel to the short dimension of the grille. Horizontal rectangle: The blades shall run parallel to the long dimension of the grille.

2.2 MANUFACTURERS

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

1. Price
2. Titus
3. Metal-Aire
4. Anemostat
5. Nailor

2.3 RETURN OR EXHAUST

A. Return/Exhaust Grille, 45-degree deflection

1. Material: steel (Price 530 Series) or aluminum (Price 630 Series)
2. Provide damper as scheduled.
3. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Provide diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

C. Drawings indicate general arrangement of ducts, fittings, and accessories. Make final locations where indicated, as much as practicable.
   1. For units installed in lay-in ceiling panels, locate units in the center of the panel.
   2. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

D. Provide diffusers, registers, and grilles with airtight connection to ducts.

E. Provide 18” minimum of vertical straight ductwork at the entrance to ceiling diffusers.

F. Plenum boxes on grilles/registers shall be 8” minimum height.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

B. Adjustable outlets: adjust pattern for draft-free air distribution.

3.3 CLEANING

A. Protect unit interiors from moisture, construction debris and dust, and other foreign materials. Comply with Section 233113 “Ductwork” Paragraph: Field Quality Control.

B. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 235123 - GAS VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 23 Section: “Common Work Results”
2. Division 23 Section: “Gas Fired Furnace with Split Dx”

1.2 SUMMARY

A. Section includes venting for gas-fired appliances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

1. Catalog cuts
2. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.
3. Installation drawings
4. Installation instructions
5. Sample of warranty

1.4 QUALITY ASSURANCE

A. Provide per NFPA 54.

B. Shall comply with UL 1738 Standard for Venting Systems for Gas Burning Appliances.

PART 2 - PRODUCTS

2.1 GAS VENTS

A. Available Manufacturers; Note: Submitted venting manufacturer must be approved by the manufacturer of the gas appliance that it serves.

1. AMPCO
2. Heat-Fab Inc.
3. Metal-Fab, Inc.
4. Schebler Co.
5. Selkirk
6. Van-Packer Co.
7. MG Duravent
8. Security Chimney
9. Centrotherm InnoFlue

B. Double Wall Metal Vent (Gas Furnace):

1. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.
2. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.
3. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
4. Outer Jacket: Stainless steel.

C. Provide support clamps, termination, condensate drains, supports, appliance adapters, elbows, and other fittings as recommended by the vent manufacturer and appliance manufacturer.

D. Roof Termination: Provide a listed termination designed to exclude minimum 90 percent of rainfall. Termination height shall be 4’ minimum above roof. Roof penetration pieces shall be UL Listed and provided by the vent manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LISTED VENTS

A. Provide in accordance with manufacturers’ recommendations, UL Listing, and state or local codes.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Provide in accordance with Division 7.

C. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

D. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer. The system shall be installed and sealed per

manufacturers' instructions, so all joints are gas tight, preventing leakage of products of combustion into a building.

E. A Condensate Drain shall be installed in the vent system as close to the flue outlet as possible.

F. Penetrations of fire rated walls/ceilings shall be sealed using fire stops that are approved for such use and shall be installed according to the boiler and passive fire stop manufacturers installation instructions.

G. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading. Support vents and chimneys from building structure with according to manufacturer's written instructions. Use of vent-manufacturer supplied supports is strongly recommended. In instances where vent-manufacturer supports are not suitable, field supplied supports that are of clam shell design and have a minimum threaded rod diameter of 5/16" are permissible.

H. Lap joints in direction of flow. Slope vents and connectors in accordance with NFPA 211.

I. When installing a venting system, the following recommended venting practices apply:

1. Keep length and number of 90º elbows to a minimum.
2. Do not use back-to-back 90º elbows.
3. Use 45º elbows where possible to minimize the number of 90º elbows in case redirection of flue gas is required.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean vents internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of vents and chimneys that are not completed or connected to equipment.

END OF SECTION 235123

SECTION 235400 – GAS-FIRED FURNACES WITH SPLIT DX

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division Section: “Common Work Results”

1.2 SUMMARY

A. This Section includes the following:

1. Gas furnaces and accessories complete with controls.
2. Refrigeration components.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Wiring Diagrams: Power, signal, and control wiring.

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

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE/IESNA 90.1-2021 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2021.

C. Comply with NFPA 70.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: 10 years.
b. Integrated Ignition and Blower Control Circuit Board: Five years.
c. Draft-Inducer Motor: Five years.
d. High-Efficiency Burner: Three years.
e. Refrigeration Compressors: 10 years.
f. Evaporator and Condenser Coils: Five years.

PART 2 - PRODUCTS

2.1 GAS-FIRED FURNACES, CONDENSING

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

1. Carrier
2. Bryant
3. Lennox
4. Trane
5. York, Johnson Controls Corp, Contact Daniel Meyers: tel 603-222-2409.

B. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54.

C. Cabinet: Galvanized steel.

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

E. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.

F. Type of Gas: Propane.

G. Heat Exchanger:

1. Primary: Aluminized steel.
2. Secondary: polypropylene laminate coated aluminized steel.

H. Burner:

1. Gas Valve: 100 percent safety modulating main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

I. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

J. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

K. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; diagnostic light with viewport.

L. Disposable Filters: 1-inch- (25-mm-) thick fiberglass media with ASHRAE 52.2 MERV rating of 8 or higher, in sheet metal frame.

M. Accessories:

1. Combination Combustion-Air Intake: Vent through roof.
   a. Furnish and install concentric vent kit by furnace manufacturer Trane Model BAYAIR30AVENTA.

N. Capacities and Characteristics: as scheduled.

2.2 THERMOSTATS

A. Solid-State Thermostat: Wall-mounting, programmable, microprocessor-based unit with automatic switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day,and battery backup protection against power failure for program settings.

B. Control Wiring: Unshielded twisted-pair cabling.

1. No. 24 AWG, 100 ohm, four pair.

C. Controls shall comply with requirements in ASHRAE/IESNA 90.1-2004, "Controls."

2.3 VENTILATION AIR HEAT EXCHANGER

A. Cabinet: Steel, with factory-installed interior insulation and manufacturer's standard factory finish. Fabricate with space for piping and electrical conduits.

B. Heat-Recovery Device: Fixed-plate, polypropylene copolymer (high-density plastic) heat-exchanger plates evenly spaced and sealed and arranged for counter airflow.

C. Supply and Exhaust Fans: Forward curved centrifugal with direct drive. Motors comply with requirements in Division 15 Section "Motors."

D. Filters: 1-inch- (25-mm-) thick disposable type with ASHRAE 52.2 MERV rating of 8 or higher, in galvanized-steel frame, mounted upstream of unit in both supply and exhaust airstreams.

E. Wiring: Wire motors and controls so only external connections are required during installation.

2.4 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1-2004.

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.

1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, 1/2 inch (13 mm) thick.

D. Air-Cooled, Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed scroll type.

a. Crankcase heater.
b. Vibration isolation mounts for compressor.

c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
e. Refrigerant: R-407C or R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for gas and refrigerant piping systems to verify actual locations of piping connections before equipment installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 58.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb. Install seismic restraints to limit movement of furnace by resisting code-required seismic acceleration.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions. Anchor furnace to substrate to resist code-required seismic acceleration.

D. Controls: Install thermostats at mounting height of 60 inches (1500 mm) above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install ground-mounted, compressor-condenser components on 4-inch- (100-mm-) thick, reinforced concrete base; 4 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 230500. Coordinate anchor installation with concrete base.

3.3 CONNECTIONS

A. Gas piping installation requirements are specified in Division 15 Section "Fuel Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. Slope pipe vent back to furnace or to outside terminal.

D. Connect ducts to furnace with flexible connector. Comply with requirements in Division 15 Section "Duct Accessories."

E. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.

1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
3. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

C. Measure and record airflows.

D. Verify proper operation of capacity control device.

E. After startup and performance test, lubricate bearings.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 235400

SECTION 235513.16 - GAS-FIRED DUCT HEATERS

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 gas-fired duct heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of gas-fired duct heater.

1. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: For gas-fired duct heaters. Include plans, elevations, sections, and attachment details.

1. Prepare by or under the supervision of a qualified professional engineer detailing fabrication and assembly of gas-fired duct heaters, as well as procedures and diagrams.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
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. Include diagrams for signal and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For gas-fired duct heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gas-fired duct heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of gas-fired duct heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane

B. York

C. Approved equal

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas-fired duct heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Seismic Fabrication Requirements: Fabricate and reinforce suspension attachments of gas-fired duct heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when gas-fired duct heater is anchored to building structure.
2. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. 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.

C. Capacities and Characteristics:

1. Heat Exchanger: Stainless steel.
2. Burner Material: Stainless steel.
3. Venting: Indoor, separated combustion, power vented.

a. Combustion air vent through sidewall, exhaust vent through roof.

2.3 MANUFACTURED UNITS

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z83.8/CSA 2.6.

B. Fuel Type: Design burner for propane gas having characteristics same as those of gas available at Project site.

C. Indoor External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.

1. External Casings and Cabinets: Powder coating over corrosion-resistant-treated surface.

D. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.

E. Power Venter: Integral, motorized centrifugal fan interlocked with gas valve.

F. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

1. Ignition: Electronically controlled electric spark with flame sensor.
2. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
3. Vent Flow Verification: Flame rollout switch.
4. Control transformer.
5. High Limit: Thermal switch or fuse to stop burner.
6. Thermostat: Devices and wiring are specified in Section 237314. The intent is that the furnace shall be staged to maintain heating setpoint for the air handling system (cooling provided by split dx air handling unit).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired duct heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written instructions.

B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Spring hangers are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
2. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for spring hangers and seismic restraints.
3. Restrain the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to gas-fired duct heaters, allow space for service and maintenance.

C. Gas Piping: Comply with Section 221123. Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Section 235123 "Gas Vents."

E. Duct Connections: Comply with Section 233113.

F. Electrical Connections: Comply with applicable requirements in electrical Sections.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Gas-fired duct heater will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired duct heaters.

END OF SECTION 235513.16

SECTION 236200 - PACKAGED CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division Section: “Common Work Results”
2. Section 232200 “Refrigerant Piping”

1.2 SUMMARY

A. Section includes packaged, refrigerant condensing units.

1.3 ACTION SUBMITTALS

A. Product Data: For each condensing unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Verification of Performance: Rate condensing units according to ARI 206/110.

B. Performance shall be in accordance with ARI Standard 365-94.

C. Energy Efficiency: Equal to or greater than prescribed by local energy code.

D. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

F. 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.

G. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with Division 7.

C. Coordinate location of piping and electrical rough-ins.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED

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

1. Trane
2. Daikin
3. Johnson Controls
4. Carrier

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls. The unit shall be in accordance with industry standards and any local codes in effect.

2.2 CONDENSING UNITS, AIR COOLED – TRANE

1. The outdoor condensing units are factory charged with the system charge required for the
2. outdoor condensing unit, ten (10) feet of tested connecting line, and the smallest rated indoor evaporative coil match. This unit is designed to operate at outdoor ambient temperatures as high as

115°F. Cooling capacities are matched with a wide selection of air handlers and furnace coils that are AHRI certified. The unit is certified to UL 1995. Exterior is designed for outdoor application.

3. Unit casing is constructed of heavy gauge, galvanized steel and painted with a weather-resistant powder paint finish. The corner panels are pre-painted. All panels are subjected to our 1,000 hour salt spray test.
4. Refrigeration system controls include condenser fan, compressor contactor and low and high pressure switches. A factory-supplied, field installed liquid line drier shall be provided.
5. The compressor features internal over temperature and pressure protection. Other features
6. include: Centrifugal oil pump and low vibration and noise.
7. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on all four sides by louvered panels.
8. Provide evaporator defrost control to permits cooling operation down to 40°F ambient.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of condensing units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where condensing units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide units level and plumb, firmly anchored in locations indicated.

B. Equipment Mounting: Provide condensing units on cast-in-place concrete equipment bases or equipment supports as indicated.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Loose Components: Provide electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Comply with requirements for piping in other Section 232113 "Hydronic Piping". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Provide furnished field-mounted accessories. Refrigerant piping and specialties shall be provided per manufacturer's installation instructions.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Adjust the APR control per manufacturer’s instructions.
6. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Inspect for physical damage to unit casing.
b. Verify that access doors move freely and are weathertight.
c. Clean units and inspect for construction debris.
d. Verify that all bolts and screws are tight.
e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

E. Measure and record airflow and air temperature rise over coils.

F. Verify proper operation of condenser capacity control device.

G. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

H. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units.

END OF SECTION 236200

SECTION 237314 – INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division Section: “Common Work Results”

1.2 SUMMARY

A. Section includes indoor air handling units.

1.3 REFERENCES

A. UL 60335-2-40 - Standard for Safety, Household and Similar Electrical Appliances - Safety - Part 2-40.

B. AHRI 340 / 360 - Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat pump Equipment

C. ASHRAE 90.1 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.

1.4 SUBMITTALS

A. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.

B. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.

C. Submit manufacturer's installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.

1.6 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.7 WARRANTY

A. Provide a full parts warranty for one year

B. OEM provides several Extended Warranty options to include:

C. Whole Units Parts Warranty (Year 2 plus)

D. Whole Unit Labor Warranty (Year 1 plus)

1.8 MAINTENANCE SERVICE

A. All work on units shall be accomplished by OEM factory trained and authorized servicing technicians.

1.9 SUMMARY

A. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Trane
2. Daikin
3. Johnson Controls
4. Carrier

2.2 General requirements

A. Completely factory assembled

B. Convertible for horizontal or vertical configuration

C. Convertible for cooling only or heat pump application

D. Convertible for left or right external connections (refrigerant and/or electrical)

E. Convertible for front or bottom air return

F. Nitrogen holding charge

G. Certified to UL60335-2-40 for indoor blower coil units

2.3 Casing shall consist of

A. Zinc coated, heavy gauge, galvanized steel

B. Weather resistant baked enamel finish

C. Access panels with captive screws

D. Completely insulated with foil faced, cleanable, fire retardant, permanent, odorless glass fiber material

E. Captured or sealed insulation edges

F. Electrical connection bushings or plugs

G. Refrigerant connection bushings or plugs

H. Withstand elevated internal static pressure

2.4 Refrigeration System shall be

A. Single or dual circuit

B. Distributor(s)

C. Thermal expansion valves (TXVs)

2.5 Evaporator Coil shall be

A. 3/8-inch internally enhanced copper tube mechanically bonded to lanced aluminum plate fins

B. Factory pressure and leak tested to 449 psig.

C. Draw-through airflow

D. Dual circuits are interlaced/intertwined

E. Double sloped, removable, cleanable, composite drain pan

F. Four drain pan positions

2.6 Indoor Fan includes

A. Double inlet, double width, forward curved, centrifugal type fan

B. Dual fans on 12.5 to 25 ton air handlers

C. Adjustable belt drive

D. Permanently lubricated bearings

2.7 Indoor Motor will include

A. Adjustable motor sheaves (constant volume units)

B. Fixed motor sheaves (SZVAV and 2-Speed VFD)

C. Thermal overload protection

D. Permanently lubricated bearings

E. Meet energy policy of 1992 (EPACT)

F. Optional oversized motors for high static applications

2.8 Controls shall be

A. Completely internally wired

B. Colored and keyed connectors, colored wires

C. Magnetic indoor fan contactor

D. Detachable low voltage connectors

E. Single point power entry

F. Evaporator defrost control

2.9 Filters shall be

A. Access from side coil panels

B. Filters slide on rack

C. One inch (1-inch), throwaway filters on 5 to 10 ton units

D. Filter rack convertible to two inch (2-inch) capability on 5 to 10 ton units

2.10 Leak Detection System shall include

A. Compliance to standard UL 60335-2-40.

B. Two refrigerant detection sensors are present.

C. Internal mitigation sequence of operation – if leak is detected, indoor unit commands compressors and electric heat (if present) off, commands fan on. Once leak has not been detected for a 5 minutes, unit returns to normal operation.

2.11 Single Zone Variable Air Volume

A. Variable Frequency Drive (VFD)

B. Motor soft start — avoids start up belt noise and increases belt life

C. Programmable VFD keypad accessible outside of airstream

D. Airflow adjustment via display/keypad on SymbioTM 700 controller in condenser

E. Discharge air sensor

F. Symbio 700 Options Module

G. VFD rated motor

H. Factory installed oversized motor available

2.12 Vibration Isolators

A. Neoprene-in-shear or spring flex choice

B. Floor or suspended applications

C. Reduce vibration transmission to building structures, equipment, and adjacent spaces

D. Reduce noise transmission to building structures, equipment, and adjacent spaces

2.13 Oversize Motors

A. High static applications

B. Motor, sheaves, belt included

2.14 Filters

A. 2 inch, MERV 13 high efficiency filters

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Protect unit interiors from moisture, construction debris and dust, and other foreign materials. Comply with Section 233113 “Ductwork” Paragraph: Field Quality Control.

B. Roof Curb: Provide on roof structure, level and secure, in accordance with NRCA's "The NRCA Roofing Manual: Membrane Roof Systems". Provide units on curbs and coordinate roof penetrations and flashing with roof construction with Division 7. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

C. Provide differential pressure filter gages per manufacturer’s instructions.

D. Provide separate devices furnished by manufacturer and not factory installed.

E. Provide new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to units, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Hydronic Piping Connections:

1. Comply with requirements in Section 232113 "Hydronic HVAC Piping".
2. Provide shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.

E. Duct Connections:

1. Comply with requirements in Section 233113 "Ductwork"
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Division 26.

B. Ground equipment in accordance with Division 26.

C. Provide electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Provide nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

E. Provide control and electrical power wiring to field-mounted control devices. Connect control wiring in accordance Division 26.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup-checks in accordance with manufacturer's written instructions.
2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
3. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:

    a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    c. Condenser coil entering-air dry-bulb temperature.
    d. Condenser coil leaving-air dry-bulb temperature.

4. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

5. Inspect casing insulation for integrity, moisture content, and adhesion.

6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. After mounting and wiring of the motorized impeller control panel (MICP), on the AHUs, trained factory personnel shall ensure proper operation of each MICP, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor. Each MICP shall be energized, and the fan run to ensure the MICP and MI fan will operate throughout the usable range of the drive and that the fan rotation is correct.
9. Verify that filters are installed.
10. Clean coils and inspect for construction debris.
11. Inspect and adjust vibration isolators.
12. Verify bearing lubrication.
13. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Start unit.
15. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
16. Operate unit for run-in period.
17. Calibrate controls.
18. Adjust and inspect high-temperature limits.
19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
20. Verify operational sequence of controls.
21. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Relief-air flow.
    c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 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.

3.7 FIELD QUALITY CONTROL

A. Cleaning:

1. Comply with Section 233113 “Ductwork” Paragraph: Field Quality Control.
2. After completing system installation; testing, adjusting, and balancing unit and air-distribution systems; and completing startup service, clean units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Testing of Drain Pans. To minimize conditions of water stagnation that may result in microbial growth, inspect drain pans to verify proper drainage under operating conditions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237314

SECTION 238216 – DUCT MOUNTED HEATING COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results"

1.2 SUMMARY

A. This Section includes duct heating air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.
3. Diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Comply with ASHRAE 33 for methods of testing heating coils.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

PART 2 - PRODUCTS

2.1 ELECTRIC-RESISTANCE AIR COILS

A. Coil Assembly: Comply with UL 1996.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Equally balance heater electrical load for each step across all electrical phases.

D. Part-Load Operation: Provide arrangement with operation staged for uninterrupted operation over the full range of airflow down to the minimum airflow indicated.

E. Heating Elements:

1. Open Elements:

a. Open-coil resistance wire of 80 percent nickel and 20 percent chromium; supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in a frame.
b. Safety Screens: safety screens to protect operators from accidentally coming into direct connect with elements.

2. Finned Tubular Elements:

a. Coiled resistance wire of 80 percent nickel and 20 percent chromium; center-mounted and surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
b. Finish finned tubular elements with a baked-on aluminum paint, and mount in a frame.
c. Each element individually removable from terminal box.
d. Use threaded stainless steel element terminals and hardware.

F. Frame: Galvanize steel; minimum, slip in or flanged mounting.

G. Terminal Box/Control Panel: Unit mounted; with disconnection means and overcurrent protection.

1. Enclosure: NEMA 250, Type 1 enclosure complying with UL 50.
2. Factory insulate terminal box to prevent condensation from occurring within box.
3. Provide a laminated elementary wiring diagram on inside face of heater control panel door or in another protected location than visible be service personnel. Wiring diagram to match installation.

H. Controls:

1. Safety Controls: Each heater is to be provided with the following factory-mounted safety controls:

a. Thermal cutout switch with automatic reset.
b. Airflow Proving Switch

2. SCR Control: Silicone-controlled rectifier (SCR) for 100 percent stepless capacity control.
3. Provide programmable room thermostat for control as specified.

I. Electrical:

1. Single-Point Field Power Connection: and wire the heater to accommodate a single field electrical connection for electrical power.
2. Disconnecting Means: Provide each heater with a main electrical power connection, door mounted and interlocking, and disconnecting means to prevent access into panel, unless switched to the off position.
3. Factory install and wire branch circuit fusing or circuit breakers in accordance with NFPA 70.
4. Pilot Lights: Include labeled pilot lights on face of control panel for the following:

    a. Power on.
    b. Low-airflow alarm.
    c. High-temperature alarm.

5. Terminations: Wire terminations and field interface terminations to labeled terminal strips.
6. Control Transformer: Size control circuit transformer for load.
7. Labeling: Label each electrical device with a laminated phenolic tag.
8. Use only NRTL-labeled electrical components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide coils level and plumb. Provide coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

B. Straighten bent fins on air coils.

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 ELECTRIC DUCT COILS

A. Connect wiring and ground equipment according to Division 26.

B. Provide electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

C. Provide control and electrical power wiring to field-mounted control devices.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Prepare test and inspection reports.

END OF SECTION 238216

SECTION 261000 - BASIC ELECTRICAL REQUIREMENTS

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. Alternates: Refer to Division 01 to determine extent of, if any, work of this section that will be affected by any alternates if accepted.

B. Furnish all materials, equipment, labor, and supplies and perform all operations necessary to complete the electrical work in accordance with the intent of the drawings and these specifications.

C. Temporary Power and Lighting: Provide separate meter and service for construction area.

1. Power Distribution: Provide weatherproof, grounded circuits with ground-fault interruption features, with proper power characteristics and either permanently wired or plug-in connections as appropriate for intended use. Provide overload-protected disconnect switch for each circuit at distribution panel. Space 4-gang convenience outlets (20 amp circuit) so that every portion of work can be reached with 100' extension cord.
2. Temporary Lighting: Provide lighting of intensity and quality sufficient for proper and safe performance of the work and for access thereto and security thereof. (Consult OSHA requirements.)

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall be an Efficiency Maine Qualified Partner and shall participate in the activities associated with Efficiency Maine incentive pre-approval and approval process including but not limited to; preparation and submission of required incentive application(s) and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

B. The contractor shall also:

1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.
2. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.

C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from Efficiency Maine. No equipment shall be purchased until preapproval is received from Efficiency Maine.

D. All invoices shall be forwarded to Efficiency Maine in accordance with Efficiency Maine requirements. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.

1.4 FIRE ALARM SYSTEM

A. Modify and add to the existing fire alarm system to provide a complete and code compliant system including but not limited to: new smoke detectors, heat detectors and notification appliances in all areas required. Fire alarm systems shall generally comply with requirements of NFPA 72 for local building systems except as modified and supplemented by this specification. All units of equipment shall be listed by Underwriters Laboratories and shall consist of a battery-backed fire alarm control station, with audio/visual and visual alarm indicating devices, heat detectors, smoke detectors, and pull stations. All equipment shall be located as shown on the plans and wired in accordance with the manufacturer's instructions to form a complete and workable emergency evacuation life safety system as hereinafter described.

1.5 QUALITY ASSURANCE

A. All wiring shall be in accordance with the latest issue of the National Electrical Code.

B. The Contractor shall show evidence, upon request, of having successfully completed at least five similar projects. Installation of each system shall be under the supervision of a factory-authorized organization.

C. The Contractor shall show evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor must have a service contract program for the maintenance of the system after the guarantee period.

D. All electrical equipment shall be listed by Underwriters Laboratories, Inc. Each system shall be products of a single manufacturer of established reputation and experience. The Contractor shall have supplied similar apparatus to comparable installations rendering satisfactory service for at least three years.

E. For each system, the manufacturer shall furnish "gratis" to the Owner a one-year contract effective from the date of installation for maintenance and inspection services of the manufacturer's equipment with a minimum of two inspections during the contract year.

F. Furnish the services of a competent instructor for not less than one four- hour period for instructing personnel in the operation and maintenance of the closed-circuit television system, on the dates requested by the Owner.

1.6 ARC-FLASH HAZARD STUDY AND IDENTIFICATION

A. The work of this section includes updating the Owner’s existing arc-flash hazard study to include equipment provided under this project. The existing study was performed using EasyPower computed software developed by ESA, Inc. The study shall be updated using computer software that is compatible with the existing study. The existing study document files shall be available for use in preparing the study specified herein.

B. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

C. Comply with NFPA 70E and its Annex D for hazard analysis study.

D. Provide arc-flash hazard warning labels as specified in Part 3 of this section

1.7 SUBMITTALS

A. In accordance with Division 01, furnish the following:

1. Manufacturer's descriptive literature: For each type of product indicated.
2. Submit shop drawings which include engineering drawings of the system with specification sheets covering all component parts of the system and interconnection diagrams.
3. Certification:

    a. Prior to final inspection, deliver to the Owner's Representative certification that the material is in accordance with the drawings and specifications and has been properly installed.
    b. Submit certification of system operating test.

4. Manuals: Submit copies of complete set of operating instructions including circuit diagrams and other information of system components.

1.8 PROJECT CONDITIONS

A. Regulatory Requirements:

1. Conform to the requirements of all laws and regulations applicable to the work.
2. Cooperate with all authorities having jurisdiction.
3. Compliance with laws and regulations governing the work on this project does not relieve the Contractor from compliance with more restrictive requirements contained in these specifications.
4. If the Contract Documents are found to be at variance with any law or regulation, the Contractor shall notify the Architect/Engineer promptly in writing. The Contractor shall assume full responsibility for any work contrary to law or regulation, and shall bear all costs for the corrections thereof.
5. Minimum Requirements: The National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), the National Fire Codes, and National Fire Protection Association (NFPA) are a minimum requirement for work under this section. Design drawings and other specification sections shall govern in those instances where requirements are greater than those required by code.

B. Permits, Fees, and Inspections:

1. Secure and pay for all permits, fees, licenses, inspections, etc., required for the work under Division 26.
2. Schedule and pay for all legally required inspections and cooperate with inspecting officers.

3. Provide Certificates of Inspection and Approval from all regulatory authorities having jurisdiction over the work in Division 26.

C. Drawings:

1. Do not scale the drawings. The general location of the apparatus and the details of the work are shown on the drawings, which form a part of this specification. Exact locations are to be determined at the building as the work progresses, and shall be subject to the Architect/Engineer's approval. Actual field conditions shall govern all dimensions.
2. Anything shown on the drawings and not mentioned in the specifications or vice versa shall be provided as if it were both shown and specified.
3. It is not intended that the drawings shall show every wire, device, fitting, conduit or appliance, but it shall be a requirement to furnish without additional expense, all material and labor necessary to complete the systems in accordance with applicable codes and the best practice of the trade.

1.9 WARRANTY

A. The Contractor shall guarantee all equipment and wiring free from inherent mechanical or electrical defects for one year from date of acceptance.

1.10 RELATED WORK

A. Division 23 - Mechanical

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches

1. Toggle Switches: 20A, 277V, 1-pole, ivory specification grade, mount 4'-0" above finished floor at door entrance.
2. Push-Button Switches: Modular, momentary-contact, low-voltage type connected to lighting control panels. Use for all permanently installed luminaires unless otherwise noted. Mount 4'-0" above finished floor at door entrance.

B. Switchbox type occupancy sensors: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. Configure for manual-on/automatic-off operation.

C. Indoor Occupancy Sensors

1. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

a. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
c. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
d. Mounting:

1) Sensor: Suitable for mounting in any position on a standard outlet box.
2) Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

e. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
f. Bypass Switch: Override the on function in case of sensor failure.
g. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

2. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

a. Sensitivity Adjustment: Separate for each sensing technology.
b. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

D. Receptacles shall be specification grade, mounted 18" above finished floor unless otherwise noted.

1. Provide type TR tamper-resistant where required by code.
2. Provide type GFCI and GFPE where required by code
3. Provide type AFCI where required by code
4. Provide type WR weather-resistant where required by code.

E. Duplex Receptacles with Ground-Fault Interrupter shall be an integral unit suitable for mounting in a standard outlet box.

1. Ground-Fault Interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120-volt, 20-ampere branch circuit. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
2. Receptacle shall be rated 20 amperes, 125 volts for indoor use and shall be the standard duplex, three-wire, grounding type.
3. Provide type WR weather-resistant where required by code.

F. Weatherproof Receptacles shall consist of a duplex GFI receptacle, as specified, mounted in a weatherproof box with a gasketed, weatherproof, cast metal cover plate. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

G. Plates shall be 302 stainless steel with tamper-proof screws.

H. Boxes shall be steel minimum 2-1/2" deep.

I. Light Fixtures: The light fixtures shall be as described on the drawings or approved equal.

J. Disconnect Switches shall be heavy-duty type, horsepower rated.

K. Motor Starters:

1. Manual motor starters shall be toggle-switch type with melting alloy thermal overload relay. Thermal units shall be one-piece construction and interchangeable. Starter shall be inoperative with thermal unit removed. Contacts shall be double break, silver alloy. Starters in finished areas shall be flush mounted over the light switch at 60" above finished floor. Starters shall be mounted behind stainless steel device plate and shall have adjacent pilot lights. Square D Class 2510 Type FS-1P-FL1 or approved equal. Starters in unfinished areas shall be surface mounted 60" above finished floor. Square D Class 2510 Type FG-5P or approved equal.
2. Magnetic motor starters shall be combination circuit breaker or fused disconnect switch type, mounted in a common enclosure. Starters shall be three-pole with three melting alloy overload relays. Overload heaters shall be coordinated with Division 23. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative with any thermal unit removed. The disconnect operating handle shall be position indicating.

    a. Provide a control device and pilot light on the cover of each combination starter. Control devices for motors with remote manual or automatic control shall be "hand-off-auto" switches. Control devices for locally controlled motors shall be "start-stop" pushbuttons.
    b. 120-volt magnetic motor starters may consist of a circuit breaker or fused disconnect switch and a magnetic starter in separate enclosures mounted next to each other.
    c. Control circuits shall operate at a maximum of 120 volts. Provide control transformers as required.

3. Starters shall be mounted within NEMA-1 enclosures unless specified otherwise.
4. All starters shall be lockable in the "off" position.
5. Overload heaters shall be sized for the motor nameplate full-load amperes per the manufacturer's recommendations.

L. Wiring Materials:

1. Wiring shall be enclosed in electrical rigid galvanized steel, intermediate metal conduit, or electrical metallic tubing sized in accordance with code requirements for the conductors. Types MC or NM cable may be used where concealed in walls or ceilings and allowed by code.

    a. Conduit fittings shall be steel compression type.
    b. Terminations for all conduit shall have insulated bushings or insulated throat connectors in accordance with code requirements.
    c. All conduits shall be substantially supported with approved clips or hangers spaced not to exceed ten feet on center. Minimum conduit size shall be 1/2".

2. Flexible Metal Conduit shall be used for all connections to motors and vibrating equipment and shall comply with Fed. Spec. WW-C-566.
3. Liquid-Tight Flexible Metal Conduit shall consist of flexible steel conduit with a liquid-tight PVC jacket over the conduit.

    a. Fittings shall incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
    b. Liquid-tight flexible metal conduit shall be used in damp or wet locations when flexible metal conduit would otherwise be used.
    c. Liquid-tight flexible metal conduit shall not penetrate the roof or exterior walls, and shall not be installed in lengths exceeding 72” except where necessary for flexibility.

4. All Wiring shall be type THW, XHHW, or THWN, UL labeled, copper conductors with 600-volt insulation, except as otherwise noted. Minimum size wire shall be No. 12 AWG.
5. Nonmetallic-Sheathed Cable (Type NM) shall be two-or three-conductor with a ground conductor and an overall covering that is flame-retardant and moisture-resistant. Minimum wire size shall be No. 12 AWG.
6. Type MC Cable shall have minimum No. 12 AWG type THWN or XHHW insulated copper conductors with an internal bare or insulated copper ground wire.

M. Fire-Stop Material:

1. Fire-stopping material shall maintain its dimension and integrity while preventing the passage of flame, smoke, and gases under conditions of installation and use when exposed to the ASTM E 119 time-temperature curve for a time period equivalent to the rating of the assembly penetrated. Cotton waste shall not ignite when placed in contact with the non-fire side during the test. Fire-stopping material shall be noncombustible as defined by ASTM E 136; and in addition for insulation materials, melt point shall be a minimum of 1700^{o}F for one-hour protection and 1850^{o}F for two-hour protection.
2. Seals for floor, exterior wall, and roof shall also be watertight.

N. Circuit Breakers: Circuit breakers to be added to existing panelboards shall match existing circuit breakers; manufacturer, mounting type, AIC rating, voltage rating and UL listed for operation in respective panelboard.

O. Panelboards:

1. Provide standard manufacturer products. All components of panelboards shall be the product and assembly of the same manufacturer. All similar units of all panelboards shall be of the same manufacturer.
2. All panels shall be dead front safety type.
3. All panelboards shall be completely factory assembled with molded case circuit breakers.
4. Panels shall have main breaker or main lugs, bus size, voltage, phase, and flush or surface mounting all as scheduled on the drawings. Panelboards to be used as service equipment shall be listed for such use.
5. Panelboards shall have the following features:

    a. Non-reduced size copper or aluminum bus bars and connection straps bolted together and rigidly supported on molded insulators. Bus bar taps shall be arranged for sequence phasing of branch circuit devices.
    b. Full size neutral bar mounted on insulated supports.
    c. Ground bar with sufficient terminals for all grounding wires. The ground bar shall be insulated and isolated where called for on the drawings.
    d. Buses braced for the available short-circuit current, but not less than scheduled and never less than 10,000 amperes symmetrical. All panelboards shall be fully rated. Series rated assemblies are not acceptable.
    e. All breakers arranged so that it will be possible to substitute a two-pole breaker for two single pole breakers or a three-pole breaker for three single pole breakers when frame size is 100 amperes or less.
    f. Design interior so that protective devices can be replaced without removing adjacent units, main bus connectors and without drilling or tapping.
    g. Where designated, on panel schedule as "space", include all necessary bussing, device supports and connections. Provide blank cover for each space.
    h. Provide galvanized steel cabinets to house panelboards. Cabinets for panelboards may be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL standard for outdoor applications.
    i. Back and sides shall be of one-piece formed steel. Cabinets for panelboards may be of formed sheet steel with end and side panels welded, riveted or bolted as required.
    j. Provide minimum of four interior mounted studs and necessary hardware for in and out adjustment of panel interior.
    k. Fabricate trim of sheet steel consisting of frame with door attached by concealed hinges. Provide flush or surface trim as shown on the drawings.
    l. Surface trim shall have the same width and height as the box.
    m. Provide doors with flush type latch and manufacturer's standard lock.
    n. In making switching devices accessible, doors shall not uncover any live parts.
    o. Provide concealed butt hinges welded to the doors and trims.
    p. Provide keyed alike system for all panelboards.
    q. Provide a directory card, metal holder, and transparent cover. Permanently mount holders on inside of doors.

    r. Circuit breakers in panelboards shall be bolt on type on phase bus bar or branch circuit bar. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips

P. Transient Voltage Surge Suppressors (TVSS):

1. Provide factory installed integral TVSS in panels where scheduled, listed in the specifications or indicated on the drawings. Field installed units shall not be acceptable.
2. UL Listed, UL1449.
3. Noise: less then 45 dBA at 5 feet.
4. 3 phase, 4 wire plus ground.
5. Dedication Modes:

    a. Line to ground (L-G)
    b. Line to Line (L-L)
    c. Neutral to Ground (N-G)
    d. Line to Neutral (L-N)

6. Category C with 8 x 20 microsecond waveform.
7. Joule rating shall meet or exceed ANSI/IEEE C62.41.
8. 5 year warranty from shipping data against part failure.
9. Quality Assurance

    a. The specified system shall be thoroughly factory tested before shipment. Testing of each system shall include, but shall not be limited to, quality control checks, “Hi-Pot” tests at two times rated voltage plus 1000 volts per UL requirements, IEEE C62.41 Category B surge tests, UL ground leakage test, and operational and calibration tests.
    b. The product shall be life cycle tested following suggested wait times as defined by ANSI/IEEE C62.45 and shall be capable of surviving 1000 sequential Category B surges of 10,000 Amps without failure.

    c. The TVSS shall be provided with computer-generated graphs or oscillograms demonstrating the TVSS clamping voltage and operability. This test shall follow procedures outlined in ANSI/IEEE C62.45 for the installation category and applicable protection modes of the TVSS

Q. Grounding Conductors:

1. Grounding conductors shall be soft-drawn bare copper.
2. Insulated grounding wires shall be UL and NEC approved types, copper, with THWN or XHHW insulation color identified green, except where otherwise shown on the drawings or specified.
3. Wire shall not be less than shown on the drawings and not less than required by the NEC.

R. Ground Clamps:

1. Ground clamps shall be cast bronze or cast copper and shall be UL listed for grounding connections.
2. Ground clamps shall be sized for the specific conductor and electrode to be clamped.

S. Equipment Grounding Connections: Connections shall be of the compression type solderless connectors.

T. Fire Alarm System Components:

1. Fire alarm system components shall be compatible and listed for use with the existing fire alarm system, and shall match existing similar devices or be the system manufacturer's current recommended replacement for existing similar devices.
2. Fire Alarm Control Panel: Provide all necessary common components, power supply, battery charger, batteries, programming, etc. as required to support the addition of components provided under this section for completion of a totally operational fire alarm panel and its respective remote annunciator when existing.
3. Intelligent Duct Smoke Detector:

    a. The duct smoke detector housing shall accommodate an intelligent ionization detector that provides continuous analog monitoring and alarm verification from the panel.
    b. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
    c. Provide sampling tubes as required by the ductwork.
    d. Provide remote test/indicator stations where indicated. Provide engraved nameplate with HVAC unit designation for each station.
    e. The detector shall use the photoelectric principal to sense products-of-combustion and report the measured level of such products to the control panel

4. Provide addressable modules as required to monitor and control non-addressable devices such as solenoid valves, water flow switches, etc. indicated on the drawings and where required to provide a complete and operational system in accordance with the intent of the drawings and specifications. All shall be monitored separately.
5. Sprinkler and Standpipe Valve Supervisory Switches:

    a. Valve supervisory switches shall be furnished and installed under Div. 21 and wired and connected under this section.

6. Conduit and Wire:

    a. Wiring shall be in accordance with NEC Article 760, as shown on the drawings, and as recommended by the manufacturer of the fire alarm system. All wires shall be color-coded. Exposed wiring in unfinished areas shall be installed in metal conduit. Conduit fill shall not exceed 40 percent of interior cross-sectional area. Number and size of conductors shall be as recommended by the fire alarm system manufacturer. Conduit shall be 1/2" minimum. Type FPL cable shall be permitted where concealed and acceptable to the Authority Having Jurisdiction.
    b. Wires in junction boxes and cabinets shall be permanently tagged and identified with tags.
    c. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. All work shall be in accordance with the National Electrical Code's requirements as amended to date, with the local electric utility company's rules, the Fire Underwriter's requirements, and all local, state and federal laws and regulations.
2. In general, all wiring in finished areas shall be concealed in walls or above ceilings. Where wiring cannot be concealed due to existing construction, exposed wiring shall be installed in conduit or surface metal raceway as indicated on the drawings. Exposed wiring shall not be installed in finished areas without prior written authorization from the Engineer.
3. Conduits shall be of sizes required by the National Electrical Code. Exposed conduits shall be installed with runs parallel or perpendicular to walls and ceiling, with right-angle turns consisting of bends, fittings, or outlet boxes. No wire shall be installed until work that might cause damage to wires or conduits has been completed. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.
4. Where conduits, wireways and other electrical raceways pass through fire partitions, fire walls, or floor, install a fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and completely fill clearances between raceways and openings. Floor, exterior wall, and roof seals shall also be made watertight.
5. Where raceways puncture roof, coordinate with Division 07.
6. Raceway penetrations through roof and exterior walls shall be made with rigid metal conduit, intermediate metal conduit, or EMT with compression fittings.
7. All splices shall be mechanically and electrically perfect, using crimp type wire connectors.
8. Provide all disconnect switches required by the N.E.C.
9. Locate motor starters as shown on drawings.
10. Mount disconnect switches and starters at a height of 60" above finished floor unless otherwise noted.
11. Provide all necessary hardware for mounting motor starters.
12. Revise existing panelboard directories. Furnish new cards as needed. Directories shall be typewritten or printed using a computer.
13. Mount the distribution equipment so that maximum height of circuit breakers or operating handle above finished floor shall not exceed 78".
14. Circuit numbers indicated on the drawings are the actual numbers assigned to the circuit in the panelboard and shall not be varied without the consent of the Architect/Engineer.
15. Provide all necessary hardware for mounting distribution equipment.
16. Branch circuit wiring may be nonmetallic-sheathed cable where concealed and allowed by Code, Type NM. NOTE: All romex shall be Properly Supported. (Provide continuous ground wire.)
17. Feeder circuit wiring shall be in conduit or EMT.
18. All wiring in outside walls shall be in conduit or EMT.
19. All wiring in masonry walls shall be in conduit or EMT.
20. In general, conductors shall be the same size from the last protective device to the load and shall have an ampacity the same as or greater than the ampacity of the protective device where the wire size is not shown on the drawings. Use the 60^{o}C ampacity rating for wire sizes No. 12 through No.

1. For 120V circuits, home runs longer than 100 feet shall be minimum No. 10 AWG, longer than 200 feet shall be minimum No. 8 AWG.

B. Fire Alarm System Installation:

1. Installation shall be in accordance with the NEC Article 760, and the Americans with Disabilities Act and as shown on the drawings.
2. Installation shall be as shown on the drawings and on the manufacturer's wiring diagrams, and shall be performed under the supervision of a factory-trained representative.
3. All wiring shall be one wire per terminal to insure supervision. Crimp-on connectors shall not be used.
4. All wiring shall be color-coded and tagged and shall be checked for continuity, short circuiting, and resistance to ground.
5. All fire alarm wiring shall be installed in raceways.
6. A factory-trained technician shall be present during testing and final inspection and shall instruct the Owner in system operation.
7. Splices and taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
8. Mounting Heights:

    a. Manual Stations: 48" AFF
    b. Visual Units: 80" above the highest floor level within the space or 6 in (152 mm) below the ceiling, whichever is lower.

9. Tests:

    a. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the Owner's Representative.
    b. When the systems have been completed and prior to the final inspection, furnish testing equipment and perform the following tests in the presence of the Owner's Representative.

        1) Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
        2) Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
        3) Open fire alarm detector circuits to see if trouble signal actuates.
        4) Check installation, supervision, operation and sensitivity of smoke detectors as recommended by the manufacturer to ascertain that they will avoid false alarm signals and will function as specified.
        5) Perform any other tests recommended by the equipment manufacturer.

10. Final Inspection: At the final inspection a factory-trained representative of the manufacturer of the existing equipment shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Architect/Engineer

C. Grounding:

1. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.

2. Connections to junction boxes, equipment frames, etc., shall be bolted.
3. Conduit Systems:

    a. Ground all metallic conduit systems.
    b. Conduit systems shall contain a grounding conductor sized per NEC Table 250-122 or as shown on the drawings. Increase conduit size where necessary to accommodate the grounding conductor.

4. Feeders and Branch Circuits: Install green grounding conductors with all feeders and branch circuits.
5. Lighting Fixtures: Conduits shall not be used for grounding fixtures. Green equipment grounding conductor must be bonded to all fixtures.

D. Alterations:

1. The Contractor shall study all drawings and specifications, visit the site, and acquaint himself with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to familiarize himself with the conditions and extent of the proposed work.
2. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.
3. Reconnect existing circuits to remain. Remove existing equipment to be discontinued.
4. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Engineer's satisfaction.
5. Equipment relocated or removed and reinstalled shall be cleaned and repaired to a first-class condition before reinstallation.

E. Continuity of Services: Arrange to execute work at such times and in such locations to provide uninterrupted service to the building or any of its sections. If necessary, temporary power shall be installed to provide for this condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal supply shall be performed during an overtime period to be scheduled with the Owner. Cost for overtime work shall be included in the bid.

F. Identification:

1. Provide tags on each end of all pulled wires giving location of other end.
2. Provide phenolic nameplates for all panelboards, motor starters, disconnect switches (except switches located at motors), and duct smoke detector remote test/alarm-indicating stations.
3. Label each receptacle faceplate using machine-printed thermal adhesive labels to indicate source panel and branch circuit. For receptacles connected to normal power, labels shall be white with black letters. For receptacles connected to circuits from operational standby (OS) panels, labels shall be red with white letters.
4. Arc-Flash Warning Labels:

    a. Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
    b. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.
8) Labels shall be machine printed, with no field-applied markings.

c. Apply one arc-flash label for 480-V ac, and 208-V ac panelboards and disconnects and for each of the following locations:

1) Motor-control center.
2) Low-voltage switchboard.
3) Switchgear.
4) Medium-voltage switch.
5) Control panel

G. Record Drawings: The Contractor shall keep on the job a set of prints showing any changes to the installation. These shall be given to the Engineer at the completion of the work.

H. Testing and Adjusting:

1. The entire installation shall be free from short-circuits and improper grounds. Tests shall be made in the presence of the Engineer or his representatives.
2. Each individual branch circuit shall be tested at the panel; and in testing for insulation resistance to ground, the equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code. Failures shall be corrected in a manner satisfactory to the Architect/Engineer.
3. Each system shall be completely tested and shall be adjusted for proper operation as required by the Engineer.
4. Final Inspection: At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Owner's Representative.

END OF SECTION 261000