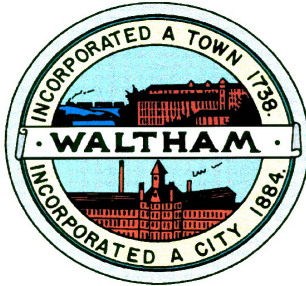


The City of Waltham



**Invites
Interested Parties
To propose the best offer and or bid
For the service or product herewith described:**

HVAC RENOVATIONS FOR WALTHAM PUBLIC LIBRARY, 2024

The GENERAL CONTRACTOR BID is Due: **Thursday March 7th, 2024 at 10:00AM**

FILED SUB BIDS is Due: **Thursday February 22nd, 2024 at 10:00AM**

PRE-BID MEETING and On Site: **Wednesday February 14th, 2024 at 10:00AM**

Meet at the Library, 735 Main Street, Waltham, MA 02451

LAST DAY FOR WRITTEN QUESTIONS: **Thursday February 15th, 2024 at 12:00PM**

(To cphilpott@city.waltham.ma.us)

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Not included in Specification

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Not included in Specification

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Not included in Specification

HVAC REPLACEMENT AT
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Waltham, MA

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[* Indicates Filed Sub-Bid Required.]

The City of Waltham

Purchasing Department

REQUEST FOR BID (RFB)

Under the rules of M.G.L. Chapter 149, the Chief Procurement Officer of the City of Waltham Purchasing Department hereby requests sealed bids for:

HVAC RENOVATIONS FOR WALTHAM PUBLIC LIBRARY, 2024

Price Proposals will be received at the office of the Purchasing Agent, City Hall, 610 Main Street, Waltham MA 02452, until,

February 22, 2024 @ 10:00 am for Filed Sub-bidders

March 7, 2024 @ 10:00 am for General Contractors

At which time and place the bids will be publicly opened and read via ZOOM. The meeting information can be found on our City's website.

Site Inspection will be held: February 14, 2024 @ 10:00 am (Meet at 735 Main St. Waltham)

Specifications and information available on line by visiting the Waltham Purchasing Department web site at www.city.waltham.ma.us/bids

BIDS MUST BE SIGNED AND ENCLOSED IN A SEALED ENVELOPE AND MARKED:

BID FOR: HVAC RENOVATIONS FOR WALTHAM PUBLIC LIBRARY

A 5% Bid Bond or Certified Check must accompany each bid submitted and made payable to, and become the property of the City of Waltham, if the successful bidder refuses or neglects to comply with the terms of the Contract.

If the Bidder is a corporation, state your correct corporate name and State of incorporation. If Bidder is a partnership, state names and addresses of partners. If Bidder is a trust or other legal entity, state correct names and addresses of trustees or names and address of those legally authorized to bid and enter into contracts.

EXCEPTION OR ALTERNATES TO SPECIFICATIONS, TERMS OF SALE, AND DISCOUNTS AVAILABLE, MUST BE INCLUDED IN THE BID PRIOR TO OPENING DATE.

AGREEMENT

CITY OF WALTHAM

ARTICLE 1. This agreement, made this _____ day of _____, 2024 by and between the CITY OF WALTHAM, party of the first part, hereinafter called the CITY, by its MAYOR, and

hereinafter called the CONTRACTOR.

ARTICLE 2. Witnesseth, that the parties to this agreement, each in consideration of the agreement on the part of the others herein contained, do hereby agree, the CITY OF WALTHAM for itself, and said contractor for his heirs, executors, administrators and assigns as follows:

To furnish all equipment, machinery, tools and labor, to furnish and deliver all materials required to be furnished (except as otherwise specified) and deliver in and about the project and to do and perform all work in strict conformity with the provisions of this Contract and of the Notice to Bidders, bid, Project Manual, and Drawings hereto annexed. The said Notice to Bidders, bid, Project Manual, and Drawings are hereby made a part of this contract as fully and to the same effect as if the same had been set forth at length and incorporated in the contracts.

ARTICLE 3. In consideration of the foregoing premises the CITY agrees to pay and the CONTRACTOR agrees to receive as full compensation for everything furnished and done by the CONTRACTOR under this contract, including all work required by not included in the items herein mentioned, and also for all loss or damage arising out of the nature of the work aforesaid, or from the action of the elements, or from any unforeseen obstruction or difficulty encountered in the prosecution of the work, and for all expenses incurred by or in consequence of the suspension or discontinuance of the work specified, and for well and faithfully completing the work, and the whole thereof, as herein provided, such prices as are set forth in the accompanying bid.

This Agreement entered into as of the day and year first written above.

CITY OF WALTHAM, MASSACHUSETTS

FOR THE COMPANY

FOR THE CITY

Jeannette A. McCarthy, MAYOR,
City of Waltham
Date: _____

CONTRACTOR (Signature),
Date: _____

Company

Address

John B. Cervone, City Solicitor
Date: _____
APPROVED AS TO FORM ONLY

Jon Millian, Building Maintenance
Date: _____

Kelly Linehan, Library Director
Date: _____

Crystal Philpott, Purchasing Agent
Date: _____

Paul Centofanti, Auditor
Date: _____

I CERTIFY THAT SUFFICIENT FUNDS
ARE AVAILABLE FOR THIS CONTRACT

**SECTION 00050
CITY OF WALTHAM
MASSACHUSETTS**

NOTICE TO BIDDERS, INCLUDING SUB-BIDDERS

**HVAC RENOVATIONS AT WALTHAM PUBLIC LIBRARY
735 MAIN STREET, WALTHAM, MASSACHUSETTS**

The City of Waltham, Massachusetts invites sealed bids from Contractors for the Renovations at the Waltham Public Library, 735 Main Street, Waltham, Massachusetts. The work includes renovations of windows and Cupola.

PLANS, SPECIFICATIONS and other Contract Documents may be obtained by visiting the City's Web Site at <https://www.city.waltham.ma.us/category/tags/purchasing-bids-open-0>

Copies of Addenda will be e- mailed to the registered Bidders without charge. Addenda will also be posted on the web site above.

Sealed **SUB-BIDS** for categories of "Roofing and Flashing" and "Electrical", will be accepted at the Purchasing Department, Waltham City Hall, 610 Main Street, Waltham, MA 02452 until **Thursday February 22nd, 2024 at 10:00AM**, at which place and time they shall be publicly opened via ZOOM, read aloud and recorded for presentation to the Awarding Authority.

Sealed **GENERAL BIDS** for this project will be accepted from eligible bidders at the Purchasing Department, Waltham City Hall, 610 Main Street, Waltham, MA 02452 until **Thursday March 7th, 2024 at 10:00AM**, at which place and time they shall be publicly opened via ZOOM, read aloud and recorded for presentation to the Awarding Authority.

A **PRE-BID CONFERENCE** will be held for all interested parties at **Wednesday February 14th, 2024 at 10:00AM** at the site at the **Waltham Library, 735 Main Street, Waltham, MA**. Attendance at this pre-bid conference is strongly recommended, but it is not required, for parties submitting a bid. It will be the only opportunity to visit the site prior to the bid opening.

Each general bid, and each sub-bid shall be accompanied by a bid deposit in the form of a bid bond, certified check, or a treasurer's or cashier's check issued by a responsible bank or trust company, payable to the City of Waltham in the amount of five percent (5%) of the value of the bid. Bid deposits will be dealt with as provided in Massachusetts General Laws, Chapter 149, Section 44B.

To be given consideration, all general bids and all sub-bids must be accompanied by a copy of the Bidder's DCAMM Certificate of Eligibility (DCPO Form CQ7) and a DCAMM Update Statement (DCPO Form CQ3). The General Bidder must be certified eligible in the HVAC category and the filed sub-bidders must be certified in their respective categories.

Bids shall be made on the basis of the Minimum Wage Rates as determined by the Commissioner of Labor and Industries, Pursuant to the Provisions of Chapter 149, Sections 26 to 27D inclusive of Massachusetts General Laws, a copy of which is attached to and is made a part of the Contract.

Bidders' selection procedures and contract award shall be in conformity with applicable statutes of the Commonwealth of Massachusetts.

Performance and Labor and Materials payment bonds in the full amount of the contract price will be required from the successful bidder.

The Awarding Authority reserves the right to reject any or all general bids, if it be in the public interest to do so, and to reject any sub-bid on any sub-trade if it determines that such sub-bid does not represent the sub-bid of a person competent to perform the work as specified or that less than three such sub-bids were received and that the prices are not reasonable for acceptance without further competition.

The successful bidder will be required to furnish a Certificate of Insurance, naming the City of Waltham as an Additional Named Insured with a waiver of subrogation, for General Liability and Vehicle Liability in the amount of \$500,000 per occurrence and \$1,000,000 in the aggregate and Worker's Compensation Insurance as prescribed by law.

In accordance with M.G.L.Ch 149 the undersigned certifies that all employees to be employed at the worksite will have successfully completed a course in construction safety and health approved by OSHA that is at least 10 hours in duration at the time the employee begins work and shall furnish documentation of successful completion of said course with the first certified payroll report for each employee.

CITY ORDINANCE. APPROVAL OF CONTRACTS BY MAYOR, SEC. 3-12 OF THE CITY ORDINANCES.

All contract made by any department, board or commission where the amount involved is two thousand dollars (\$2,000) or more shall be in writing, and no such contract shall be deemed to have been made or executed until the approval of the Mayor is affixed thereto. Any construction contract shall, and all other contracts may, where the contract exceed five thousand dollars (\$5,000) be required to be accompanied by a bond with sureties satisfactory to the Mayor.

CITY OF WALTHAM

Crystal Philpott,
Purchasing Agent
Purchasing Department
City Hall, 610 Main Street
Waltham, MA 02452

SECTION 00100 - INSTRUCTION TO BIDDERS

PART 1 - GENERAL

1.1 SCHEDULE OF DATES

- A. Advertisement appears in Central Register, Plans and Specifications are available on the City of Waltham website after **10:00AM Wednesday January 31st, 2024**
- B. **Pre-bid** walkthrough on **Wednesday February 14th, 2024 at 10:00AM** at the Waltham Library, Waltham, MA.
- C. Questions and requests for interpretations may be submitted in writing by Bidders via e-mail ONLY to cphilpott@city.waltham.ma.us until: **Thursday February 15th, 2024 at Noon, 12:00PM.**
- D. Addenda will be issued with interpretations as determined by the Purchasing Department only via e-mail and posting on the web site.
- E. File Sub-Bids Deadline: **Thursday February 22nd, 2024 at 10:00AM**, in the Purchasing Department, City Hall, 610 Main Street, Waltham, MA 02452, Attn: Purchasing Agent, where the bids will be publicly opened and read via ZOOM.
- F. General Bids Deadline: **Thursday March 7th, 2024 at 10:00AM** in the Purchasing Department, City Hall, 610 Main Street, Waltham, MA 02452, Attn: Purchasing Agent, where the bids will be publicly open and read via ZOOM.

1.2 BIDDING PROCEDURE

- A. Bids for the work are subject to the provisions of General Laws, Chapter 149, Sections 44A-44L inclusive, as amended. Regulations governing the bidding procedures as set forth in the above mentioned amended General Laws must be followed.
- B. In the event of any inconsistencies between any of the provisions of these Contract Documents and of the cited statute, anything herein to the contrary notwithstanding, the provisions of the said statute shall control.
- C. No General Bid received by the Awarding Authority after the time respectively established herein for the opening of General Bids will be considered, regardless of the cause for the delay in the receipt of any such bid.

1.3 WITHDRAWAL OF BIDS

- A. Bids may be withdrawn prior to the time respectively established for the opening of General Bids only on written request to the Awarding Authority.

1.4 INTERPRETATION OF CONTRACT DOCUMENTS

- A. No oral interpretation will be made to any bidder. All questions or requests for interpretations must be made in writing to the Architect.
- B. Every interpretation made to a bidder will be in the form of an Addendum to the drawings and/or specifications, which will be made available to all persons to whom Contract Documents have been issued.
- C. Failure of the Awarding Authority to send, or of any bidder to receive any such Addendum shall not relieve any bidder from obligation under his bid as submitted.
- D. All such Addenda shall become a part of the Contract Documents.

1.5 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

- A. Each bidder shall visit the site of the proposed work and fully acquaint himself with conditions as they exist, and shall also thoroughly examine the Contract Documents. Failure of any bidder to visit the site and acquaint himself with the Contract Documents shall not relieve any bidder from any obligation with respect to his bid.
- B. By submitting a bid, the bidder agrees that the Contract Documents are adequate and that the required result for a full and complete installation can be produced. The successful bidder shall furnish any and all labor, materials, insurance, permits and all other items needed to produce the required result to the satisfaction of the Awarding Authority.

1.6 BID SECURITY

- A. The General Contractor's bid must be accompanied by bid security in the amount of five percent (5%) of the bid.
- B. At the option of the bidder, the security may be bid bond, certified, treasurer's or cashier's check issued by a responsible bank or trust company. No other type of bid security is acceptable.

Bid Bonds shall be issued by a Surety Company qualified to do business under the laws of the Commonwealth of Massachusetts.

- C. Certified, Treasurer's or Cashier's check shall be made payable to the City of Waltham, Massachusetts.
- D. The bid security shall secure the execution of the Contract and the furnishing of a Performance and Payment Bond by the successful General Bidder for 100% of the contract value.
- E. Should any General Bidder to whom an award is made fail to enter into a contract therefore within five (5) days, Saturdays, Sundays and Legal Holidays, excluded, after

notice of award has been mailed to him or fail within such time to furnish a Performance Bond and also a Labor and Materials or Payment Bond as required, the amount so received from such General Bidder through his Bid Bond, Certified, Treasurer's or Cashier's check as bid deposit shall become the property of the City of Waltham, Massachusetts as liquidated damages; provided that the amount of the bid deposit, which becomes the property of the City of Waltham, Massachusetts, shall not in any event exceed the difference between his bid price and the bid price of the next lowest responsible and eligible bidder; and provided further that, in case of death, disability, bona fide clerical error or mechanical error of a substantial nature, or other unforeseen circumstances affecting the General Bidder, his deposit shall be returned to him.

1.7 BID FORM

- A. General Bids shall be submitted on the "FORM FOR GENERAL BID" enclosed. Erasures or other changes must be explained or noted over the signature of the bidder.
- B. Bid forms must be completely filled in. Bids which are incomplete, conditional, or obscure, or which contain additions not called for will be rejected.
- C. General Bidders shall submit one set of executed bid forms to the Awarding Authority.

1.8 SUBMISSION OF BIDS AND BID SECURITIES

- A. Each bid submitted by a General Contractor shall be enclosed in a sealed envelope that shall be placed with the bid security in an outer envelope. The outer envelope shall be sealed and clearly marked as follows:

(Firm Name): _____
General Bid and Bid Security for:
HVAC Renovation Waltham Public Library

1.9 AWARD OF CONTRACT

- A. The Contract shall be awarded to the lowest responsible and eligible General Bidder on the basis of competitive bids in accordance with the procedure set forth in the provision of Section 44B-44L inclusive, as amended or inserted, of Chapter 149 of the General Laws of the Commonwealth of Massachusetts.
- B. If the bidder selected as the General Contractor fails to perform his agreement to execute a contract in accordance with the terms of his General Bid, and furnish a Performance Bond and also a Labor and Materials or Payment Bond, as stated in his General Bid in accordance with Section 44F, an award shall be made to the next lowest responsible and eligible bidder.
- C. The words "lowest responsible and eligible bidder" shall be the bidder whose name is the lowest of those bidders possessing the skill, ability and integrity necessary for the faithful performance of the work and who shall certify that he is able to furnish labor

that can work in harmony with all other elements of labor employed, or to be employed, on the work. Essential information in regard to such qualifications shall be submitted in such form as the Awarding Authority may require.

- D. Action on the award will be taken within sixty (60) days, Saturdays, Sundays and Legal Holidays excluded after the opening of the bids.

1.10 SECURITY FOR FAITHFUL PERFORMANCE

- A. The successful bidder must deliver to the Awarding Authority simultaneously with his delivery of the executed contract, an executed Performance Bond, and also a Labor and materials or Payment Bond, each issued by a surety company qualified to do business under the laws of the Commonwealth and satisfactory to the Awarding Authority and each in the sum of One Hundred Percent (100%) of the Contract Price, as surety for the faithful performance of his contract, and for the payment of all persons performing labor or furnishing materials in connection therewith. Said bonds shall provide that, if the General Contractor fails or refuses to complete the Contract, the Surety Company will be obligated to do so.
- B. Premiums are to be paid by the General Contractor, and are to be included in the Contract Price.

1.11 EQUAL OPPORTUNITY

- A. The City of Waltham is an Equal Opportunity employer and will require compliance with the minority business enterprise plan (MBE) on file in the Purchasing Department

1.12 PRE-BID WALK-THRU

- A. A pre-bid conference will be held at the site on **Wednesday February 14th, 2024 at 10:00AM** at the Waltham Library, 735 Main Street, Waltham, MA. Interested parties are encouraged to attend given that this will be the only time the building is open prior to the submission of bids. Further, prior to the bid opening, potential bidders may not go onto the site any time other than the aforementioned pre-bid conference.

1.13 SITE VISITS

- A. Prospective bidders are prohibited from going onto the site prior to the Bid Opening or any time other than the pre-bid walk-thru, as set forth in Section 1.12 above, unless authorized by the Architect in an Addendum to the bid documents.

1.14 CONTRACT DOCUMENTS

- A. The Awarding Authority shall make available the bid documents and addenda in the City Web site at <https://www.city.waltham.ma.us/category/tags/purchasing-bids-open-0>
No plans will be mailed.

1.15 EQUALITY

- A. Except where otherwise specifically provided to the contrary, the words “or approved equal” are hereby inserted immediately following the name or description of each article, assembly, system, or any component part thereof in the Contract Documents. It is the Contractor’s responsibility to provide all the research and documentation that would prove a product or assembly is “equal”. Failure to provide research or documentation does not alleviate the Contractor’s responsibility to meet the schedule.

1.16 TAX FREE NUMBER

- A. The City of Waltham has a tax-free number.

1.17 SCHEDULE

- A. The work of the Contract shall be Substantially Complete in **365 calendar days** after the date of the Notice-to-Proceed.

1.18 LATE PENALTY FEES

- A. If the work is not Substantially Complete as specified in 1.17, the Contractor shall be charged Five Hundred Dollars (\$500.00) per day to pay for consulting and testing fees required to manage and arrange for the completion of the project. Late fees will be deducted from the Contract via Change Order.

1.19 WEEKLY JOB MEETINGS

- A. There will be a weekly job meeting at the site on the same agreed-upon day and time. Time will be provided to discuss and view the progress of the work and to answer questions. The Contractor’s job Superintendent and Project Manager shall attend each meeting. The City reserves the right to have job meetings conducted in the Planning Department at 119 School Street, Waltham.

1.20 PROJECT SUPERINTENDENT

- A. The Contractor shall provide the same person as Superintendent for the entire duration of the project. Failure to maintain the same person in this position shall result in a One Thousand Dollar (\$1,000.00) penalty per incident which shall cover the Architect’s time to re-orient new personnel.

1.21 AWARD

- A. The Awarding Authority reserves the right to reject any or all bids if it be in the public interest to do so, and to act upon the bids and make its award in any lawful manner.

1.22 PREVAILING WAGE SCHEDULE

- A. Bids shall be made on the basis of the Prevailing Wage Schedule, as determined by the Commissioner of Labor and Industries, pursuant to the provision of Chapter 149, Section 26 to 27D inclusive, of the Massachusetts General Laws. The Prevailing wage Schedule for this project can be found in the City's web Site at:
<https://www.city.waltham.ma.us/category/tags/purchasing-bids-open-0>

1.23 CONFLICT OF INTEREST

- A. A bidder filing a proposal thereby certifies that the proposal is made in good faith, without fraud, collusion, or connection of any kind with any other bidder for the same work, and that the bidder is competing solely on its own behalf without connection with, or obligation to, any undisclosed person or firm.

1.24 PROCEED ORDERS

- A. No bidder is to proceed without a proceed order as set out in the contract.

1.25 STAGING

- A. The General Contractor shall provide all the vertical access (which includes staging, vertical lifts, etc.) for the work of the Contract for the General Bidder and his/her non File Sub-bid subcontractor. **Exception:** ALL File Sub-Bidders shall provide ALL their own staging, vertical access, and hoisting necessary to perform their own work.

1.26 COMPLIANCE WITH MASSACHUSETTS GENERAL LAWS

- A. Pursuant to Massachusetts General Laws, Chapter 62C, Section 49A, I certify under the penalty of perjury that I, to the best of my knowledge and belief have filed all state tax returns and paid all the state taxes required under law.

1.27 CONSTRUCTION BARRICADES

- A. The General Contractor shall provide all barricades to enclose the work area to prevent unauthorized access to the site.
1. The barricades shall provide enough room for all construction activities to be performed while separated from pedestrians, students, and staff on site.
 2. Safety is the sole responsibility of the Contractor and any barricades necessary to protect the work and the public shall be provided.
 3. Provide entrance protection.

1.28 INSURANCE

A. The contractor shall purchase and maintain, at his expense all insurance required by the Contract. Documents and all insurance required by the applicable laws of Massachusetts, including but not limited to, General Laws, Chapter 146, in connection with all hoisting equipment.

B. The Contractor shall purchase and maintain such insurance as will protect him from claims under workmen's compensation acts and from claims for damages because of bodily injury, including death and all property damage including, without limitation, damage to buildings and adjoining the site of construction which might arise from and during operations under this contract, whether such operations be by himself or by any subcontractor or anyone directly or indirectly employed by either of them including:

1. Statutory Worker's Compensation and Employer's Liability

The contractor shall provide insurance for the payment of compensation and the furnishing of other benefits under Chapter 152 of the General Laws (so-called Worker's Compensation Act) to all persons to be employed under this contract and shall continue in force such insurance as aforesaid shall be deemed a material breach of this Contract and shall operate as an immediate termination thereof. The contractor shall, without limiting the generality of the foregoing, conform to the provisions of Section 34A of Chapter 149 of the General Laws, which Section is incorporated herein by reference and made a part of hereof.

2. Comprehensive General Liability Insurance

Minimum bodily injury limits of \$ 500,000 per person and \$ 1,000,000 per accident, and property damage limits of \$ 500,000 per accident and \$ 1,000,000 aggregate during any 12 month period, shall include the following:

- a. Public liability (bodily injury and property damage)
- b. X.C.U. (explosion, collapse, and underground utilities)
- c. Independent contractor's protective liability.
- d. Products and completed operations.
- e. Save harmless agreement for Owner and Architects set forth in ARTICLE 10.11 of the GENERAL CONDITIONS.

3. Comprehensive All Risk Motor Vehicle Liability Insurance

Minimum bodily injury limits of \$ 500,000 per person, \$ 1,000,000 per accident, and property damage limit of \$ 1,000,000 per accident.

4. All Risk Insurance

Covering all Contractor's equipment with a provision for Waiver of Subrogation against the Owner.

5. Excess Liability Insurance in Umbrella Form with combined Bodily Injury and Property Damage Limit of \$ 1,000,000.
6. City of Waltham is a Named Additional Insured for General Liability with a Waiver of Subrogation on the insurance policy for this project.

1.29 SITE ACCESS

- A. The General Contractor shall gain access to the site via routes approved by the Owner.
 1. The General Contractor as part of the bid price will restore all roads, curbs, driveways, walks and grassed or landscaped areas damaged during construction.

1.30 CONSTRUCTION TRAILER

- A. The General Contractor shall locate the construction trailer at locations approved by the Owner.
- B. The General Contractor shall locate all on site stored or staged materials within the enclosed area designated by the Owner.

1.31 BUILDING PERMIT FEES

- A. Building permit fees will be waived for this project. However, the general Contractor is expected to obtain all proper permits as required by City Ordinances

1.32 COMPLETE BID FORMS

- A. Please Note: Each bidder must fill in all the blanks on all the bid forms, even if the information is “zero dollars” or “not applicable”. Also, please acknowledge all Addenda even if they do not pertain to your trade.

1.321 READ ALL DOCUMENTS.

Bidders should familiarize themselves with all the documents contained herein; it is mandatory that all Bids be in compliance with all the provisions contained in said documents.

1.33. FORMS AND ATTACHMENTS.

Bids are to be completed on the forms provided ONLY and enclosed in a sealed envelope marked on the outside “BID (title)” and the name and address of bidder. Attachments submitted in addition to the Waltham Purchasing Department produced forms may not be considered.

1.34. PRINTED OR TYPED RESPONSE.

All information must be typewritten or printed in ink, including the price the bidder offers in the space as provided on the bid form.

1.35. CORRECTIONS.

Bids that are submitted containing cross outs, white outs or erasures, will be rejected. All corrections or modifications to the original bid are to be submitted in a separate envelope, properly marked on the outside, "CORRECTION/ MODIFICATION TO BID (title)" and submitted prior to the bid opening.

ALL DOCUMENTS SUBMITTED WITH YOUR RESPONSE WILL BE INCORPORATED INTO THE CONTRACT.

1.36. PRICE IS ALL INCLUSIVE.

Bid prices shall encompass everything necessary for furnishing all items, materials, supplies or services as specified, and in accordance with the specifications, including proper packing, cost of delivery, and in the case of services, completion of same, as per specifications.

1.37. PRICE DISCREPANCY.

In the event of a discrepancy between the Unit Price and the Extension, the Unit Price shall prevail.

1.38. EXPLANATIONS, EXCEPTIONS

Explanations, exceptions or other information pertinent to the specifications may be made in writing and included in the same envelope with the bid.

1.39. BID DEPOSITS.

Bid deposits are to be made payable to the City of Waltham. In the event that the successful bidder fails to execute a Contract within (10) days of the receipt of said contract, such security shall be retained by the city as liquidated damages. Unsuccessful bidders' deposits will be returned immediately following the award to said successful bidder.

1.40. WITHDRAW.

A Bid may be withdrawn by written request prior to the schedule for the Bid Opening. No withdrawals are permitted after the bid opening date and time. Withdrawals after the bid opening date will cause the forfeit of the bid Deposit.

1.41. AWARD.

Bids will be awarded not later than (90) ninety days after the scheduled bid opening date, unless otherwise stated, in the specifications. Unless otherwise specified, bids will be evaluated on the basis of, completeness of your RFP response, responsiveness, responsibility, best price and experience.

1.42. AWARD CRITERIA.

Qualified and responsive proposals will be evaluated based on Price, Technical, and Compliance requirements.

1.43. DISCOUNTS.

Discounts for prompt payments will be considered when making awards.

1.44. TAX EXEMPT.

Purchases by the City of Waltham are exempt from any Federal, State or Massachusetts Municipal Sales and/or Excise Taxes.

1.45. SAMPLES.

The City of Waltham may require the submission of samples either before or after the awarding of a contract. Samples are to be submitted, at no charge to the City, so as to ascertain the product's suitability. If specifically stated in the Bid that samples are required, said samples must be submitted with the Bid prior to the Official Bid Opening. Failure to submit said samples would be cause for rejection of Bid. All samples must be called for and picked up within (30) thirty days of award or said samples will be presumed abandoned and will be disposed of.

1.46. ACTIVE VENDOR LIST.

Vendors who wish to remain on the Active Bid List must either submit a Bid, No Bid, or a letter requesting same, no later than the Official Bid Opening. This is applicable to those vendors who have received the Invitation to Bid.

1.47. FUNDS APPROPRIATION.

THE CONTRACT OBLIGATION ON BEHALF OF THE CITY IS SUBJECT TO PRIOR APPROPRIATION OF MONIES FROM THE GOVERNMENTAL BODY AND AUTHORIZATION BY THE MAYOR.

1.48. THE AWARDING AUTHORITY RESERVES THE RIGHT TO REJECT ANY OR ALL BIDS, OR ANY PART OF ANY BID, WHICH IN THE OPINION OF THE AWARDING AUTHORITY, IS IN THE BEST INTERESTS OF THE CITY OF WALTHAM.

1.49. THE TAX ATTESTATION CLAUSE, CERTIFICATION OF NON-COLLUSION AND THE CERTIFICATE OF VOTE AUTHORIZATION, are required by statute and are an integral part of the Invitation for Bid and must be completed and signed by the person submitting the Bid, or by the person/persons who are officially authorized to do so. Failure to do so may disqualify the bid.

1.50. STANDARD OF QUALITY.

Where, in the specifications, one certain kind, type, catalog number, brand or manufacturer of material is named, it shall be regarded as the required standard of quality. Where two or more are named, these are presumed to be equal and the Bidder

may select one or the other. If the Bidder proposes to offer a substitute as an equal, he shall so indicate on the Bid Form, the kind, type, catalog number, brand, or manufacturer of material that is offered as an equal, and describe where it differs from the specifications. Substituted items must be capable of performing all the functions and/or operational features described or indicated in the specifications. Failure to indicate the description of any substitute item on the Bid will be interpreted to mean that the Bidder will furnish the item or service as specified.

1.51. MODIFICATION.

No agreement, understanding, alteration or variation of the agreement, terms or provisions herein contained shall bind the parties, hereto unless made and executed in writing by the parties hereto.

1.52. ASSIGNMENT.

The final payment for work done under this Contract shall be made only after the Contractor has signed a statement under the penalty of perjury, certifying that he has completed the work described in the final estimate. Neither party hereto shall assign this Contract or sublet it in part or as a whole without the prior written consent of the other party hereto. The Contractor shall not assign any sum or sums due or becoming due to him hereunder without the prior written consent of the City.

1.53. DELIVERIES:

a) The Contractor shall pay all freight and delivery charges. The Waltham Purchasing Department does not pay for shipping and packaging expenses. Items must be delivered as stipulated in the specifications. All deliveries must be made to the inside of city buildings. Sidewalk deliveries will not be accepted. City personnel are not required to assist in the deliveries and contractors are cautioned to notify their shippers that adequate assistance must be provided at the point of delivery, when necessary.

b) All items of furniture must be delivered inside the building, set up, in place and ready for use. Deliveries are to be made between the hours of 8:30 a.m. and 3:00 p.m., Monday through Friday, except on holidays.

c) All damaged items, or items which do not comply with specifications will not be accepted and title therefore will not vest to the Waltham Purchasing Department until such items are accepted and signed for, in good order, by the receiving department.

d) The contractor must replace, without further cost to the Waltham Purchasing Department, such damaged or non-complying items before payment will be made.

1.54. LABELING.

All packages cartons or other containers must be clearly marked with (a) building and room destination; (b) description of contents of item number from specifications; (c) quantity; (d) City of Waltham Purchase Order Number and (e) Vendor's name and order number.

1.56. GUARANTEES.

Unless otherwise stipulated in the specifications, furniture, equipment and similar durable items shall be guaranteed by the contractor for a period of not less than one year from the

date of delivery and acceptance by the receiving department. In addition, the manufacturer's guarantee shall be furnished. Any items provided under this contract which are or become defective during the guarantee period shall be replaced the contractor free of charge with the specific understanding that all replacements shall carry the same guarantee as the original equipment. The contractor shall make such replacement immediately upon receiving notice from the Purchasing Agent.

1.57. CHANGE ORDERS.

Change orders are not effective until, if, as and when signed by the Mayor and no work is to commence until the change orders are fully executed.

1.58. BID OPENING INCLEMENT WEATHER

If, at the time of the originally scheduled bid opening, City Hall is closed to inclement weather or another unforeseeable event, the bid opening will be extended until 2:00 PM on the next normal business day. Bids will be accepted until that date and time.

Signature of Individual or Corporate Name

By:

(Signature of Corporate Officer if applicable)

Title: _____

Social Security Number or Federal Identification Number: _____

END OF SECTION

GENERAL CONDITIONS

GENERAL CONDITIONS

1. INFORMATION

All information shall come from the Office of the City Purchasing Agent. The Contractor shall inquire at this office for any information needed. Wherever the words "or equal as approved" are used, it is to be understood that the opinion of the City Purchasing Agent shall govern.

2. SUITS

The Contractor shall assume defense of and shall indemnify and hold the City and its agents harmless from all suits and claims against the City and its sub-contractors arising from the use of any invention, patent right labor or employment, or from any act of omission or neglect of the City, its agents, employees or any subcontractor in performing the work, under this contract.

3. LAWS AND REGULATIONS

The Contractor shall conform to all the applicable rules, regulations, laws and ordinances of the City of Waltham, the Commonwealth of Massachusetts, the United States of America and all agencies having jurisdiction over this contract.

4. PROTECTION OF PROPERTY

The Contractor shall take all proper precautions to protect the City's property from damage and unnecessary inconvenience. Any City property damaged by the Contractor in carrying out the provisions of this contract shall be restored to its original condition, by and at the expense of the Contractor.

5. PROTECTION OF PERSONS

The Contractor shall take all proper precautions to protect persons from injury, unnecessary inconvenience, and shall be responsible for his failure to do so. The Contractor agrees to hold the City harmless from any and all liabilities of every nature and description, which may be suffered through bodily injury, including death, to any person, by reason of negligence of the Contractor, his agents or employees, or any subcontractor.

6. CONTRACT DURATION.

This contract is for the period required to complete the project. All guarantees remain in effect.

7. **INSURANCE**

A. **WORKMAN’S COMPENSATION:** The Contractor shall provide insurance for the payment of compensation and furnishing of other benefits under Chapter 152 of the General Laws of the Commonwealth of Massachusetts to all persons to be employed under this contract, the premiums for which shall be paid by the Contractor. Contractors shall provide insurance on a primary basis and the contractor’s policy shall be exhausted before resorting to other policies. The contractor’s policy is the primary one not the contributory.

B. **COMPREHENSIVE GENERAL LIABILITY**

Bodily Injury:	\$1,000,000 Each Occurrence \$2,000,000 Aggregate
Property Damage:	\$1,000,000 Each Occurrence \$2,000,000 Aggregate

C. **AUTOMOBILE (VEHICLE) LIABILITY**

Bodily Injury	\$2,000,000 Each Occurrence
Property Damage	\$1,000,000 Aggregate

D. **UMBRELLA POLICY**

General liability	\$1,000,000
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Your bid response must include a Certificate of Insurance with the above limits as a minimum. In addition, the Certificate of Insurance must have the following text contained in the bottom left box of the Certificate: *“The City of Waltham is a named additional insured for all insurances under the contract, excluding Automobile and Workers Compensation coverage”*. **Failure by the contractor to provide a current and updated insurance policy, during the entire duration of the contract, may result in additional legal liability.** The Certificate of Insurance must be mailed directly to:

Office of the Purchasing Agent
Purchasing Department
City of Waltham
610 Main Street
Waltham, MA 02451

8. LABOR AND MATERIALS BOND

The Contractor agrees to execute and deliver to the City, a Labor and Materials or Payment Bond equal to 100% of the contract value. This contract shall not be in force until said bond has been delivered and accepted by the City. Bond to be issued by a company licensed by the Commonwealth of Massachusetts.

A LETTER FROM A SURETY COMPANY CERTIFYING THAT THE CONTRACTOR IS QUALIFIED AND CAPABLE OF OBTAINING THE ABOVE BONDS MUST BE INCLUDED WITH HIS/HERS BID.

9. PERSONNEL:

The Contractor shall employ a competent supervisor and all properly licensed personnel necessary to perform the services required in this contract. The City Purchasing Agent shall have the right to require the Contractor to remove and/or replace any of the personnel for nonperformance or for unprofessional behavior. The City Purchasing Agent may require the Contractor to submit a weekly performance record of the areas and of the work performed, on forms approved by the City Purchasing Agent. The Contractor or his supervisor shall be available to inspect such work as required by the City Purchasing Agent.

10. PREVAILING WAGES

The Contractor is required to pay the prevailing wages as determined under the provisions of Chapter 149, Sections 26 and 27D of the Massachusetts General Laws, including the submission of weekly payrolls to the awarding authority. The prevailing wage schedule for this project can be found at www.city.waltham.ma.us/bids.

11. MATERIALS

The City or its Agent reserves the right to approve or reject any supplies, material or equipment used by the Contractor. The Contractor agrees to replace any supplies, material or equipment used by the Contractor. The Contractor agrees to replace any rejected supplies, materials or equipment, to the satisfaction of the City or its Agents.

12. TERMINATION OF CONTRACT

This contract may be terminated by the City upon deliverance to the Contractor of a five-day written notice of said termination.

13. CONTRACT OBLIGATIONS

Contract obligations on behalf of the City are subject to an annual appropriation to cover the contract obligation.

14. BIDDER EXPERIENCE EVALUATION

Each bidder shall submit with his bid, all the information relative to their experience and qualifications in performing the work required under this contract and shall have been in business for a minimum of five (5) years, in order for their bid to be considered.

15. NOT-TO-EXCEED AMOUNT

The bid amount proposed in your company's response is a "not-to- Exceed" amount unless the City makes changes, in writing, to the scope of work to be performed. The Change Order must be signed and approved by the City's Purchasing Agent, City Auditor, Law Department and the Mayor prior to the commencement of the change order work. No work is to begin until the proper approvals have been obtained. A change order will be priced at the unit price. Failure to comply with this procedure will result in the cancellation of the contract and the non-payment of services provided

16. FINANCIAL STATEMENTS.

The City may require, within five (5) days after the bid opening, a complete and detailed Financial Statement prepared by a Certified Public Account, to determine a bidder's financial stability.

17 BREACH OF CONTRACT/ NON PERFORMANCE

If the Contractor shall provide services in a manner, which is not to the satisfaction of the City, the City may request that the Contractor refurnish services at no additional cost to the City until approved by the City. If the Contractor shall fail to provide services, which are satisfactory to the City, the City in the alternative may make any reasonable purchase or Contract to purchase services in substitution for those due from the

Contractor. The City may deduct the cost of any substitute Contract for nonperformance of services together with incidental and consequential damages from the Contract price and shall withhold such damages from sums due or to become due to the Contractor. If the damages sustained by the City exceed sums due or to become due, the Contractor shall pay the difference to the City upon demand. The Contractor shall not be liable for any damages sustained by the City due to the Contractor's failure to furnish services under the terms of this Contract if such failure is in fact caused by the occurrence of a contingency the nonoccurrence of which was a basic assumption under which this Contract was made, including a state of war, embargoes, expropriation of labor strike or any unanticipated federal, state or municipal governmental regulation of order, provided that the Contractor has notified the City in writing of such cause within seven (7) days after its occurrence.

18. RIGHT TO AUDIT

The City of Waltham has the right to review and audit documents related to this contract. This right extends to any subcontractor, supplier or other entity used by the prime contractor to fulfill the obligations under this contract.

19. CITY ORDINANCE. APPROVAL OF CONTRACTS BY MAYOR, SEC. 3-12 OF THE CITY ORDINANCES.

All contract made by any department, board or commission where the amount involved is two thousand dollars (\$2,000) or more shall be in writing, and no such contract shall be deemed to have been made or executed until the approval of the Mayor is affixed thereto. Any construction contract shall, and all other contracts may, where the contract exceed five thousand dollars (\$5,000) be required to be accompanied by a bond with sureties satisfactory to the Mayor.

20. ORIGINAL SIGNATURES

Where a signature is required in the bid documents, the vendor is required to place an original "wet" signature. The Certificate of Vote Authorization, Certificate of Non Collusion Certificate, Tax Compliance Certificate, Debarment Certification, Notary Public Certification and the Bid Form (price form) MUST bear an original "Wet" signature by the authorized corporate officer. The Notary Public Certification must be from a notary

permitted to practice in this country. No certifications by a foreign Notary public will be accepted.

21. **PRINTING AND ASSEMBLY BID SUBMISSION**

Bid responses shall be submitted in single page printing format. No double sided printing is accepted by the City. The response binding shall be with an appropriately sized clip binder. No staples, no metal or plastic binding is accepted.

NOTE

Failure to submit any of the required documents, in this or in other sections, with your bid response package may cause the disqualification of your proposal.

Compliance

(Required Documents.)

Compliance

The compliance documents in this section must be completed, signed and returned **with your bid package.**

Purchasing Department

City of Waltham
610 Main Street
Waltham, MA 02452

Failure to submit the completed documents will cause the disqualification of the proposal.

Section Index

Check when Complete

- Non-collusion form and Tax Compliance form..... _____
- Corporation Identification Form..... _____
- Certificate of Vote Authorization..... _____
- Certificate of Insurance (showing all limits of WC &GL)..... _____
- Three (3) References..... _____
- 5% Bid Bond or Certified Check..... _____
- Debarment Certificate _____
- Prevailing Wage Certificate..... _____
- Right-to-know Law..... _____
- OSHA 10 Certificate for all Assigned Employees (MGL ch30, §39M and Ch 149) _____

Before the commencement of the Job, the contractor must provide to the above office:

- Performance Bond for 100% of the contract value and naming the City of Waltham
(letter must be included with your response)

Your Company's Name: _____

Service or Product Bid _____

NOTE: Failure to submit any of the required documents, in this or in other sections, with your bid response package may cause the disqualification of your proposal.

NON-COLLUSION FORM AND TAX COMPLIANCE FORM

CERTIFICATE OF NON-COLLUSION

The undersigned certifies under penalties of perjury that this bid or proposal has been made and submitted in good faith and without collusion or fraud with any other person. As used in this certification, the word "person" shall mean any natural person, business, partnership, corporation, union, committee, club, or other organization, entity or group of individuals. The undersigned certifies that no representations made by any City officials, employees, entity, or group of individuals other than the Purchasing Agent of the City of Waltham was relied upon in the making of this bid

_____, _____
(Signature of person signing bid or proposal) Date

(Name of business)

TAX COMPLIANCE CERTIFICATION

Pursuant to M.G.L. c. 62C, & 49A, I certify under the penalties of perjury that, to the best of my knowledge and belief, I am in compliance with all laws of the Commonwealth relating to taxes, reporting of employees and contractors, and withholding and remitting child support.

_____, _____
Signature of person submitting bid or proposal Date

Name of business

NOTE

Failure to submit any of the required documents, in this or in other sections, with your bid response package may cause the disqualification of your proposal.

CERTIFICATE OF VOTE OF AUTHORIZATION

Date:

I _____, Clerk of _____ hereby certify that at a meeting of the Board of Directors of said Corporation duly held on the _____ day of _____ at which time a quorum was present and voting throughout, the following vote was duly passed and is now in full force and effect:

VOTED: That _____ (*name*) is hereby authorized, directed and empowered for the name and on behalf of this Corporation to sign, seal with the corporate seal, execute, acknowledge and deliver all contracts and other obligations of this Corporation; the execution of any such contract to be valid and binding upon this Corporation for all purposes, and that this vote shall remain in full force and effect unless and until the same has been altered, amended or revoked by a subsequent vote of such directors and a certificate of such later vote attested by the Clerk of this Corporation.

I further certify that _____ is duly elected/appointed _____ of said corporation

SIGNED:

(Corporate Seal)

Clerk of the Corporation:

Print Name: _____

COMMONWEALTH OF MASSACHUSETTS

County of _____

Date:

Then personally appeared the above named and acknowledged the foregoing instrument to be their free act and deed before me, _____

Notary Public;

My Commission expires: _____

CORPORATION IDENTIFICATION

The bidder for the information of the Awarding Authority furnishes the following information.

If a Corporation:

Incorporated in what state _____

President _____

Treasurer _____

Secretary _____

Federal ID Number _____

If a foreign (out of State) Corporation – Are you registered to do business in Massachusetts?

Yes _____, No _____

If you are selected for this work you are required under M.G.L.ch. 30S, 39L to obtain from the Secretary of State, Foreign Corp. Section, State House, Boston, a certificate stating that you Corporation is registered, and furnish said certificate to the Awarding Authority prior to the award.

If a Partnership: (Name all partners)

Name of partner _____

Residence _____

Name of partner _____

Residence _____

If an Individual:

Name _____

Residence _____

If an Individual doing business under a firm's name:

Name of Firm _____

Name of Individual _____

Business Address _____

Residence _____

Date _____

Name of Bidder _____

By _____

Signature _____

Title _____

Business Address _____ (POST OFFICE BOX NUMBER NOT ACCEPTABLE)

City _____ State _____ Telephone Number _____ Today's Date _____

PROVIDE THREE (3) SERVICE APPROPRIATE REFERENCES

1. Company Name:

Address:

Contact Name:

Phone #

Type of service/product provided to this Company:

Dollar value of service provided to this Company:

2. Company Name:

Address:

Contact Name:

Phone #

Type of service/product provided to this Company:

Dollar value of service provided to this Company:

3. Company Name:

Address:

Contact Name:

Phone #

Type of service/product provided to this Company:

Dollar value of service provided to this Company:

NOTE

Failure to submit any of the required documents, in this or in other sections, with your bid response package will be cause for the disqualification of your company.

**WEEKLY PAYROLL RECORDS REPORT &
STATEMENT OF COMPLIANCE**

In accordance with Massachusetts General Law c. 149, §27B, a true and accurate record must be kept of all persons employed on the public works project for which the enclosed rates have been provided, A Payroll Form has been printed on the reverse of this page and includes all the information required to be kept by law. Every contractor or subcontractor is required to keep these records and preserve them for a period of three years from the date of completion of the contract.

In addition, every contractor and subcontractor is required to submit, on a weekly basis, a copy of his or her weekly payroll records to the awarding authority. For every week in which an apprentice is employed, a photocopy of the apprentice's identification card must be attached to the payroll report. Once collected, the awarding authority is also required to preserve those reports for three years.

In addition, each such contractor, subcontractor, or public body shall furnish to the awarding authority directly, within fifteen days after completion of its portion of the work, a statement, executed by the contractor, subcontractor or public body who supervises the payment of wages, in the following form:

STATEMENT OF COMPLIANCE

_____, 200__

I _____,
(Name of signatory party) (Title)

I do hereby state that I pay or supervise the payment of the persons employed by

_____ on the _____
(Contractor, subcontractor or public body) (Building or project)

and that all mechanics and apprentices, teamsters, chauffeurs and laborers employed on said project have been paid in accordance with wages determined under the provisions of sections twenty-six and twenty-seven of chapter one hundred and forty nine of the General Laws.

Signature _____, Title _____

Print _____

WEEKLY PAYROLL REPORT FORM

Company Name: _____

Prime Contractor

Project Name: _____

Subcontractor

Awarding Auth.: _____

List Prime Contractor: _____

Work Week Ending: _____

Employer Signature: _____

Print Name & Title: _____

Final Report

Employee Name & Address	Work Classification	Hours Worked							(A) Tot. Hrs.	(B) Hourly Base Wage	Employer Contributions			(F) Hourly Total Wage (prev. wage)	(G) Weekly Total Amount
		S	M	T	W	T	F	S			(C) Health & Welfare	(D) Pension	(E) Supp. Unemp.		

NOTE: Every contractor and subcontractor is required to submit a copy of their weekly payroll records to the awarding authority.

RIGHT TO KNOW LAW

Any vendor who receives an order or orders resulting from this invitation agrees to submit a Material Safety Data Sheet (MSDS) for each toxic or hazardous substance or mixture containing such substance, pursuant to M.G.L. c. 111F, §§8,9 and 10 and the regulations contained in 441 CMR 21.06 when deliveries are made. The vendor agrees to deliver all containers properly labeled pursuant to M.G.L. c. 111F §7 and regulations contained in 441 CMR 21.05. Failure to furnish MSDS and/or labels on each container may result in civil or criminal penalties, including bid debarment and action to prevent the vendor from selling said substances, or mixtures containing said substances within the Commonwealth. All vendors furnishing substances or mixtures subject to Chapter 111F or M.G.L. are cautioned to obtain and read the laws, rules and regulations referenced above. Copies may be obtained from the State House Bookstore, Secretary of State, State House, Room 117, Boston, MA (617) 727-2834.

Authorized Signature Indicating Compliance with the Right-to-know laws:

Signature

Date

Print Name

NOTE

Failure to submit any of the required documents, in this or in other sections, with your bid response package may cause the disqualification of your proposal.

DEBARMENT CERTIFICATION

In connection with this bid and all procurement transactions, by signature thereon, the respondent certifies that neither the company nor its principals are suspended, debarred, proposed for debarment, declared ineligible, or voluntarily excluded from the award of contracts, procurement or non procurement programs from the Commonwealth of Massachusetts, the US Federal Government and /or the City of Waltham. "Principals" means officers, directors, owners, partners and persons having primary interest, management or supervisory responsibilities with the business entity. Vendors shall provide immediate written notification to the Purchasing Agent of the City of Waltham at any time during the period of the contract of prior to the contract award if the vendor learns of any changed condition with regards to the debarment of the company or its officers. This certification is a material representation of fact upon which reliance will be placed when making the business award. If at any time it is determined that the vendor knowingly misrepresented this certification, in addition to other legal remedies available to the city of Waltham, the contract will be cancelled and the award revoked.

Company Name _____

Address _____

City _____, State _____, Zip Code _____

Phone Number (____) _____

E-Mail Address _____

Signed by Authorized Company Representative:

Print name _____,

Date _____

10 HOURS OSHA TRAINING CONFIRMATION

Chapter 306 of the Acts of 2004

CONSTRUCTION PROJECTS

AN ACT RELATIVE TO THE HEALTH AND SAFETY ON PUBLIC

The undersigned hereby certifies that all employees to be employed at a worksite for construction, reconstruction, alteration, remodeling, repair, installation, demolition, maintenance or repair of any public work or any public building estimated to cost more than \$10,000.00 have successfully completed a course in construction safety and health approved by the **United States Occupational Safety and Health Administration** that is at least **10 hours** in duration at the time the employee begins work and who shall furnish documentation of successful completion of said course with the first payroll report for each employee and will comply with all laws and regulations applicable to awards of subcontracts subject to section 44F.

Company Name: _____

Address: _____

Signature: _____

Title: _____

Print Name _____

Date

See Chapter 306 of the Acts of 2004

NOTE

Failure to submit any of the required documents, in this or in other sections, with your bid response package will be cause for the disqualification of your company.

000600 – FORM FOR GENERAL BID

A. The undersigned proposes to furnish all labor and materials required for **HVAC Replacement at Waltham Public Library**, in accordance with the accompanying plans and specifications prepared by **CGKV Architects, Inc.** for the contract price specified below, subject to additions and deductions according to the terms of the specifications.

B. This bid includes addenda numbered : _____

C. The proposed contract price is:

_____ dollars [in words]
(\$ _____) [in figures]

For Alternate No. 1:	Add	\$ _____	Subtract	\$ _____
For Alternate No. 2:	Add	\$ _____	Subtract	\$ _____
For Alternate No. 3:	Add	\$ _____	Subtract	\$ _____
For Alternate No. 4:	Add	\$ _____	Subtract	\$ _____

D. The subdivision of the proposed contract price is as follows:

Item 1. The work of the General Contractor, being all work other than that covered by Item 2.

\$ _____

Item 2. Sub-Bids as follows:

Section	Sub-Trade	Name of Sub-Bidder	Amount	Bonds Required - Yes or No
070001	Roofing and Flashing			

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
WALTHAM, MA

Total Item 2: \$ _____

The undersigned agrees that each of the above named sub-bidders will be used for the the work indicated at the amount stated, unless a substitution is made. The undersigned further agrees to pay the premiums for the performance and payment bonds furnished by sub-bidders as requested herein and that the cost of all such premiums is included in the amount set forth in Item 1 of this bid.

The undersigned agrees that if he/she is selected as General Contractor, he/she will promptly confer with the Awarding Authority on the question of sub-bidders; and that the Awarding Authority may substitute any sub-bid listed above a sub-bid filed with the Awarding Authority by another sub-bidder for the sub-trade against whose standing and ability the undersigned makes no objection; and that the undersigned will use all such finally selected sub-bidders at the amounts named in their respective sub-bids and be in every way as responsible for them and their work as if they had been originally named in this general bid, the total contract price being adjusted to conform thereto.

- E. The undersigned agrees that, if he/she is selected as General Contractor, he/she will within five days, Saturdays, Sundays, and legal holidays excluded, after presentation thereof by the Awarding Authority, execute a contract in accordance with the terms of this bid and furnish a performance bond and also a labor and materials or payment bond, each of a surety company qualified to do business under the laws of the Commonwealth and satisfactory to the Awarding Authority and each in the sum of the contract price, the premiums for which are to be paid by the General Contractor and are included in the contract price; provided, however, that if there is more than one surety company, the surety companies shall be jointly and severally liable.

The undersigned hereby certifies that he/she is able to furnish labor that can work in harmony with all other elements of labor employed or to be employed on the work; that all employees to be employed at the worksite will have successfully completed a course in construction safety and health approved by the United States Occupational Safety and Health Administration that is at least 10 hours in duration at the time the employee begins work and who shall furnish documentation of successful completion of said course with the first certified payroll report for each employee; and that he/she will comply fully with all laws and regulations applicable to awards made subject to section forty-four A.

The undersigned further certifies under the penalties of perjury that this bid is in all respects bona fide, fair, and made without collusion or fraud with any other person. As used in this subsection the work "person" shall mean any natural person, joint venture, partnership, corporation, or other business or legal entity. The undersigned further certifies under penalty of perjury that the said undersigned is not presently debarred from doing public construction work in the Commonwealth under the provisions of section twenty-nine F of chapter twenty-nine, or any other applicable debarment provisions of any other chapter of the General Laws or any rule or regulation promulgated thereunder.

Date: _____

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
WALTHAM, MA

Name of General Bidder: _____

By (Signature): _____

Title: _____

Business Address: _____

City / State / Zip: _____

Provide four (4) references for similar work completed within the past five (5) years:

Project Name & Location	Reference Contact**	Company Name	Telephone

** = Designer, Owner, or General Contractor

End of Form for General Bid

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
WALTHAM, MA

000601 - FORM FOR SUB-BID

To all General Bidders except those excluded:

- A. The undersigned proposes to furnish all labor and materials required for completing, in accordance with the hereinafter described plans, specifications and addenda, all the work specified in **Section No.** _____ of the specifications and in any plans specified in such section, prepared by **CGKV Architects, Inc.**, for **HVAC Replacement at Waltham Public Library, Waltham, MA** for the contract sum of

_____ dollars [in words]

(\$ _____ [in figures])

For Alternate No. 1: Add \$ _____ Subtract \$ _____

For Alternate No. 2: Add \$ _____ Subtract \$ _____

For Alternate No. 3: Add \$ _____ Subtract \$ _____

For Alternate No. 4: Add \$ _____ Subtract \$ _____

- B. This sub-bid includes addenda numbered : _____

- C. This sub-bid

[] may be used by any general bidder except:

[] may only be used by the following general bidders:

[To exclude general bidders, insert "X" in one box only and fill in blank following that box. Do not answer C if no general bidders are excluded.]

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
WALTHAM, MA

- D. The undersigned agrees that, if he/she is selected as a sub-bidder, he/she will, within five days, Saturdays, Sundays and legal holidays excluded, after presentation of a subcontract by the general bidder selected as the General Contractor, execute with such general bidder a subcontract in accordance with the terms of this sub-bid, and contingent upon the execution of the General Contract, and, if requested so to do in the general bid by such general bidder, who shall pay the premiums therefor, furnish a performance and payment bond of a surety company qualified to do business under the laws of the Commonwealth and satisfactory to the Awarding Authority, in the full sum of the subcontract price.
- E. The names of all persons, firms, and corporations furnishing to the undersigned labor or labor and materials for the class or classes or part thereof of work for which the provisions of the section of the specifications for this sub-trade require a listing in this paragraph, including the undersigned if customarily furnished by persons on his/her own payroll and in the absence of a contrary provision in the specifications, the name of each such class of work or part thereto and the bid price for such class of work or part thereof are:

Name:	Class of Work:	Bid Price:
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

[Do not give bid price for any class or part thereof furnished by undersigned.]

- F. The undersigned agrees that the above list of bids to the undersigned represents bona fide bids based on the hereinbefore described plans, specifications, and addenda and that, if the undersigned is awarded the contract, they will be used for the work indicated at the amounts stated, if satisfactory to the Awarding Authority.
- G. The undersigned further agrees to be bound to the General Contractor by the terms of the hereinbefore described plans, specifications, including all general conditions stated therein, and addenda, and to assume toward him/her all the obligations and responsibilities that he/she, by those documents, assumes toward the Owner.
- H. The undersigned offers the following information as evidence of his/her qualifications to perform the work as bid upon according to all the requirements of the plans and specifications:
1. Have been in business under present business name _____ years.
 2. Ever failed to complete any work awarded? [Yes or NO]: _____

HVAC REPLACEMENT AT
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3. List one or more recent buildings with names of the General Contractor and Architect on which you served as a subcontractor for work of similar character as required for the above-named building.

Building:	Architect:	General Contractor:	Amount of Contract:
(a) _____	_____	_____	_____
(b) _____	_____	_____	_____
(c) _____	_____	_____	_____

4. Bank Reference: _____

- I. The undersigned hereby certifies that he/she is able to furnish labor that can work in harmony with all other elements of labor employed or to be employed on the work; that all employees to be employed at the worksite will have successfully completed a course in construction safety and health approved by the United States Occupational Safety and Health Administration that is at least 10 hours in duration at the time the employee begins work and who shall furnish documentation of successful completion of said course with the first certified payroll report for each employee; and that he/she will comply fully with all laws and regulations applicable to awards of subcontracts subject to section forty-four F.

The undersigned further certifies under penalties of perjury that this sub-bid is in all respects bona fide, fair, and made without collusion or fraud with any other person. As used in this subsection the word "person" shall mean any natural person, joint venture, partnership, corporation, or other business or legal entity. The undersigned further certifies under penalty of perjury that the said undersigned is not presently debarred from doing public construction work in the Commonwealth under the provisions of section twenty-nine F of chapter twenty-nine, or any other applicable debarment provisions of any other chapter of the General Laws or any rule or regulation promulgated thereunder.

Date: _____

Name of Sub-Bidder: _____

By (Signature): _____

Title: _____

Business Address: _____

City / State / Zip: _____

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Provide four (4) references for similar work completed within the past five (5) years:

Project Name & Location	Reference Contact**	Company Name	Telephone

** = Designer, Owner, or General Contractor

End of Form for Sub-Bid

SECTION 00 70 00

PREVAILING WAGE SCHEDULE

Please visit the City Web Site at <https://www.city.waltham.ma.us/category/tags/purchasing-bids-open-0> for a copy of the schedules

**PRIME/GENERAL UPDATE STATEMENTS ARE NOT PUBLIC RECORDS AND
ARE NOT OPEN TO PUBLIC INSPECTION (M.G.L. C.149, §44D)**

TO ALL BIDDERS AND AWARDING AUTHORITIES

A COMPLETED AND SIGNED PRIME/GENERAL CONTRACTOR UPDATE STATEMENT MUST BE SUBMITTED WITH EVERY PRIME/GENERAL BID FOR A CONTRACT PURSUANT TO M.G.L. c.149, §44A AND M.G.L. c. 149A. ANY PRIME/GENERAL BID SUBMITTED WITHOUT AN APPROPRIATE UPDATE STATEMENT IS INVALID AND MUST BE REJECTED.

Caution: This form is to be used for submitting Prime/General Contract bids. It is not to be used for submitting Filed Sub-Bids or Trade Sub-Bids.

AWARDING AUTHORITIES

If the Awarding Authority determines that the bidder does not demonstrably possess the skill, ability and integrity necessary to perform the work on the project, it must reject the bid.

BIDDER'S AFFIDAVIT

I swear under the pains and penalties of perjury that I am duly authorized by the bidder named below to sign and submit this Prime/General Contractor Update Statement on behalf of the bidder named below, that I have read this Prime/General Contractor Update Statement, and that all of the information provided by the bidder in this Prime/General Contractor Update Statement is true, accurate, and complete as of the bid date.

Bid Date	Print Name of Prime/General Contractor
----------	----------------------------------------

Project Number (or name if no number)	Business Address
------------------------------------------	------------------

Awarding Authority	Telephone Number
--------------------	------------------

SIGNATURE ⇨

Bidder's Authorized Representative

INSTRUCTIONS

INSTRUCTIONS TO BIDDERS

- This form must be completed and submitted by all Prime/General contractors bidding on projects pursuant to M.G.L. c. 149, §44A and M.G.L. c. 149A.
- You must give complete and accurate answers to all questions and provide all of the information requested. MAKING A MATERIALLY FALSE STATEMENT IN THIS UPDATE STATEMENT IS GROUNDS FOR REJECTING YOUR BID AND FOR DEBARRING YOU FROM ALL PUBLIC CONTRACTING.
- **This Update Statement must include all requested information that was not previously reported on the Application used for your firm's most recently issued (not extended or amended) Prime/General Contractor Certificate of Eligibility. The Update Statement must cover the entire period since the date of your Application, NOT since the date of your Certification.**
- You must use this official form of Update Statement. Copies of this form may be obtained from the awarding authority and from the Asset Management Web Site: www.mass.gov/dcam .
- If additional space is needed, please copy the appropriate page of this Update Statement and attach it as an additional sheet.
- See the section entitled "Bidding Limits" in the *Instructions to Awarding Authorities* for important information concerning your bidding limits.

INSTRUCTIONS TO AWARDING AUTHORITIES

Determination of Bidder Qualifications

- It is the awarding authority's responsibility to determine who is the lowest eligible and responsible bidder. You must consider all of the information in the low bidder's Update Statement in making this determination. Remember: this information was not available to the Division of Capital Asset Management and Maintenance at the time of certification.
- The bidder's performance on the projects listed in Parts 1 and 2 must be part of your review. Contact the project references.
- AWARDING AUTHORITIES ARE STRONGLY ENCOURAGED TO REVIEW THE LOW BIDDER'S

ENTIRE CERTIFICATION FILE AT THE DIVISION OF CAPITAL ASSET MANAGEMENT AND MAINTENANCE. Telephone (617) 727-9320 for an appointment.

Bidding Limits

Single Project Limit: The total amount of the bid, including all alternates, may not exceed the bidder's Single Project Limit.

Aggregate Work Limit: The annual value of the work to be performed on the contract for which the bid is submitted, when added to the annual cost to complete the bidder's other currently held contracts, may not exceed the bidder's Aggregate Work Limit. Use the following procedure to determine whether the low bidder is within its Aggregate Work Limit:

Step 1 Review Update Statement Question #2 to make sure that all requested information is provided and that the bidder has accurately calculated and totaled the annualized value of all incomplete work on its currently held contracts (column 9).

Step 2 Determine the annual dollar value of the work to be performed on your project. This is done as follows:

(i) If the project is to be completed in less than 12 months, the annual dollar value of the work is equal to the full amount of the bid.

(ii) If the project will take more than 12 months to complete, calculate the number of years given to complete the project by dividing the total number of months in the project schedule by 12 (calculate to 3 decimal places), then divide the amount of the bid by the calculated number of years to find the annual dollar value of the work.

Step 3 Add the annualized value of all of the bidder's incomplete contract work (the

total of column 9 on page 5) to the annual dollar value of the work to be performed on your project. **The total may not exceed the bidder's Aggregate Work Limit.**

Correction of Errors and Omissions in Update Statements

Matters of Form: An awarding authority shall not reject a contractor's bid because there are mistakes or omissions of form in the Update Statement submitted with the bid, provided the contractor promptly

corrects those mistakes or omissions upon request of the awarding authority. [810 CMR 8.05(1)].

Correction of Other Defects: An awarding authority may, in its discretion, give a contractor notice of defects, other than mistakes or omissions of form, in the contractor's Update Statement, and an opportunity to correct such defects, provided the correction of such defects is not prejudicial to fair competition. An awarding authority may reject a corrected Update Statement if it contains unfavorable information about the contractor that was omitted from the Update Statement filed with the contractor's bid. [810 CMR 8.05(2)].

PART 1 - COMPLETED PROJECTS

LIST ALL PUBLIC AND PRIVATE *BUILDING* PROJECTS YOUR FIRM HAS COMPLETED SINCE THE DATE OF APPLICATION FOR YOUR MOST RECENTLY ISSUED (NOT EXTENDED OR AMENDED) DCAM CERTIFICATE OF ELIGIBILITY. YOU MUST REPORT ALL REQUESTED INFORMATION NOT PREVIOUSLY REPORTED ON THAT DCAM APPLICATION*.

PROJECT TITLE & LOCATION	WORK CATEGORY	CONTRACT PRICE	START DATE	DATE COMPLETED

Attach additional sheets if necessary

* If your firm has been terminated from a project prior to completion of the work or has failed or refused to complete its work under any contract, full details and an explanation must be provided. See Part 3 of this Update Statement.

PROVIDE THE FOLLOWING REFERENCE INFORMATION FOR EACH COMPLETED PROJECT LISTED ON THE PREVIOUS PAGE.

PROJECT TITLE	COMPANY NAME	CONTACT PERSON	TELEPHONE
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone

Is your company or any individual who owns, manages or controls your company affiliated with any owner, designer or general contractor named above, either through a business or family relationship? YES NO

Are any of the contact persons named above affiliated with your company or any individual who owns, manages or control your company, either through a business or family relationship? YES NO

If you have answered YES to either question, explain. _____

PART 2 - CURRENTLY HELD CONTRACTS

LIST ALL PUBLIC AND PRIVATE BUILDING AND NON-BUILDING *CONSTRUCTION* PROJECTS YOUR FIRM HAS UNDER CONTRACT ON THIS DATE REGARDLESS OF WHEN OR WHETHER THE WORK COMMENCED.

1	2	3	4	5	6	7	8	9
PROJECT TITLE & LOCATION	WORK CATEGORY	START AND END DATES	ON SCHEDULE (yes / no)	CONTRACT PRICE	% NOT COMPLETE	\$ VALUE OF WORK NOT COMPLETE (col. 5 X col. 6)	NO. OF YEARS REMAINING (see note below)	ANNUALIZED VALUE OF INCOMPLETE WORK (col. 7 ÷ col. 8) (divided by)

ANNUALIZED VALUE OF ALL INCOMPLETE CONTRACT WORK (Total of Column 9)

\$ _____

Column 8 • If less than one year is left in the project schedule, write 1.

- If more than 12 months are left in the project schedule, divide the number of months left in the project schedule by 12 (calculate to three decimal places).

PROVIDE THE FOLLOWING REFERENCE INFORMATION FOR EACH INCOMPLETE PROJECT LISTED ON THE PREVIOUS PAGE.

PROJECT TITLE	COMPANY NAME	CONTACT PERSON	TELEPHONE
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone
	OWNER: Owner	Contact Person	Telephone
	DESIGNER: Designer	Contact Person	Telephone
	GC: GC	Contact Person	Telephone

Is your company or any individual who owns, manages or controls your company affiliated with any owner, designer or general contractor named above either through a business or family relationship? YES NO

Are any of the contact persons named above affiliated with your company or any individual who owns, manages or control your company, either through a business or family relationship? YES NO

If you have answered YES to either question, explain. _____

PART 3 - PROJECT PERFORMANCE

For Parts 3 and 4, if you answer YES to any question, please provide on a separate page a complete explanation. Information you provide herein must supplement the Application for your most recently issued (not extended or amended) DCAM Certificate of Eligibility. You must report all requested information not previously reported on that DCAM Application for Prime/General Certificate of Eligibility. Include all details [project name(s) and location(s), names of all parties involved, relevant dates, etc.].

	YES	NO
1. Has your firm been terminated on any contract prior to completing a project or has any officer, partner or principal of your firm been an officer, partner or principal of another firm that was terminated or failed to complete a project?		
2. Has your firm failed or refused either to perform or complete any of its work under any contract prior to substantial completion?		
3. Has your firm failed or refused to complete any punch list work under any contract?		
4. Has your firm filed for bankruptcy, or has any officer, principal or individual with a financial interest in your current firm been an officer, principal or individual with a financial interest in another firm that filed for bankruptcy?		
5. Has your surety taken over or been asked to complete any of your work under any contract?		
6. Has a payment or performance bond been invoked against your current firm, or has any officer, principal or individual with a financial interest in your current firm been an officer, principal or individual with a financial interest in another firm that had a payment or performance bond invoked?		
7. Has your surety made payment to a materials supplier or other party under your payment bond on any contract?		
8. Has any subcontractor filed a demand for direct payment with an awarding authority for a public project on any of your contracts?		
9. Have any of your subcontractors or suppliers filed litigation to enforce a mechanic's lien against property in connection with work performed or materials supplied under any of your contracts?		
10. Have there been any deaths of an employee or others occurring in connection with any of your projects?		
11. Has any employee or other person suffered an injury in connection with any of your projects resulting in their inability to return to work for a period in excess of one year?		

PART 4 - Legal or Administrative Proceedings; Compliance with Laws

Please answer the following questions. Information must supplement all judicial and administrative proceedings involving bidder’s firm, which were instituted or concluded (adversely or otherwise) since your firm’s Application for your most recently issued (not extended or amended) Certificate of Eligibility. You must report all requested information not previously reported on that DCAM Application for Prime/General Certificate of Eligibility.

The term “administrative proceeding” as used in this Prime/General Contractor Update Statement includes (i) any action taken or proceeding brought by a governmental agency, department or officer to enforce any law, regulation, code, legal, or contractual requirement, except for those brought in state or federal courts, or (ii) any action taken by a governmental agency, department or officer imposing penalties, fines or other sanctions for failure to comply with any such legal or contractual requirement.

The term “anyone with a financial interest in your firm” as used in this Section “I”, shall mean any person and/or entity with a 5% or greater ownership interest in the applicant’s firm.

If you answer YES to any question, on a separate page provide a complete explanation of each proceeding or action and any judgment, decision, fine or other sanction or result. Include all details (name of court or administrative agency, title of case or proceeding, case number, date action was commenced, date judgment or decision was entered, fines or penalties imposed, etc.).

	YES	NO
1. Have any civil, judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to the procurement or performance of any construction contract, including but not limited to actions to obtain payment brought by subcontractors, suppliers or others?		
2. Have any criminal proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to the procurement or performance of any construction contract including, but not limited to, any of the following offenses: fraud, graft, embezzlement, forgery, bribery, falsification or destruction of records, or receipt of stolen property?		
3. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a violation of any state’s or federal procurement laws arising out of the submission of bids or proposals?		
4. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a violation of M.G.L. Chapter 268A, the State Ethics Law?		

PART 4 - Legal or Administrative Proceedings; Compliance with Laws (continued)

	YES	NO
5. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a violation of any state or federal law regulating hours of labor, unemployment compensation, minimum wages, prevailing wages, overtime pay, equal pay, child labor or worker's compensation?		
6. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a violation of any state or federal law prohibiting discrimination in employment?		
7. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a claim of repeated or aggravated violation of any state or federal law regulating labor relations?		
8. Have any proceedings by a municipal, state, or federal agency been brought, concluded, or settled relating to decertification, debarment, or suspension of your firm or any principal or officer or anyone with a financial interest in your firm from public contracting?		
9. Have any judicial or administrative proceedings involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled relating to a violation of state or federal law regulating the environment?		
10. Has your firm been fined by OSHA or any other state or federal agency for violations of any laws or regulations related to occupational health or safety? Note: this information may be obtained from OSHA's Web Site at www.osha.gov		
11. Has your firm been sanctioned for failure to achieve DBE/MBE/WBE goals, workforce goals, or failure to file certified payrolls on any public projects?		
12. Other than previously reported in the above paragraphs of this Section I, have any administrative proceedings or investigations involving your firm or a principal or officer or anyone with a financial interest in your firm been brought, concluded, or settled by any local, state or federal agency relating to the procurement or performance of any construction contract?		
13. Are there any other issues that you are aware which may affect your firm's responsibility and integrity as a building contractor?		

PART 5 - SUPERVISORY PERSONNEL

List all supervisory personnel, such as project managers and superintendents, who will be assigned to the project if your firm is awarded the contract. **Attach the resume of each person listed below.**

NAME	TITLE OR FUNCTION

PART 6 - CHANGES IN BUSINESS ORGANIZATION OR FINANCIAL CONDITION

Have there been any changes in your firm’s business organization, financial condition or bonding capacity since the date your current Certificate of Eligibility was issued? Yes No

If YES, attach a separate page providing complete details.

PART 7 – LIST OF COMPLETED CONSTRUCTION PROJECTS SUBMITTED TO THE DIVISION OF CAPITAL ASSET MANAGEMENT AND MAINTENANCE.

Attach here a copy of the list of completed construction projects which was submitted with your firm’s DCAM Application for your most recently issued (not extended or amended) DCAM Certificate of Eligibility. The Attachment must include a complete copy of the entire Section G – “Completed Projects” and the final page – “Certification” (Section J) containing the signature and date that the Completed Projects list (Section G) was submitted to the Division of Capital Asset Management and Maintenance.



**SUB-BIDDERS' UPDATE STATEMENTS ARE NOT PUBLIC RECORDS AND
ARE NOT OPEN TO PUBLIC INSPECTION (M.G.L. C.149, §44D)**

Sub-Bidder Update Statement

TO ALL SUB-BIDDERS, TRADE CONTRACTORS AND AWARDING AUTHORITIES

A COMPLETED AND SIGNED SUB-BIDDER UPDATE STATEMENT MUST BE SUBMITTED WITH EVERY FILED SUB-BID PURSUANT TO M.G.L. c.149, §44F AND EVERY TRADE SUB-BID PURSUANT TO M.G.L. c. 149A. ANY FILED SUB-BID OR TRADE SUB-BID SUBMITTED WITHOUT AN APPROPRIATE SUB-BIDDER UPDATE STATEMENT IS INVALID AND MUST BE REJECTED.

Caution: This form is to be used for submitting Filed Sub-Bids and Trade Sub-Bids Only

AWARDING AUTHORITIES

If the Awarding Authority determines that the Sub-Bidder is not competent to perform the work as specified on the project, it should reject the bid.

SUB-BIDDER'S AFFIDAVIT

I swear under the pains and penalties of perjury that I am duly authorized by the bidder named below to sign and submit this Sub-Bidder Update Statement on behalf of the bidder named below, that I have read this Sub-Bidder Update Statement, and that all of the information provided by the bidder in this Sub-Bidder Update Statement is true, accurate, and complete as of the bid date.

Bid Date

Print Name of Sub-Bidder or Trade Contractor

Project Number
(or name if no number)

Business Address

Awarding Authority

Telephone Number

SIGNATURE ⇨

Bidder's Authorized Representative

INSTRUCTIONS

INSTRUCTIONS TO SUB-BIDDERS

- This form must be completed and submitted by all Filed Sub-Bidders bidding on projects and Trade Contractors bidding on projects.
- You must give complete and accurate answers to all questions and provide all of the information requested. **MAKING A MATERIALLY FALSE STATEMENT IN THIS SUB-BIDDER UPDATE STATEMENT IS GROUNDS FOR REJECTING YOUR BID AND FOR DEBARRING YOU FROM ALL PUBLIC CONTRACTING.**
- This Sub-Bidder Update Statement must include all requested information that was not previously reported on the application used for your company's most recently issued (not extended or amended) Sub-Bidder Certificate of Eligibility. **The Sub-Bidder Update Statement must cover the entire period since the date of that application, NOT since the date of your Certification.**
- You must use this official form of Sub-Bidder Update Statement. Copies of this form may be obtained from the awarding authority or from the DCAMM Web Site:
www.mass.gov/DCAMM/certification.
- If additional space is needed, please copy the appropriate page of this Sub-Bidder Update Statement and attach it as an additional sheet.
- It is acceptable to attach your projects in progress and completed projects spreadsheet for Part 7.

Division of Capital Asset Management and Maintenance
Sub-Bidder Update Statement

INSTRUCTIONS TO AWARDING AUTHORITIES

Determination of Sub-Bidder Qualifications

Division of Capital Asset Management and Maintenance
Sub-Bidder Update Statement

- It is the awarding authority's responsibility to determine each responsible bidder. You must consider all of the information in the bidder's Sub-Bidder Update Statement in making this determination. **Remember: this information was not available to the Division of Capital Asset Management and Maintenance at the time of certification.**
- The Sub-Bidder's performance on the projects listed in Parts 1 and 2 must be part of your review.
- Contact the project references.
- AWARDING AUTHORITIES ARE STRONGLY ENCOURAGED TO REVIEW THE LOW BIDDERS CERTIFICATION FILE. WITH THE IMPLEMENTATION OF ELECTRONIC DOCUMENT MANAGEMENT FILE REVIEWS CAN BE PROVIDED ELECTRONICALLY. To discuss your request/options contact DCAMM's Contractor Certification (857) 204-1305.

Correction of Errors and Omissions in Sub-Bidder Update Statements

Matters of Form: An awarding authority shall not reject a Sub-Bidder's bid because there are mistakes or omissions of form in the Sub-Bidder Update Statement submitted with the bid provided the Sub-Bidder promptly corrects those mistakes or omissions upon request of the awarding authority.

Correction of Other Defects: An awarding authority may, in its discretion, give a Sub-Bidder notice of minor defects and omissions as to form in the Sub-Bidder's Update Statement and provide an opportunity to correct its Sub-Bidder Update Statement. However, the Sub-Bidder shall not be allowed to make corrections to a Sub-Bidder Update Statement if material information about the Sub-Bidder was omitted from the Sub-Bidder Update Statement filed with the Sub-Bidder's bid. The Awarding Authority shall advise DCAMM of any material omissions in a Sub-Bidder's Update Statement.

PART 1 - COMPLETED PROJECTS

List All Public And Private Projects Of \$20,000 or more your company has completed since the date of application for your most recently issued (not extended or amended) Sub-Bidder Certificate Of Eligibility*.

PROJECT TITLE & LOCATION	WORK CATEGORY	CONTRACT PRICE	START DATE	DATE COMPLETED

Attach additional sheets if necessary

* If your company has been terminated from a project prior to completion of the work or has failed or refused to complete its work under any contract, full details and an explanation must be provided. See Part 3 of this Sub-Bidder Update Statement.

PROVIDE THE FOLLOWING REFERENCE INFORMATION FOR EACH COMPLETED PROJECT LISTED ON THE PREVIOUS PAGE.

PROJECT TITLE		COMPANY NAME	CONTACT PERSON	TELEPHONE	EMAIL ADDRESS
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				

Is your company or any individual who owns, manages or controls your company affiliated with any owner, designer or general contractor named above, either through a business or family relationship? YES NO

Are any of the contact persons named above affiliated with your company or any individual who owns, manages or control your company, either through a business or family relationship? YES NO

If you have answered YES to either question, explain. _____

PART 2 – PROJECTS IN PROGRESS CONTRACTS

List all public and private projects of \$20,000 or more your company has under contract on this date regardless of when or whether the work commenced.

1	2	3	4	5	6	7
PROJECT TITLE & LOCATION	WORK CATEGORY	START AND END DATES (MM/YYYY)	ON SCHEDULE (yes / no)	CONTRACT PRICE	% NOT COMPLETE	\$ VALUE OF WORK NOT COMPLETE (col. 5 X col. 6)

PROVIDE THE FOLLOWING REFERENCE INFORMATION FOR EACH INCOMPLETE PROJECT LISTED ON THE PREVIOUS PAGE.

PROJECT TITLE		COMPANY NAME	CONTACT PERSON	TELEPHONE	EMAIL ADDRESS
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				
	OWNER:				
	DESIGNER				
	GC:				

Is your company or any individual who owns, manages or controls your company affiliated with any owner, designer or general contractor named above either through a business or family relationship? YES NO

Are any of the contact persons named above affiliated with your company or any individual who owns, manages or control your company, either through a business or family relationship? YES NO

If you have answered YES to either question, explain. _____

PART 3 - GENERAL PERFORMANCE (in the prime update it's called Project Performance – can we change it?)

For Parts 3 and 4, if you answer YES to any question, please provide on a separate page a complete explanation. Information you provide herein must supplement the application for your most recently issued (not extended or amended) DCAMM Sub-Bidder Certificate of Eligibility. You must report all requested information not previously reported on that application. Include all details [project name(s) and location(s), names of all parties involved, relevant dates, etc.].

	YES	NO
1. Has your company been terminated on any contract prior to completing a project or has any officer, partner or principal of your company been an officer, partner or principal of another company that was terminated or failed to complete a project?		
2. Has your company failed or refused either to perform or complete any of its work under any contract prior to substantial completion?		
3. Has your company failed or refused to complete any punch list work under any contract?		
4. Has your company filed for bankruptcy, or has any officer, principal or individual with a financial interest in your current company been an officer, principal or individual with a financial interest in another company that filed for bankruptcy?		
5. Has your surety taken over or been asked to complete any of your work under any contract?		
6. Has a payment or performance bond been invoked against your current company, or has any officer, principal or individual with a financial interest in your current company been an officer, principal or individual with a financial interest in another company that had a payment or performance bond invoked?		
7. Has your surety made payment to a materials supplier or other party under your payment bond on any contract?		
8. Has any subcontractor filed a demand for direct payment with an awarding authority for a public project on any of your contracts?		
9. Have any of your subcontractors or suppliers filed litigation to enforce a mechanic's lien against property in connection with work performed or materials supplied under any of your contracts?		
10. Have there been any deaths of an employee or others occurring in connection with any of your projects?		
11. Has any employee or other person suffered an injury in connection with any of your projects resulting in their inability to return to work for a period in excess of one year?		

Division of Capital Asset Management and Maintenance
Sub-Bidder Update Statement

PART 4 - Legal or Administrative Proceedings; Compliance with Laws

Please answer the following questions. Information must supplement all judicial and administrative proceedings involving bidder’s company, which were instituted or concluded (adversely or otherwise) since your company’s Application for your most recently issued (not extended or amended) Sub-Bidder Certificate of Eligibility. You must report all requested information not previously reported on that DCAMM Application.

The term “administrative proceeding” as used in this Sub-Bidder Update Statement includes (i) any action taken or proceeding brought by a governmental agency, department or officer to enforce any law, regulation, code, legal, or contractual requirement, except for those brought in state or federal courts, or (ii) any action taken by a governmental agency, department or officer imposing penalties, fines or other sanctions for failure to comply with any such legal or contractual requirement.

The term “anyone with a financial interest in your company” as used in this Section “I”, shall mean any person and/or entity with a 5% or greater ownership interest in the applicant’s company.

If you answer YES to any question, on a separate page provide a complete explanation of each proceeding or action and any judgment, decision, fine or other sanction or result. Include all details (name of court or administrative agency, title of case or proceeding, case number, date action was commenced, date judgment or decision was entered, fines or penalties imposed, etc.).

	YES	NO
1. Have any civil, judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to the procurement or performance of any construction contract, including but not limited to actions to obtain payment brought by subcontractors, suppliers or others?		
2. Have any criminal proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to the procurement or performance of any construction contract including, but not limited to, any of the following offenses: fraud, graft, embezzlement, forgery, bribery, falsification or destruction of records, or receipt of stolen property?		
3. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a violation of any state’s or federal procurement laws arising out of the submission of bids or proposals?		
4. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a violation of M.G.L. Chapter 268A, the State Ethics Law?		

PART 4 - Legal or Administrative Proceedings; Compliance with Laws (continued)

	YES	NO
5. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a violation of any state or federal law regulating hours of labor, unemployment compensation, minimum wages, prevailing wages, overtime pay, equal pay, child labor or worker's compensation?		
6. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a violation of any state or federal law prohibiting discrimination in employment?		
7. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a claim of repeated or aggravated violation of any state or federal law regulating labor relations?		
8. Have any proceedings by a municipal, state, or federal agency been brought, concluded, or settled relating to decertification, debarment, or suspension of your company or any principal or officer or anyone with a financial interest in your company from public contracting?		
9. Have any judicial or administrative proceedings involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled relating to a violation of state or federal law regulating the environment?		
10. Has your company been fined by OSHA or any other state or federal agency for violations of any laws or regulations related to occupational health or safety? Note: this information may be obtained from OSHA's Web Site at www.osha.gov		
11. Has your company been sanctioned for failure to achieve DBE/MBE/WBE goals, workforce goals, or failure to file certified payrolls on any public projects?		
12. Other than previously reported in the above paragraphs of this Section I, have any administrative proceedings or investigations involving your company or a principal or officer or anyone with a financial interest in your company been brought, concluded, or settled by any local, state or federal agency relating to the procurement or performance of any construction contract?		
13. Are there any other issues that you are aware which may affect your company's responsibility and integrity as a building contractor?		

PART 5 - SUPERVISORY PERSONNEL

List all supervisory personnel who will be assigned to the project if your company is awarded the contract.

Attach the resume of each person listed below.

NAME	TITLE OR FUNCTION

PART 6 - CHANGES IN BUSINESS ORGANIZATION OR FINANCIAL CONDITION

Have there been any changes in your company’s business organization, financial condition or bonding capacity since the date your current Contractor Certificate of Eligibility was issued? Yes No

If YES, attach a separate page providing complete details.

PART 7 – LIST OF COMPLETED CONSTRUCTION PROJECTS SUBMITTED TO THE DIVISION OF CAPITAL ASSET MANAGEMENT AND MAINTENANCE ALONG WITH CERTIFICATION SIGNATURE PAGE.

Attach here a copy of the list of completed construction projects which was submitted with your company’s application for your most recently issued (not extended or amended) Sub-Bidder Certificate of Eligibility. The Attachment must include a complete copy of the entire Completed Projects spreadsheet and the final page Certification Page of the online application, containing the signature and date the completed projects list was submitted to the Division of Capital Asset Management and Maintenance.

SECTION 00 50 10

PERFORMANCE BOND

CITY OF WALTHAM

KNOW ALL MEN BY THESE PRESENT THAT,

_____ as

principal and _____ as surety, are held and firmly bound unto the CITY OF WALTHAM and to such persons, firms, and corporations, who may furnish materials for or perform labor on the work, construction or improvements contemplated in the Contract hereinafter mentioned, or who may have any suits or claims for injury or damage to persons or property resulting from or arising out of the work done under this Contract, in the

SUM OF _____ DOLLARS (\$ _____)

(lawful money of the United States of America) for the payment whereof the Contractor and the Surety of Sureties bind themselves and their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, THAT for the above burden (the Contractor) its

heirs, executors, administrators and assigns, shall faithfully perform the Contract, on his part and during the life of any guaranty or warranty, for defective materials and workmanship required under this Contract, and satisfy all claims and demands incurred for the same; and shall fully indemnify and save harmless the City from all cost and damage which it may suffer by reason of failure so to do, and shall fully reimburse and repay the City all outlay and expense which the City may incur in making good any such default, and shall promptly make payment to all persons supplying labor or materials for use in the prosecution of the work provided for in said Contract; and shall indemnify and save harmless the said City, its officers and agents from any and all suits or claims for injury or damage to persons or property resulting from or arising out of the work done under this Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

PROVIDED, HOWEVER, that (except as to the City) no suit, action or proceeding by reason of any default whatever shall be brought on this Bond after two years from the day on which the final payment under the Contract falls due.

AND PROVIDED, that any alterations which may be made in the terms of the Contract or in the work to be done under it, or any assignment, transfer or subletting of any part of the work, or the giving by the City of any extension of time for the performance of the Contract, or any other forbearance on the part of either the City or the Contractor to the other, shall not in any way release the Contractor and the Surety of Sureties, or either or any of them, their heirs, executors, administrators, successors or assigns from their liability hereunder, notice to the Surety or Sureties of any such alterations, assignment, transfer, subletting extension or forbearance being hereby waived.

This Bond is made for the use and benefit of all persons, firms, and corporations who may furnish materials, or perform any labor for or on account of said work, construction or improvements, or who may have any suits or claims for injury or damage to persons or property resulting from or arising out of the work done under this Contract, and they and each of them are hereby made obligees hereunder the same as if their own proper names were written herein as such, and they and each of them may sue hereon in their own names for their own use and benefit.

And the Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed hereunder, or the Specifications accompanying the same, shall in any way affect its obligations on this Bond, and it does hereby waive notice of any such changes, extension of time, alteration or addition to the terms of the Contract or to the work, or to the Specifications.

IN WITNESS WHEREOF, said Contractor and Surety have hereunto set their respective names this

_____ day of _____, 20_____.

WITNESSES:

(CONTRACTOR) (SEAL)

NAME _____ BY _____
(SIGNATURE AND TITLE)

ADDRESS _____
(SURETY) (SEAL)

NAME _____ BY _____
(SIGNATURE AND TITLE)

ADDRESS _____ BY _____
(ATTORNEY-IN-FACT)

POWER OF ATTORNEY

Attorneys-in-fact who sign bonds must file with each bond a certified copy of their power of attorney to sign said bonds.

SECTION 00 52 00

PAYMENT BOND

CITY OF WALTHAM

KNOW ALL MEN BY THESE PRESENT THAT,

_____ as

principal and _____ as
surety, are held and firmly bound unto the CITY OF WALTHAM and to such persons, firms, and
corporations, who may furnish materials for or perform labor on the work, construction or
improvements contemplated in the Contract hereinafter mentioned, or who may have any suits
or claims for injury or damage to persons or property resulting from or arising out of the work
done under this Contract, in the

SUM OF _____ DOLLARS (\$ _____)
(lawful money of the United States of America) for the payment whereof the Contractor and the
Surety of Sureties bind themselves and their heirs, executors, administrators, successors and
assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, THAT for the above burden (the Contractor) its

heirs, executors, administrators and assigns, shall faithfully perform the Contract, on his part and
during the life of any guaranty or warranty, for defective materials and workmanship required under
this Contract, and satisfy all claims and demands incurred for the same; and shall fully indemnify and
save harmless the City from all cost and damage which it may suffer by reason of failure so to do,
and shall fully reimburse and repay the City all outlay and expense which the City may incur in
making good any such default, and shall promptly make payment to all persons supplying labor or
materials for use in the prosecution of the work provided for in said Contract; and shall indemnify
and save harmless the said City, its officers and agents from any and all suits or claims for injury or
damage to persons or property resulting from or arising our of the work done under this Contract,
then this obligation shall be null and void; otherwise it shall remain in full force and effect.

PROVIDED, HOWEVER, that (except as to the City) no suit, action or proceeding by reason of any
default whatever shall be brought on this Bond after two years from the day on which the final
payment under the Contract falls due.

AND PROVIDED, that any alterations which may be made in the terms of the Contract or in the work to
be done under it, or any assignment, transfer or subletting of any part of the work, or the giving by the
City of any extension of time for the payment of the Contract, or any other forbearance on the part of
either the City or the Contractor to the other, shall not in any way release the Contractor and the
Surety of Sureties, or either or any of them, their heirs, executors, administrators, successors or
assigns from their liability hereunder, notice to the Surety or Sureties of any such alterations,
assignment, transfer, subletting extension or forbearance being hereby waived.

This Bond is made for the use and benefit of all persons, firms, and corporations who may furnish
materials, or perform any labor for or on account of said work, construction or improvements, or who

may have any suits or claims for injury or damage to persons or property resulting from or arising out of the work done under this Contract, and they and each of them are hereby made obligees hereunder the same as if their own proper names were written herein as such, and they and each of them may sue hereon in their own names for their own use and benefit.

And the Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed hereunder, or the Specifications accompanying the same, shall in any way affect its obligations on this Bond, and it does hereby waive notice of any such changes, extension of time, alteration or addition to the terms of the Contract or to the work, or to the Specifications.

IN WITNESS WHEREOF, said Contractor and Surety have hereunto set their respective names this

_____ day of _____, 20____.

WITNESSES:

(CONTRACTOR)

(SEAL)

NAME _____ BY _____
(SIGNATURE AND TITLE)

ADDRESS _____
(SURETY) (SEAL)

NAME _____ BY _____
(SIGNATURE AND TITLE)

ADDRESS _____ BY _____
(ATTORNEY-IN-FACT)

POWER OF ATTORNEY

Attorneys-in-fact who sign bonds must file with each bond a certified copy of their power of attorney to sign said bonds.

TECHNICAL SPECIFICATIONS

SECTION 011000

SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Instructions to Bidders and Division 01 General Requirements, are a part of this Section and shall be binding on the Contractor and all Subcontractors who perform this work.

1.2 SUMMARY

- A. This Section includes the following:

- 1. Project information.
- 2. Work covered by the Contract Documents.
- 3. Work under other contracts.
- 4. Use of premises.
- 5. Owner's occupancy requirements.
- 6. Work restrictions.
- 7. Specification formats and conventions.

- B. Related Sections include the following:

- 1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: HVAC Replacement at Waltham Public Library

- 1. Project Location: 735 Main Street, Waltham, MA 02451.

- B. Owner: County of Middlesex.

- C. Architect: The Contract Documents, dated 1/31/24 were prepared for the Project by CGKV Architects, Inc.; 204A Hampshire Street, Cambridge, MA 02139.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Project generally consists of HVAC replacement at the existing Waltham Public Library.

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
Waltham, MA

B. The Work includes, but is not limited to the following:

1. Selective demolition; mechanical; and electrical.

1.5 TYPE OF CONTRACT

A. The Project will be constructed under a single contract. The General Contractor must be DCAMM certified in the category of **HVAC**.

1.6 SCHEDULE

A. General: The Contractor shall prepare a detailed construction schedule, to be submitted to the Owner, Architect, and Owner's Representative for review and approval. The schedule must clearly demonstrate the proper sequencing of construction activities. The Owner reserves the right to request a specific sequencing of construction activities.

B. The Sequence of work is to be completed per the following schedule:

1. Notice to Proceed (NTP): TBD
2. Substantial Completion: 365 calendar days from NTP
3. Final Completion: 30 calendar days from Substantial Completion
4. Contract Closeout: 30 calendar days from Final Completion

C. If any of the Work remains incomplete after the times specified above for Substantial Completion (365 calendar days from Notice to Proceed) and Final Completion (30 calendar days from Substantial Completion), the Contractor shall pay to the Owner liquidated damages of \$500 per day.

1.7 WORK UNDER OTHER CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

1.8 USE OF PREMISES

A. General: Contractor shall have full use of premises for construction operations, including use of Project site, during construction period, subject to Owner's Occupancy Requirements and Work Restrictions described below. Contractor's use of premises may be limited by Owner's right to perform work or to retain other contractors on portions of Project.

B. Use of Site: Limit use of premises to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Confine and consolidate the parking of workmen's and construction vehicles, and the storage of construction materials to a designated staging area.

2. Entrances: Keep entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Building Security: Continuously maintain the security of the building and the Work.

1.9 OWNER'S OCCUPANCY REQUIREMENTS

- A. Owner Occupancy: Owner reserves the right to occupy all areas of building during the construction period, before Substantial Completion. Such occupancy shall not constitute acceptance of the total Work.
 1. Architect will prepare a Certificate of Substantial Completion for the Work or specific portions thereof.
 2. Maintain a Certificate of Occupancy from authorities having jurisdiction during construction period for full Owner occupancy.
 3. Before issuance of Certificate of Substantial Completion, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed.
 4. Upon occupancy following Substantial Completion, Owner will assume responsibility for maintenance and custodial service for occupied portions of building.
- B. The Contractor shall be responsible for maintaining all means of egress and other life safety conditions necessary during periods of occupancy by Owner.
- C. Public Occupancy: The building will be open to the public Mondays through Fridays, 8:30 a.m. to 4:30 p.m. The work of this contract must maintain public access to the greatest extent practicable.

1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours:
 1. Contractor will have access to the building 24 hours per day, seven days per week, with the exception of legal holidays, subject to the Owner's occupancy requirements and local noise ordinances.
 2. The building will be open to the public Mondays through Fridays, 8:30 a.m. to 4:30 p.m. The work of this contract must maintain public access to the greatest extent practicable.

3. Prior to the start of construction, the Owner and the Contractor will establish a mutually acceptable work / phasing plan and schedule. Some phases or scopes of work may not be compatible with the Owner's work restriction requirements and may need to be performed outside weekday hours of 8:30 a.m. to 4:30 p.m.
 4. The Owner will generally have on-site representation 24 hours per day, seven days per week. The Owner will pay for the costs associated with its own on-site representation.
 5. Hours for Utility Shutdowns: Coordinate with Owner and local authorities, one week notice required.
- C. The Contractor shall comply with, and pay all expenses related to, the work restrictions described herein.
- D. Nonsmoking Building and Site: Smoking is not permitted within the building or anywhere on the school site.

1.11 SPECIFICATION FORMATS AND CONVENTIONS

- A. The Specifications and Drawings included in the Project Manual are intended to describe and illustrate all material, labor, and equipment necessary to complete the **HVAC Replacement at Waltham Public Library**.
- B. Specification Format: The Specifications are organized into Divisions and Sections using the 48-division format and CSI/CSC's "MasterFormat" numbering system.
1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.
- C. 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. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. 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.

- D. In general, the Specifications will describe the quality of the work and the Drawings will describe the extent of the work. The Specifications and Drawings are cooperative and supplementary; however, each item of the work is not necessarily mentioned in both the Specifications and the Drawings. All work necessary to complete the project, so described, is to be included in this Contract.
 - 1. Comply with Division 01 Section "Product Requirements."
- E. In case of disagreement between the Specifications and Drawings, or within either document itself, the Architect shall interpret the Documents to require the better quality or greater quantity of work for the Owner that can reasonably be construed therefrom. Any work performed by the Contractor without consulting the Architect, when the same requires a decision, shall be performed at the Contractor's risk.

1.12 CODES, STANDARDS AND PERMITS

- A. All work under this contract shall conform to all codes and standards in effect as of the date of receipt of Bids which are applicable to this Project. All work shall also conform to specific requirements and interpretations of local authorities having jurisdiction over the Project. These Codes, standards, and authorities are referred to collectively as "the governing codes and authorities" and similar terms throughout the Specifications. Determination of applicable codes and standards and requirements of the authorities having jurisdiction shall be the responsibility of the Contractor; as shall be the analysis of all such codes and standards in regard to their applicability to the Project for the purposes of determining necessary construction to conform to such code requirements, for securing all approvals and permits necessary to proceed with construction, and to obtain all permits necessary for the Owner to occupy the facility for its intended use. In the case of conflicts between the requirements of different codes and standards, the most restrictive or stringent requirements shall be met.
- B. The codes that were used in the design of this Project are as include:
 - 1. Commonwealth of Massachusetts State Building Code, 780 CMR Ninth Edition, including all referenced standards.
 - 2. Massachusetts Fire Prevention Regulations, 527 CMR.
 - 3. Massachusetts Fuel Gas and Plumbing Code, 248 CMR.
 - 4. National Fire Protection Association (NFPA) codes and standards.
 - 5. Architectural Access Board regulations, 521 CMR, as amended (AAB).
- C. Code Enforcement and Approvals: Secure the general building permit for the work, and conform to all conditions and requirements of the permit and code enforcement authorities.
- D. The Contractor and each Subcontractor shall identify all permits (other than general building permit) required from authorities having jurisdiction over the Project for the construction and occupancy of the work. Prepare the necessary applications and submit required plans and documents to obtain such permits in a timely manner.
 - 1. Display all permit cards as required by the authorities, and deliver legible photocopies of all permits to the Owner promptly upon their receipt.
 - 2. Arrange for all inspections, testing and approvals required for all permits. Notify the Owner and Architect at least three business days in advance, so they may arrange to observe.
 - 3. Comply with all conditions and provide all notices required by all permits.

4. Perform and/or arrange for and pay for all testing and inspections required by the governing codes and authorities, other than those provided by the Owner, and notify the Owner and Architect of such inspections at least three business days in advance, so they may arrange to observe.
5. Where inspecting authorities require corrective work in conjunction with applicable codes and authorities, promptly comply with such requirements, except in cases where such requirements clearly exceed the requirements of the Contract Documents, in which case consult with the Architect before proceeding.

1.13 OCCUPATIONAL SAFETY AND HEALTH ACT

- A. The Contractor and each Subcontractor shall comply with the requirements of the Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, including all standards and regulations which have been promulgated by the Governmental Authorities which administer such Acts. Said requirements, standards and regulations are incorporated herein by reference.
 1. Each Contractor and Subcontractor shall comply with M.G.L. Chapter 149, Sections 44E and 44F, as amended by Chapter 306 of the Acts of 2004, which require that all employees on the Project site complete a course in construction safety and health approved by the U.S. Occupational Safety and Health Administration (OSHA), known as the "OSHA 10-hour course."
- B. The Contractor and each Subcontractor shall comply with said regulations, requirements and standards and require and be directly responsible for compliance therewith on the part of his agents, employees material men and Subcontractors; and shall directly receive and be responsible for all citations, assessments, fines or penalties which may be incurred by reason of his agents, employees, material men or Subcontractors failing to so comply.

1.14 LIST OF DRAWINGS

T-1 Title Sheet

Architectural:

AD-1 Roof Demo Plan
AD-2 Ground Floor Plan - Demo
AD-3 First Floor Plan - Demo
AD-4 Second Floor Plan - Demo
AD-5 Ground Floor Reflected Ceiling Plan - Demo
AD-6 First Floor Reflected Ceiling Plan - Demo
AD-7 Second Floor Reflected Ceiling Plan - Demo
A-1 Roof Plan - Proposed
A-2 Test Cuts / Details
A-3 Details

Mechanical:

M-0.0 Mechanical Legend Notes and Abbreviations
M-0.1 Mechanical Notes
MD-2.1 Mechanical Ground Floor Demo Plan
MD-2.2 Mechanical First Floor Demo Plan

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
Waltham, MA

MD-2.3	Mechanical Second Floor Demo Plan
MD-2.4	Mechanical Roof Demo Plan
M-2.1	Mechanical Ground Floor New Work Plan
M-2.2	Mechanical First Floor New Work Plan
M-2.3	Mechanical Second Floor New Work Plan
M-2.4	Mechanical Roof New Work Plan
M-6.0	Mechanical Controls
M-6.1	Mechanical Controls
M-6.2	Mechanical Controls
M-6.3	Mechanical Controls
M-7.0	Mechanical Details
M-7.1	Mechanical Details
M-8.0	Mechanical Schedules
M-8.1	Mechanical Schedules
M-8.2	Mechanical Schedules

Electrical:

E-0.0	Electrical Legend Notes and Abbreviations
ED-2.1	Electrical Power Ground Floor Demo Plan
ED-2.2	Electrical Power First Floor Demo Plan
ED-2.3	Electrical Power Second Floor Demo Plan
ED-2.4	Electrical Power Roof Demo Plan
E-2.1	Electrical Power Ground Floor New Work Plan
E-2.2	Electrical Power First Floor New Work Plan
E-2.3	Electrical Power Second Floor New Work Plan
E-2.4	Electrical Power Roof New Work Plan
E-8.0	Electrical Details
E-9.0	Electrical Schedules

Fire Alarm Drawings:

FA-0.0	Electrical Fire Alarm Legend Notes and Abbreviations
FA-2.3	Electrical Fire Alarm Second Floor New Work Plan

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 01 23 00

ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. BIDDING AND CONTRACT REQUIREMENTS, DIVISION 00, and the GENERAL REQUIREMENTS, DIVISION 01, are hereby made a part of this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.

HVAC REPLACEMENT AT
WALTHAM PUBLIC LIBRARY
Waltham, MA

- D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1:

1. Add all work associated with the following:
 - a. Demolish Parallel PFVAV Boxes in preparation for replacement.
 - b. Provide new Parallel FPVAV Boxes.
 - c. Remove and reinstall existing suspended ceilings to accommodate work.
 - d. Cut and patch existing gypsum wall board ceilings to accommodate work.

END OF SECTION 01 23 00

SECTION 012600

CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Sections include the following:
 - 1. Division 01 Section "Project Management and Coordination" for submitting Requests for Information (RFIs).
 - 2. Division 01 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, "Architect's Supplemental Instructions" or similar form prepared by Architect.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued by Architect are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within 10 days after receipt of Proposal Request, submit a quotation to the Architect, estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

- c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by first submitting a "Request for Information" to the Architect. This request will be responded to by the Architect, wherein the Contractor may submit a Change Order Proposal.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, the Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701 or similar form.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 - 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 - 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900
PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Sections include the following:
 - 1. Division 01 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Division 01 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule.
 - c. Contractor's Construction Schedule.
 - 2. Submit the Schedule of Values to the Architect at earliest possible date but no later than fifteen days after award of contract or seven days before the date scheduled for submittal of initial Applications for Payment, whichever comes earlier.

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- B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. For major trades with line item values greater than \$25,000, provide a separate line item for units of work within each trade with a value not exceeding \$25,000.
1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 2. Submit draft of AIA Document G702 and AIA Document G703 Continuation Sheets.
 3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate. Include the following mandatory line items:
 - a. Mobilization.
 - b. Demobilization.
 - c. Builders Risk Insurance.
 - d. Bonds.
 - e. Coordination Drawings.
 - f. Scheduling.
 - g. Project record documents.
 - h. Operation and Maintenance manuals.
 - i. Field Engineering.
 - j. Daily Building Cleanup.
 - k. Safety Program.
 - l. Full-Time Project Manager.
 - m. Full-Time Project Superintendent.
 - n. Field Offices (if provided).
 - o. Dumpsters.
 - p. Cold Weather Protection.
 - q. Temporary Heat.
 - r. Commissioning.
 - s. General Contract O&P (not to be included in each line item).

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5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
 6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.
 7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
 8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
 9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.
- C. Prevailing Wage Rates: The prevailing wage rates of MGL, Chapter 149, are applicable to this Project. Wage rates are as determined by the Massachusetts Department of Workforce Development. Certified payrolls must be submitted to the Awarding Authority on a weekly basis.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
 2. At least ten days before the date established for each formal Application for Payment, the Contractor shall submit to the Architect an itemized preliminary application for payment for review and comment. The Contractor shall then revise the preliminary application and at least two days prior to the date established for formal application, shall submit to the Architect the revised preliminary application, to allow time for the Architect to prepare a written letter of explanation setting forth any objections and recommended changes to be forwarded along with the formal application to the owner.
- B. Payment Application Forms: Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.
- C. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.

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2. Include amounts of Change Orders executed before last day of construction period covered by application.
- D. Transmittal: Submit six (6) signed and notarized original copies of each Application for Payment to Architect by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.
- E. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Waiver Forms: Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- F. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of Values.
 3. Contractor's Construction Schedule (preliminary if not final).
 4. Products list.
 5. Schedule of unit prices.
 6. Submittals Schedule (preliminary if not final).
 7. List of Contractor's staff assignments.
 8. List of Contractor's principal consultants.
 9. Copies of building permits.
 10. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 11. Initial progress report.
 12. Report of preconstruction conference.
 13. Certificates of insurance and insurance policies.
 14. Performance and payment bonds.
 15. Data needed to acquire Owner's insurance.
- G. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
- H. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.

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3. Updated final statement, accounting for final changes to the Contract Sum.
4. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
5. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
6. AIA Document G707, "Consent of Surety to Final Payment."
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Administrative and supervisory personnel.
 - 2. Project meetings.
 - 3. Requests for Information (RFIs).
- B. Related Sections include the following:
 - 1. Division 01 Section "Construction Progress Documentation" for preparing and submitting Contractor's Construction Schedule.
 - 2. Division 01 Section "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Division 01 Section "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

- A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.4 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.

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3. Make adequate provisions to accommodate items scheduled for later installation.
 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
 5. No claim for additional compensation or extension of Contract Time will be permitted for conditions resulting from lack of coordination.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Preinstallation conferences.
 6. Progress meetings.
 7. Startup and adjustment of systems.
 8. Project closeout activities.
- D. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to other Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 SUBMITTALS

- A. Key Personnel Names: Within 10 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Keep list current at all times, resubmit upon update.

1.6 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.

1.7 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner, Project Manager, and Architect of scheduled meeting dates and times.
 2. Agenda: Architect or Project Manager shall prepare the meeting agenda and distribute the agenda to all invited attendees.
 3. Minutes: Architect or Project Manager shall record significant discussions and agreements achieved and distribute the meeting minutes to everyone concerned, including Contractor, Owner, Project Manager and Architect, within five days of the meeting.
- B. Preconstruction Conference: Arrange for attendance of subcontractors at Preconstruction Conference convened by Architect, together with any other persons necessary for full review of scheduling and coordination matters for the Project.
1. Attendees: Authorized representatives of Owner, Project Manager, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Include the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for RFIs.
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Preparation of Record Documents.
 - l. Use of the premises.
 - m. Work restrictions.
 - n. Owner's occupancy requirements.
 - o. Responsibility for temporary facilities and controls.
 - p. Construction waste management and recycling.
 - q. Parking availability.
 - r. Office, work, and storage areas.
 - s. Equipment deliveries and priorities.
 - t. First aid.
 - u. Security.
 - v. Progress cleaning.
 - w. Working hours.
 - x. Owner-furnished and provided items.
 - y. Work performed under separate contracts.
 3. Minutes: The Architect or the Owner's Project Manager will record and distribute meeting minutes.

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- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Project Manager of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written recommendations.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Architect or Project Manager shall record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present, the Owner, Architect and Project Manager, and to parties who should have been present.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Schedule weekly progress meetings. Dates of meetings may coincide with preparation of payment requests.
1. Attendees: In addition to representatives of Owner, Project Manager, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review minutes of previous progress meeting. Review other items of significance that could affect progress.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Deliveries.
 - 4) Access.
 - 5) Site utilization.
 - 6) Temporary facilities and controls.
 - 7) Work hours.
 - 8) Hazards and risks.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) RFIs.
 - 14) Status of proposal requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 3. Minutes: The Architect or the Owner's Project Manager will record and distribute the meeting minutes.
 4. Reporting: The Architect or the Owner's Project Manager will distribute minutes of the meeting to each party present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
- E. Coordination Meetings: Schedule Project coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes.
1. Attendees: In addition to representatives of the Contractor, each subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

- a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to Combined Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise Combined Contractor's Construction Schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Deliveries.
 - 4) Access.
 - 5) Site utilization.
 - 6) Temporary facilities and controls.
 - 7) Work hours.
 - 8) Hazards and risks.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Change Orders.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.8 REQUESTS FOR INFORMATION (RFIs)

- A. Procedure: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI, to the Architect, in the form specified.
1. RFIs shall originate with Contractor or Subcontractor. RFIs submitted by entities other than the Contractor will be returned with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
 2. Date.
 3. Name of Contractor.
 4. Name of Architect.
 5. RFI number, numbered sequentially.
 6. Specification Section number and title and related paragraphs, as appropriate.
 7. Drawing number and detail references, as appropriate.
 8. Field dimensions and conditions, as appropriate.
 9. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

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10. Contractor's signature.
 11. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
 - a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.
- C. Hard-Copy RFIs:
1. Identify each page of attachments with the RFI number and sequential page number.
- D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- E. Architect's Action: Architect will review each RFI, determine action required, and return it. Allow five working days for Architect's response for each RFI. RFIs received after 1:00 p.m. will be considered as received the following working day.
1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Time or the Contract Sum.
 - e. Requests for interpretation of Architect's actions on submittals.
 - f. Incomplete RFIs or RFIs with numerous errors.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will start again.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Division 01 Section "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within five days if Contractor disagrees with response.
- G. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log biweekly. Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.

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4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

- 1. Preliminary Construction Schedule.
- 2. Contractor's Construction Schedule.
- 3. Submittals Schedule.
- 4. Daily construction reports.
- 5. Material location reports.
- 6. Field condition reports.
- 7. Special reports.
- 8. Certified payroll records.

- B. Related Sections include the following:

- 1. Division 01 Section "Payment Procedures" for submitting the Schedule of Values.
- 2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes.
- 3. Division 01 Section "Submittal Procedures" for submitting schedules and reports.
- 4. Division 01 Section "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

- 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
- 2. Predecessor Activity: An activity that precedes another activity in the network.
- 3. Successor Activity: An activity that follows another activity in the network.

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- B. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. Event: The starting or ending point of an activity.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time belongs to Owner.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
- G. Major Area: A story of construction, a separate building, or a similar significant construction element.
- H. Milestone: A key or critical point in time for reference or measurement.
- I. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
- J. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.4 SUBMITTALS

- A. Submittals Schedule: Submit three copies of schedule. Arrange the following information in a tabular format:
 - 1. Scheduled date for first submittal.
 - 2. Specification Section number and title.
 - 3. Submittal category (action or informational).
 - 4. Name of subcontractor.
 - 5. Description of the Work covered.
 - 6. Scheduled date for Architect's and Project Manager's final release or approval.
- B. Contractor's Construction Schedule: Submit two opaque copies of initial schedule, large enough to show entire schedule for entire construction period.
 - 1. Submit an electronic copy of schedule, using software indicated, on CD-R, and labeled to comply with requirements for submittals. Include type of schedule (Initial or Updated) and date on label.
- C. Daily Construction Reports: Submit two copies at weekly intervals, to the Architect.

- D. Material Location Reports: Submit two copies at monthly intervals, to the Architect.
- E. Field Condition Reports: Submit two copies at time of discovery of differing conditions, to the Architect.
- F. Special Reports: Submit two copies at time of unusual event, to the Architect.
- G. Certified Payroll Records: Submit two copies at weekly intervals to the Awarding Authority.

1.5 QUALITY ASSURANCE

- A. Review and approval by the Owner and Project Manager of the Contractor's Construction Schedule is advisory only and does not relieve the Contractor of the responsibility for completing the work within the Contract time.

1.6 COORDINATION

- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.
- B. Coordinate Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.
- C. Calendar: Compile a project calendar for use in scheduling. Incorporate all limitations on working days and working hours, including the following:
 - 1. Legal Holidays.
 - 2. Other non-working days determined by the Contractor.
 - 3. Optional working days determined by the Contractor.

PART 2 - PRODUCTS

2.1 SUBMITTALS SCHEDULE

- A. Preparation: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates.
 - 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 - 2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to

- maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.
 4. Update the submittals schedule periodically as the work progresses. Submit concurrently with each Application for payment.
 5. Utilize a computerized program such as Primavera Expedition or Prolog for tracking submittals. Submit the following reports bi-weekly:
 - a. Complete list of reviewed submittals.
 - b. Listing of submittals to date.
 - c. Listing of approved submittals.
 - d. Listing of rejected submittals.
 - e. Listing of submittals returned for correction.
 - f. List of outstanding submittals.
 6. At the request of the Architect provide reports capable of being sorted by the following criteria:
 - a. Approved status.
 - b. Subcontractor/Supplier.
 - c. Submission date.
 - d. Number of days late for return.
 - e. Number of days under review.

2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.
 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each story or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 1. Activity Duration: Define activities so no activity is longer than 10 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Submittal Review Time: Include review and resubmittal times indicated in Division 01 Section "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with Submittals Schedule.
 4. Startup and Testing Time: Include not less than one day for startup and testing.
 5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Project Manager's administrative procedures necessary for certification of Substantial Completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

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1. Work under More Than One Contract: Include a separate activity for each contract.
 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 3. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Partial occupancy before Substantial Completion.
 - b. Use of premises restrictions.
 - c. Provisions for future construction.
 - d. Seasonal variations.
 - e. Environmental control.
 4. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
 5. Other Constraints: Include the following specific activities in each trade in each phase.
 - a. Interface between Contractor and Subcontractor.
 - b. Electrical connections to each piece of equipment.
 - c. Mechanical connections to each piece of equipment.
 - d. Concrete finishing.
 - e. Site work constraints on other activities.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall project schedule.
- F. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules.
- 2.3 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)
- A. General: Prepare network diagrams using AON (activity-on-node) format.
 - B. Preliminary Network Diagram: Submit diagram within 14 days of date established for commencement of the Work. Outline significant construction activities for the first 60 days of

construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

- C. CPM Schedule: Prepare Contractor's Construction Schedule using a computerized, time-scaled CPM network analysis diagram for the Work.
1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for commencement of the Work.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 3. Use "one workday" as the unit of time. Include list of nonworking days and holidays incorporated into the schedule.
- D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the preliminary network diagram, prepare a skeleton network to identify probable critical paths.
1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Preparation and processing of submittals.
 - b. Mobilization and demobilization.
 - c. Purchase of materials.
 - d. Delivery.
 - e. Fabrication.
 - f. Utility interruptions.
 - g. Installation.
 - h. Work by Owner that may affect or be affected by Contractor's activities.
 - i. Testing and commissioning.
 2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
 3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
 - a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.
- E. Initial Issue of Schedule: Prepare initial network diagram from a list of straight "early start-total float" sort. Identify critical activities. Prepare tabulated reports showing the following:
1. Contractor or subcontractor and the Work or activity.
 2. Description of activity.

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3. Principal events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the Schedule of Values).

F. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float time.
7. Changes in the Contract Time.

2.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (refer to special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial Completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.

- C. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for interpretation. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.5 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

2.6 CERTIFIED PAYROLL RECORDS

- A. In compliance with MGL Chapter 149, the Contractor and each Subcontractor is required to submit a certified payroll with a statement of compliance on a weekly basis.
 - 1. Certified Payroll: Submit Massachusetts Department of Labor and Workforce Development "Weekly Payroll Report", typewritten.
 - 2. Certificate of Compliance: Submit Massachusetts Department of Labor and Workforce Development "Weekly Payroll Records Report and Statement of Compliance" form, typewritten.
- B. The Owner has the authority to verify payroll reports by checking employees' pay stubs and personal identification.
- C. The Owner may withhold a portion of the Application for Payment if payroll reports have not been submitted for a portion of the Work.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before submission of Application for Payment.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate Actual Completion percentage for each activity.
 - 4. Evaluate progress of the work jointly with the Owner and Project Manager at the end of each week to show progress and identify conflicts.

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- B. Distribution: Distribute two copies each of approved schedule to Architect, Owner, Project Manager, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013233

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final Completion construction photographs.
- B. Related Sections include the following:
 - 1. Section 013300 "Submittal Procedures" for submitting photographic documentation.
 - 2. Section 017700 "Closeout Procedures" for submitting photographic negatives and digital media as Project Record Documents at Project closeout.
 - 3. Section 024296 "Historic Removal and Dismantling" for photographic documentation before selective demolition operations commence.

1.3 SUBMITTALS

- A. Qualification Data: For photographer.
- B. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same label information as corresponding set of photographs.
- C. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.
 - 1. Format: 8-by-10-inch smooth-surface matte prints on single-weight commercial-grade photographic paper, enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
 - 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Architect.
 - d. Name of Contractor.

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- e. Date photograph was taken if not date stamped by camera.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier.
3. Digital Images: Submit a complete set of digital image electronic files with each submittal of prints on CD-ROM. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as the sensor, uncropped.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 COORDINATION

- A. Auxiliary Services: Cooperate with photographer and provide auxiliary services requested, including access to Project site and use of temporary facilities, including temporary lighting required to produce clear, well-lit photographs without obscuring shadows.

1.6 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in uncompressed TIFF or JPG format, produced by a digital camera with minimum sensor size of 4.0 megapixels, and at an image resolution of not less than 1600 by 1200 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified commercial photographer to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

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1. Date and Time: Include date and time in filename for each image.
 2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference. Identify images same as for those submitted to Architect.
- D. Preconstruction Photographs: Before commencement of demolition, take color, digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
1. Flag construction limits before taking construction photographs.
 2. Take eight photographs to show existing conditions adjacent to property before starting the Work.
 3. Take eight photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- E. Periodic Construction Photographs: Take 12 color, digital photographs monthly, coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
- F. Final Completion Construction Photographs: Take eight color, digital photographs after date of Substantial Completion for submission as Project Record Documents. Architect will direct photographer for desired vantage points.
1. Do not include date stamp.

END OF SECTION 013233

SECTION 013300

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections include the following:
 - 1. Division 01 Section "Payment Procedures" for submitting Applications for Payment and the Schedule of Values.
 - 2. Division 01 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
 - 3. Division 01 Section "Construction Progress Documentation" for submitting schedules and reports, including Contractor's Construction Schedule and the Submittals Schedule.
 - 4. Division 01 Section "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
 - 5. Division 01 Section "Closeout Procedures" for submitting warranties.
 - 6. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 7. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
 - 8. Divisions 02 through 33 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.
- C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate Submittals Schedule with list of subcontracts, the Schedule of Values, and Contractor's Construction Schedule.
 - 2. Initial Submittal: Submit concurrently with preliminary network diagram. Include submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's Construction Schedule.
 - 4. Update the submittals schedule periodically as the work progresses. Submit concurrently with each Application for payment.
 - 5. Utilize a computerized program for tracking submittals. Submit the following reports bi-weekly:
 - a. Complete list of reviewed submittals.
 - b. Listing of submittals to date.
 - c. Listing of approved submittals.
 - d. Listing of rejected submittals.
 - e. Listing of submittals returned for correction.
 - f. List of outstanding submittals.
 - 6. At the request of the Architect provide reports capable of being sorted by the following criteria:
 - a. Approved status.
 - b. Subcontractor/Supplier.
 - c. Submission date.
 - d. Number of days late for return.
 - e. Number of days under review.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will not be provided by Architect for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

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1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect and Construction Manager reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow two weeks for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Construction Manager will advise Subcontractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow two weeks for review of each resubmittal.
 - a. Resubmittals will be reviewed no more than two times at the Owner's expense. Resubmittals which fail to comply with Contract requirements will be reviewed at the Contractor's expense, based on an hourly rate of \$75 per hour, not to exceed \$600 for each subsequent submittal.
 - b. The Owner reserves the right to deduct said reimbursement from the Contractor's application for payment on a monthly basis.
 4. Concurrent Consultant Review: Submittals may be transmitted simultaneously to Architect and to Architect's consultants, as required. Allow two weeks for review of each submittal. Consultant will return submittal to Architect before being returned to Contractor.
- D. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately 6 by 8 inches on label or beside title block to record Subcontractor's review and approval markings and action taken by Architect.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect
 - d. Name and address of Subcontractor.
 - e. Name and address of supplier.
 - f. Name of manufacturer.
 - g. Submittal number or other unique identifier, including revision identifier.

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- 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 055000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 055000.01.A).
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
 - j. Location(s) where product is to be installed, as appropriate.
 - k. Other necessary identification.
4. Additional Copies: Unless additional copies are required for final submittal, and unless Architect or Construction Manager observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- a. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
5. Transmittal for Paper Submittals: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.
- a. Transmittal Form: Provide locations on form for the following information:
 - 1) Project name.
 - 2) Date.
 - 3) Destination (To:).
 - 4) Source (From:).
 - 5) Names of subcontractor, manufacturer, and supplier.
 - 6) Category and type of submittal.
 - 7) Submittal purpose and description.
 - 8) Specification Section number and title.
 - 9) Drawing number and detail references, as appropriate.
 - 10) Transmittal number, numbered consecutively.
 - 11) Submittal and transmittal distribution record.
 - 12) Remarks.
 - 13) Signature of transmitter.
- E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.

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4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Architect, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Contractor.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.
 - g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Transmittal number, numbered consecutively.
 - p. Submittal and transmittal distribution record.
 - q. Other necessary identification.
 - r. Remarks.
5. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- F. Options: Identify options requiring selection by Architect.
- G. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked "Approved" or "Approved as Corrected."
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Action Submittals: Submit **[six]** paper copies of each submittal unless otherwise indicated. Architect will return **[two]** copies.
 3. Informational Submittals: Submit **[two]** paper copies of each submittal unless otherwise indicated. Architect will not return copies.
 4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operation and maintenance manuals.
 - k. Compliance with specified referenced standards.
 - l. Testing by recognized testing agency.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
 4. For equipment, include the following in addition to the above, as applicable:

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- a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in the following format:
 - a. PDF electronic file.
 - b. Submit **six** paper copies of Product Data, unless otherwise indicated. Architect will return **two** copies. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 - m. Relationship to adjoining construction clearly indicated.
 - n. Seal and signature of professional engineer if specified.
 - o. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
 3. Number of Copies: Submit **six** copies of each submittal, unless copies are required for operation and maintenance manuals. Submit six copies where copies are required for operation and maintenance manuals. Architect will retain five copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:

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- a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of appropriate Specification Section.
3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
- a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project Record Sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
1. Type of product. Include unique identifier for each product.
 2. Number and name of room or space.
 3. Location within room or space.
 4. Number of Copies: Submit **six** copies of product schedule or list, unless otherwise indicated. Architect will return **two** copies.
 - a. Mark up and retain one returned copy as a Project Record Document.

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- F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation" for Architect's action.
- G. Submittals Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- H. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."
- I. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- J. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
 - 4. Number of Copies: Submit five copies of subcontractor list, unless otherwise indicated. Architect will return four copies.
 - a. Mark up and retain one returned copy as a Project Record Document.
- K. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation."
- L. Application for Payment and Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."
- M. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."
- N. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
- O. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data."
- P. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- Q. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- R. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

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- S. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- T. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- U. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- V. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- W. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- X. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- Y. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements."
- Z. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- AA. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- BB. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- CC. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

- DD. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates.
 2. Required substrate tolerances.
 3. Sequence of installation or erection.
 4. Required installation tolerances.
 5. Required adjustments.
 6. Recommendations for cleaning and protection.
- EE. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- FF. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- GG. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect.
1. Architect will not review submittals that include MSDSs and will return the entire submittal for resubmittal.

2.2 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit five copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

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1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Division 01 Section "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
 1. "Reviewed": The portion of Work covered by the submittal may proceed provided it complies with the Contract Documents.
 2. "Furnish as Corrected": The portion of Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal, and with the Contract Documents.
 3. "Rejected" or "Revise and Resubmit": Revise or prepare a new submittal in accordance with notations; resubmit. Do not proceed with that portion of the Work covered by the submittal.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

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END OF SECTION 013300

SECTION 013591

HISTORIC TREATMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes special procedures for historic treatment on Project including, but not limited to, the following:
 - 1. Storage and protection of existing historic materials.
 - 2. Temporary protection of historic materials during construction.
 - 3. Protection during application of chemicals.
 - 4. Protection during use of heat-generating equipment.
 - 5. Historic treatment procedures.
- B. Related Sections include the following:
 - 1. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before historic treatment.
 - 2. Section 013233 "Photographic Documentation" for preconstruction photographs taken before historic treatment.

1.3 DEFINITIONS

- A. "Preservation": To apply measures necessary to sustain the existing form, integrity, and materials of a historic property. Work may include preliminary measures to protect and stabilize the property.
- B. "Rehabilitation": To make possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.
- C. "Restoration": To accurately depict the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and the reconstruction of missing features from the restoration period.
- D. "Reconstruction": To reproduce in the exact form and detail a building, structure, or artifact as it appeared at a specific period in time.

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- E. "Stabilize": To apply measures designed to reestablish a weather-resistant enclosure and the structural reinforcement of an item or portion of the building while maintaining the essential form as it exists at present.
- F. "Protect and Maintain": To remove deteriorating corrosion, reapply protective coatings, and install protective measures such as temporary guards; to provide the least degree of intervention.
- G. "Repair": To stabilize, consolidate, or conserve; to retain existing materials and features while employing as little new material as possible. Repair includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials. Within restoration, repair also includes limited replacement in kind, rehabilitation, and reconstruction, with compatible substitute materials for deteriorated or missing parts of features when there are surviving prototypes.
- H. "Replace": To duplicate and replace entire features with new material in kind. Replacement includes the following conditions:
 - 1. Duplication: Includes replacing elements damaged beyond repair or missing. Original material is indicated as the pattern for creating new duplicated elements.
 - 2. Replacement with New Materials: Includes replacement with new material when original material is not available as patterns for creating new duplicated elements.
 - 3. Replacement with Substitute Materials: Includes replacement with compatible substitute materials. Substitute materials are not allowed, unless otherwise indicated.
- I. "Remove": To detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- J. "Remove and Salvage": To detach items from existing construction and deliver them to Owner.
- K. "Remove and Reinstall": To detach items from existing construction, repair and clean them for reuse, and reinstall them where indicated.
- L. "Existing to Remain" or "Retain": Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled.
- M. "Material in Kind": Material that matches existing materials, as much as possible, in species, cut, color, grain, and finish.

1.4 SUBMITTALS

- A. Historic Treatment Program: Submit a written plan for each phase or process including protection of surrounding materials during operations. Describe in detail materials, methods, and equipment to be used for each phase of work.
- B. Alternative Methods and Materials: If alternative methods and materials to those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other, comparable projects, and program of testing to demonstrate effectiveness for use on this Project.
- C. Qualification Data: For historic treatment specialists and supervisory personnel. Include list of completed projects with the scope of work and budget for each.

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- D. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by historic treatment operations. Submit before work begins.
- E. Record Documents: Include modifications to manufacturer's written instructions and procedures, as documented in the historic treatment preconstruction conference and as the Work progresses.

1.5 QUALITY ASSURANCE

- A. Historic Treatment Specialist Qualifications: A firm that employs personnel, including supervisory personnel, experienced and skilled in the processes and operations indicated.
- B. Historic Treatment Preconstruction Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review manufacturer's written instructions for precautions and effects of products and procedures on building materials, components, and vegetation.
 - a. Record procedures established as a result of the review and distribute to affected parties.

1.6 STORAGE AND PROTECTION OF HISTORIC MATERIALS

- A. Removed and Salvaged Historic Materials:
 - 1. Clean salvaged historic items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to Owner's storage area off-site, as designated by Owner.
 - 5. Protect items from damage during transport and storage.
 - 6. Do not dispose of items removed from existing construction without prior written consent of Owner.
- B. Removed and Reinstalled Historic Materials:
 - 1. Clean and repair historic items to functional condition adequate for intended reuse.
 - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 - 3. Protect items from damage during transport and storage.
 - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- C. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling during historic treatment. When permitted by Architect, items may be removed to a suitable, protected storage location during historic treatment and cleaned and reinstalled in their original locations after historic treatment operations are complete.

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- D. Storage and Protection: When removed from their existing location, store historic materials within a weathertight enclosure where they are protected from wetting by rain, snow, or ground water, and temperature variations. Secure stored materials to protect from theft.
 - 1. Identify removed items with an inconspicuous mark indicating their original location.

1.7 PROJECT-SITE CONDITIONS

- A. Exterior Cleaning and Repairing:
 - 1. Proceed with the work only when forecasted weather conditions are favorable.
 - a. Wet Weather: Do not attempt repairs during rainy or foggy weather. Do not apply primer, paint, putty, or epoxy when the relative humidity is above 80 percent. Do not remove exterior elements of structures when rain is forecast or in progress.
 - b. Do not perform exterior wet work when the air temperature is below 40 deg F.
 - c. Do not begin cleaning, patching, or repairing when there is any likelihood of frost or freezing.
 - d. Do not begin cleaning when either the air or the surface temperature is below 45 deg F unless approved means are provided for maintaining a 45 deg F temperature of the air and materials during, and for 48 hours subsequent to, cleaning.
 - 2. Perform cleaning and rinsing of the exterior only during daylight hours.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION, GENERAL

- A. Comply with manufacturer's written instructions for precautions and effects of products and procedures on adjacent building materials, components, and vegetation.
- B. Ensure that supervisory personnel are present when work begins and during its progress.
- C. Temporary Protection of Historic Materials during Construction:
 - 1. Protect existing materials during installation of temporary protections and construction. Do not deface or remove existing materials.
 - 2. Attachments of temporary protection to existing construction shall be approved by Architect prior to installation.
- D. Existing Drains: Prior to the start of work or any cleaning operations, test drains and other water removal systems to ensure that drains and systems are functioning properly. Notify Architect immediately of drains or systems that are stopped or blocked. Do not begin Work of this Section until the drains are in working order.

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1. Provide a method to prevent solids including stone or mortar residue from entering the drains or drain lines. Clean out drains and drain lines that become blocked or filled by sand or any other solids because of work performed under this Contract.
2. Protect storm drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

3.2 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm or damage resulting from applications of chemical cleaners and paint removers.
- B. Comply with requirements in Section 015000 "Temporary Facilities and Controls."
- C. Cover adjacent surfaces with materials that are proven to resist chemical cleaners selected for Project unless chemicals being used will not damage adjacent surfaces. Use covering materials that contain only waterproof, UV-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
- D. Do not clean surfaces during winds of sufficient force to spread cleaning solutions to unprotected surfaces.
- E. Neutralize and collect alkaline and acid wastes and dispose of off Owner's property.
- F. Dispose of runoff from chemical operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

3.3 PROTECTION DURING USE OF HEAT-GENERATING EQUIPMENT

- A. Comply with the following procedures while performing work with heat-generating equipment, including welding, cutting, soldering, brazing, paint removal with heat, and other operations where open flames or implements utilizing heat are used:
 1. Obtain Owner's approval for operations involving use of open-flame or welding equipment.
 - a. Notification shall be given for each occurrence and location of work with heat-generating equipment.
 2. As far as practical, use heat-generating equipment in shop areas or outside the building.
 3. Before work with heat-generating equipment commences, furnish personnel to serve as a fire watch (or watches) for location(s) where work is to be performed.
 4. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
 5. Remove and keep the area free of combustibles, including, rubbish, paper, waste, etc., within area of operations.

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- a. If combustible material cannot be removed, provide fireproof blankets to cover such materials.
 6. Where possible, furnish and use baffles of metal or gypsum board to prevent the spraying of sparks or hot slag into surrounding combustible material.
 7. Prevent the extension of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
 8. Inspect each location of the day's work not sooner than 30 minutes after completion of operations to detect hidden or smoldering fires and to ensure that proper housekeeping is maintained.
- B. Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, shield the individual heads temporarily with guards.

3.4 HISTORIC TREATMENT PROCEDURES

- A. The principal aim of preservation work is to halt the process of deterioration and stabilize the item's condition, unless otherwise indicated. Repair is required where specifically indicated. The following procedures shall be followed:
1. Retain as much existing material as possible; repair and consolidate rather than replace.
 2. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structure.
 3. Use reversible processes wherever possible.
 4. Use traditional replacement materials and techniques. New work shall be distinguishable to the trained eye, on close inspection, from old work.
 5. Record the work before the procedure with preconstruction photos and during the work with periodic construction photos. Photographic documentation is specified in Division 01 Section "Photographic Documentation."
- B. Prohibit smoking by personnel performing work on or near historic structures.
- C. Obtain Architect's review and written approval in the form of a Constructive Change Directive or Supplemental Instruction before making changes or additions to construction or removing historic materials.
- D. Notify Architect of visible changes in the integrity of material or components whether due to environmental causes including biological attack, UV degradation, freezing, or thawing; or due to structural defects including cracks, movement, or distortion.
1. Do not proceed with the work in question until directed by Architect.
- E. Where missing features are indicated to be repaired or replaced, provide features whose designs are based on accurate duplications rather than on conjectural designs, subject to the approval of Architect and Preservation Specialist.
- F. Where Work requires existing features to be removed, cleaned, and reused, perform these operations without damage to the material itself, to adjacent materials, or to the substrate.
- G. Identify new or replacement materials and features with inconspicuous, permanent marks to distinguish them from original materials. Record the legend of identification marks and the locations of these marks on Record Drawings.

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- H. When cleaning, match samples of existing materials that have been cleaned and identified for acceptable cleaning levels. Avoid overcleaning to prevent damage to existing materials during cleaning.

END OF SECTION 013591

SECTION 014000

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, Project Manager, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections include the following:
 - 1. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 2. Division 01 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
 - 3. Divisions 02 through 33 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

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- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect or Project Manager.
 - C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.
 - 1. Approved mockups establish the standard by which the Work will be judged.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - D. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
 - E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
 - F. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
 - G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
 - H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
 - I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
 - J. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- 1.4 CONFLICTING REQUIREMENTS
- A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the

most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Description of test and inspection.
 - 3. Identification of applicable standards.
 - 4. Identification of test and inspection methods.
 - 5. Number of tests and inspections required.
 - 6. Time schedule or time span for tests and inspections.
 - 7. Entity responsible for performing tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- C. Reports: Prepare and submit certified written reports that include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the Commonwealth of Massachusetts and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirement for specialists shall not supersede building codes and regulations governing the Work.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

- c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Payment for these services will be made by the Owner.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities

having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
1. Retesting to be performed by the Inspection and Testing Agency that performed the original tests.
 2. Retest original failed test and perform two additional tests at new locations to be determined by Architect and Testing Agency.
 3. Continue retesting until compliance is achieved.
- E. Testing Agency Responsibilities: Cooperate with Architect, Project Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect, Project Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
 7. Do not permit the Contractor to deviate from the requirements of the Contract Documents.
- F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify

agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
 2. Provide the Testing Agency with a complete set of Contract Documents.
- H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for commencement of the Work.
1. Distribution: Distribute schedule to Owner, Architect, Project Manager, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.8 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency and special inspector to conduct special tests and inspections required by the Massachusetts State Building Code and by authorities having jurisdiction as the responsibility of Owner, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.
 - a. Costs associated with retesting and reinspecting are the responsibility of the Contractor.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's and Project Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
 - 2. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200

REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.
- D. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the organizations responsible for the standards and regulations.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Sections include the following:
 - 1. Division 01 Section "Summary" for limitations on utility interruptions and other work restrictions.
 - 2. Division 01 Section "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
 - 3. Division 01 Section "Indoor Air Quality Requirements."
 - 4. Division 01 Section "Execution" for progress cleaning requirements.
 - 5. Divisions 02 through 33 Sections for temporary heat, ventilation, and humidity requirements for products in those Sections.

1.3 USE CHARGES

- A. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations. Obtain owner's permission prior to connection.
- C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations. Obtain owner's permission prior to connection.

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1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

1.5 QUALITY ASSURANCE

- A. General: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but no limited to the following:
 - 1. Massachusetts State Building Code and referenced standards.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police and Fire Department rules and regulations.
 - 5. Environmental Protection Agency regulations.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- D. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and the Massachusetts Architectural Access Board (AAB).

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portable Chain-Link Fencing: Minimum 2-inch, 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide galvanized steel bases for supporting posts.
- B. Lumber and Plywood: Comply with requirements in Division 06 Section "Miscellaneous Rough Carpentry."

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 20 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- square tack board.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. Electrical Power Cords: Provide grounded extension cords; use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.
- C. HVAC Equipment: The use of permanent HVAC system for temporary heating is not permitted. Provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary services.
 - 1. Arrange with utility company, Owner, and Project Manager for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- D. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- E. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- F. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- G. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line and one facsimile line for field office.
 - 1. Provide additional telephone lines for the following:
 - a. Provide a dedicated telephone line for each facsimile machine.

- b. Provide one telephone line(s) for common use.
2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Architect's office.
 - e. Engineers' offices.
 - f. Owner's office.
 - g. Principal subcontractors' field and home offices.
3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
4. Provide digital cable for temporary electronic communication service in common-use field office.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide incombustible construction for optional offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.
2. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment.

C. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

D. Project Signs: Provide Project signs as directed by Owner. Unauthorized signs are not permitted.

1. Identification Signs: Provide 4 ft. by 8 ft. professionally painted full color project identification signs with independent braced post supports as directed by Owner.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

- a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

E. Collection and Disposal of Waste: Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise above 80 deg F (27 deg C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by

containerizing properly. Separate, salvage, recycle and dispose of materials in accordance with the Commonwealth of Massachusetts "Waste Ban" 310 CMR 19.017.

1. Comply with Division 01 Section "Execution" for progress cleaning requirements.
2. Provide sufficient quantity of dumpsters at strategic locations within the Contract limit lines for collection of waste from the work of all subcontractors on site.
3. Do not pass materials through open windows, or through window openings when any portion of the window remains in the opening.

F. Temporary Lifts and Hoists: The Contractor shall provide, operate and maintain in safe operating order facilities for hoisting materials, rubbish, employees and to otherwise carry out the Work. Truck cranes, fork lifts, man lifts and similar devices required for the performance of the Work by the Contractor shall be provided by Contractor. Truck cranes, fork lifts, man lifts and similar devices required for the performance of the Work by Filed Sub Bid Sections shall be provided by the Filed Subcontractor.

1. Provide temporary lifts and hoists that comply in all respects with the most stringent of all applicable Federal (including OSHA), state and local laws, rules, regulations, codes and ordinances, and provisions of Division 01 of this Specification.
2. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

G. Existing Stair Usage: Use of Owner's existing interior stairs will generally not be permitted. Access to the roof will be from the exterior only. The Contractor is responsible for installing, maintaining, and removing a secured stair tower for access to the roof.

H. Staging and Scaffolding: Where staging and scaffolding is required, the Contractor shall provide the entire installation, except for the Work of all Filed Subcontractors. The Filed Subcontractors are responsible to provide all staging and scaffolding for the scope of their Work.

1. Staging shall be of approved design, erected and removed by experienced stage builders and shall have all accident prevention devices required by State and local laws.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 01 Section "Summary."

B. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

C. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heat is needed and the permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Provide enclosures as required on the exterior or interior side of the building, whether the roof has

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been installed or not, and whether windows or doors have been installed or not, in order to protect the Work and allow Work to continue in accordance with the requirements of the Specifications. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

2. Install tarpaulins securely, with fire-retardant-treated wood framing and other materials. Close openings of 25 square feet or less with plywood or similar materials.
3. Close openings through floor or roof decks and horizontal surfaces with load-bearing wood-framed construction.
4. Where temporary wood or plywood enclosure exceeds 100 square feet in area, use UL-labeled fire-retardant treated material for framing and main sheathing.
5. Do not use new permanent doors and frames for temporary enclosures until finishing work is begun, and then only if carefully protected from damage. Prior to installation of permanent doors and frames, provide temporary wood or plywood doors with wood frames and proper hardware to make the doors self-closing.

- a. Close and lock all openings accessible from ground level at end of each day's work to prevent entry of unauthorized persons.

D. Protection: Protect the Work at all times from damages. Provide all pumps, equipment and enclosures to ensure this protection.

1. Remove all snow and ice as may be required for proper protection and prosecution of the work.
2. Provide all shoring, bracing and sheeting as required for safety and for proper execution of work.
3. Protect all work from damage during cold weather. If low temperatures make it impossible to continue operations safely in spite of cold weather precautions, cease work and notify Architect. Repair and/or replacement of all work damaged from frost, freezing or any elements of the weather are the responsibility of the Contractor responsible for temporary protection of the Work.
4. Should high wind warnings be issued by the U.S. Weather Advisory Bureau, take every precaution to minimize danger to persons, to the Work, and to adjacent properties, including, but not limited to, removing all loose materials, tools and/or equipment from exposed locations, and removing or securing scaffolding or other temporary work.
5. Protect the building and the site from damage, loss or liability due to theft or vandalism when the work is not in progress at night, weekends, or holidays.
6. Exercise precaution for the protection of persons and property at all times. Observe the provisions of applicable laws and construction codes. Take additional safety and health measures, or cause such measures to be taken as reasonably necessary. Maintain guards on machinery, equipment and other hazards as set forth in the safety provisions of the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not in contravention of applicable laws.
7. Protect and preserve in operating conditions all utilities traversing the work area. Repair all damages to any utility due to work performed under this Contract, the satisfaction of the Architect at no additional cost to the Owner.

E. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

1. Prohibit smoking in construction areas.

2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 01 Section "Closeout Procedures."

END OF SECTION 015000

SECTION 016000

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
 - 1. Division 01 Section "References" for applicable industry standards for products specified.
 - 2. Division 01 Section "Closeout Procedures" for submitting warranties for Contract closeout.
 - 3. Divisions 02 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise.
 - a. Products salvaged or recycled from other projects are not considered new products.
 - b. Products manufactured and stored for more than one year prior to the start date of this project are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities

- related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
4. "Or Equal" Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
 - a. An item equal to that named or described in the specifications may be furnished; and an item shall be considered equal to the item so named or described if, in the opinion of the awarding authority: (1) it is at least equal in quality, durability, appearance, strength and design, (2) it will perform at least equally the function imposed by the general design for the public work being contracted for or the material being purchased, and (3) it conforms substantially, even with deviations, to the detailed requirements for the item in the said specifications.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
- C. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification, or for purposes of evaluating "or equal" products.
- #### 1.4 SUBMITTALS
- A. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
1. Coordinate product list with Contractor's Construction Schedule and the Submittals Schedule.
 2. Form: Tabulate information for each product under the following column headings:
 - a. Specification Section number and title.
 - b. Generic name used in the Contract Documents.
 - c. Proprietary name, model number, and similar designations.
 - d. Manufacturer's name and address.
 - e. Supplier's name and address.
 - f. Installer's name and address.
 - g. Projected delivery date or time span of delivery period.
 - h. Identification of items that require early submittal approval for scheduled delivery date.

3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 - a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.
 4. Completed List: Within 90 days after date of commencement of the Work, submit 3 copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
 5. Architect's Action: Architect will respond in writing to Contractor within 15 days of receipt of completed product list. Architect's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. Architect's response, or lack of response, does not constitute a waiver of requirement to comply with the Contract Documents.
- B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified material or product cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
 - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Contract Sum.
 - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - a. Form of Acceptance: Change Order.
 - b. Use product specified if Architect cannot make a decision on use of a proposed substitution within time allocated.
- C. Comparable Product Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 1. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Division 01 Section "Submittal Procedures."
 - b. Use product specified if Architect cannot make a decision on use of a comparable product request within time allocated.
- D. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
 1. The Contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. **Manufacturer's Warranty:** Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 2. **Special Warranty:** Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.
- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
1. **Manufacturer's Standard Form:** Modified to include Project-specific information and properly executed.
 2. **Specified Form:** When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. **List of Warranties:** Provide warranties for products and installations as specified, including but not limited to the following:
1. **Roof Membrane:** Division 07 Section "Thermoplastic Membrane Roofing."
 2. **Roof Hatches:** Division 07 Section "Roof Accessories."
- D. **Submittal Time:** Comply with requirements in Division 01 Section "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
 7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Part 2 "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures:
1. Products:
 - a. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed equal product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 2. Manufacturers:
 - a. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed equal manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 3. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
 4. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.

5. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
 - a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
6. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Requested substitution provides sustainable design characteristics that specified product provided.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Contractor's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.

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1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. 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 Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Requested substitution provides sustainable design characteristics that specified product provided.
 - e. Substitution request is fully documented and properly submitted.
 - f. Requested substitution will not adversely affect Contractor's construction schedule.
 - g. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - h. Requested substitution is compatible with other portions of the Work.
 - i. Requested substitution has been coordinated with other portions of the Work.
 - j. Requested substitution provides specified warranty.
 - k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.3 COMPARABLE PRODUCTS

- A. Conditions: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
 6. Compliance with requirements of M.G.L. Chapter 30, Section 39M.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017000

EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor and each Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. General installation of products.
 - 2. Progress cleaning.
 - 3. Starting and adjusting.
 - 4. Protection of installed construction.
 - 5. Correction of the Work.
- B. Related Sections include the following:
 - 1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 2. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.
 - 3. Division 01 Section "Closeout Procedures" for final cleaning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
 - 1. Before construction, verify the location and points of connection of utility services.

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- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; and underground electrical services.
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a

detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.4 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.5 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.6 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.7 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017000

SECTION 017329

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.

1.3 DEFINITIONS

- A. Cutting: Penetration of in-place construction necessary to permit installation or performance of other Work, including the removal of debris.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
 - 6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
 - 7. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive Architect's right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio. Structural elements include, but are not limited to the following:
1. Concrete foundation construction.
 2. Bearing and retaining walls, including architectural precast panels.
 3. Lintels.
 4. Structural steel frame.
 5. Structural decking.
 6. Miscellaneous structural metals.
 7. Interior and/or exterior load bearing masonry wall construction.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
1. Primary operational systems and equipment.
 2. Air or smoke barriers.
 3. Fire-suppression systems.
 4. Mechanical systems piping and ducts.
 5. Control systems.
 6. Communication systems.
 7. Electrical wiring systems.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Piping, ductwork, vessels, and equipment.
 4. Noise- and vibration-control elements and systems.
 5. Roofing systems.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: 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.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. 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.

- B. Cutting: 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.
1. Cutting Responsibility:
 - a. Cutting openings less than 12 inches square or in diameter in elevated concrete slabs and non-load bearing partitions in conjunction with the work of a Filed Subcontractor, is the responsibility of the Filed Subcontractor. All other cutting of elevated concrete slabs and non-load bearing partitions is the responsibility of the Contractor.
 - b. Cutting concrete slabs on grade for all work is the responsibility of the Contractor.
 - c. Cutting structural elements for all work is the responsibility of the Contractor.
 2. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 3. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 4. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 5. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, 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.
1. Patching Responsibility:
 - a. Patching in conjunction with the cutting work of each Filed Subcontractor is the responsibility of the Filed Subcontractor. All other patching is the responsibility of the Contractor.
 - b. If the size of the cut is in excess of that required for the penetrating item, and exceeds the 12 inch dimension for work of the Filed Subcontractor, the patching is the responsibility of the Filed Subcontractor.
 2. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 3. Exposed Finishes: 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.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 4. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

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- a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 5. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 017329

SECTION 017419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for environmental-protection measures during construction, and location of waste containers at Project site.
 - 2. Division 02 Section "Selective Structure Demolition" for disposition of waste resulting from partial demolition.

1.3 DEFINITIONS

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 REQUIREMENTS FOR CONSTRUCTION WASTE MANAGEMENT

- A. The Contractor shall prepare and submit a Construction Waste Management Plan to the Owner and Architect for approval. The CWM Plan shall outline the provisions to be implemented by the Contractor and Subcontractors to recycle and salvage demolition and construction waste generated during the project. The end-of-project recycling rate shall equal, at minimum, 50% (by weight) of the total waste from construction and miscellaneous demolition.
- B. Upon approval of the CWM Plan by the Owner and Architect, it shall be implemented by the Contractor and Subcontractors throughout the duration of the project, and documented in accordance with the Submittal Requirements below.
- C. The Construction Waste Management Plan shall include, but not be limited to, the following components:
 1. Listing of Targeted Materials: The contractor shall develop a list of the waste materials from the Project that will be targeted for reuse, salvage, or recycling. The following materials, at minimum, shall be accounted for (materials that will not be recycled shall be indicated as such):
 - a. Cardboard, paper, packaging
 - b. Clean dimensional wood, palette wood
 - c. Beverage containers
 - d. Concrete and/or Concrete Masonry Units (CMU)
 - e. Metals from banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - f. Drywall
 - g. Carpet and pad
 - h. Paint
 - i. Rigid Foam
 - j. Glass
 - k. Plastics
 2. Landfill Information: The contractor shall provide the name and location of the landfill(s) where trash will be disposed of.
 3. Recycling or Salvaging Facilities: The contractor shall provide the names and locations of the recycling or salvaging facilities where waste materials will be delivered.
 4. Sorting Method: The contractor shall provide a description of the proposed means of sorting and transporting the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site for off-site sorting). Waste haulers using off-site sorting operations shall provide a written description of the sorting process used, and their method for calculating project-specific recycling rates.
 5. Packaging Waste: The contractor shall note whether suppliers will eliminate or take back packaging for major materials delivered to the site.
 6. Implementation and Supervision: The contractor shall include provisions in the Construction Waste Management Plan for addressing conditions in the field that do not adhere to the CWM Plan, including provisions to rectify non-compliant conditions.
 7. Additional Information: The contractor shall include any additional information deemed relevant to describe the scope and intent of the CWM Plan to the Owner and Architect.

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- D. Construction Waste Management and recycling requirements shall be incorporated into all Subcontractors' contracts.

1.5 SUBMITTALS

- A. Waste Management Plan: Submit 3 copies of plan within 30 days of date established for the Notice to Proceed.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement waste management plan as approved by Architect and Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with Division 01 Section "Temporary Facilities and Controls" for operation, termination, and removal requirements.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
 - 2. Comply with Division 1 Section "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

- A. Salvaged Items for Reuse in the Work:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- B. Salvaged Items for Sale and Donation: Not permitted on Project site.
- C. Salvaged Items for Owner's Use:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.

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4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 4. Store components off the ground and protect from the weather.
 5. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

- A. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- B. Metals: Separate metals by type.
1. Structural Steel: Stack members according to size, type of member, and length.
 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- C. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
- D. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
- E. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

- F. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.6 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn waste materials.
- C. Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
 2. Warranties.
 3. Final cleaning.
- B. Related Sections include the following:
1. Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
 2. Division 01 Section "Execution" for progress cleaning of Project site.
 3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 5. Divisions 02 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, damage or settlement surveys, and similar final record information.

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6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
10. Complete final cleaning requirements, including touchup painting.
11. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
2. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
3. Submit lien waivers and/or certificate of payment received, as required by Owner, from all subcontractors.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

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1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Project Manager.
 - e. Name of Contractor.
 - f. Page number.

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.
- D. Provide a digital copy of warranty package.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs.
 - g. Sweep concrete floors broom clean in unoccupied spaces.
 - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - l. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Replace parts subject to unusual operating conditions.
 - n. Clean exposed surfaces of diffusers, registers, and grills.
 - o. Leave Project clean and ready for occupancy.

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2. Before requesting final inspection for determining date of Final Completion, complete cleaning operations listed above as required following Substantial Completion and completion of all punch list items.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.
1. Comply with waste ban regulations of the Massachusetts Department of Environmental Protection (MassDEP), 310 CMR 19.017, for disposal of asphalt pavement, brick, concrete, metal and wood.

END OF SECTION 017700

SECTION 017823

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.
- B. Related Sections include the following:
 - 1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
 - 2. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
 - 3. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
 - 4. Divisions 02 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 SUBMITTALS

- A. Submittals: Submit two (2) draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return one copy of draft and mark whether general scope and content of manual are acceptable.
 - 1. Correct or modify each manual to comply with Architect's comments. Submit 2 copies of each corrected manual within 15 days of receipt of Architect's comments.
 - 2. Provide submittal(s) in digital format in addition to printed format.

1.4 COORDINATION

- A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name, address, and telephone number of Contractor.
 - 6. Name and address of Architect.
 - 7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
 - 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

- b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
 1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- C. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
- D. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.
- E. Provide submittal(s) in digital format in addition to printed format.

END OF SECTION 017823

SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Sections include the following:
 - 1. Division 01 Section "Closeout Procedures" for general closeout procedures.
 - 2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 3. Divisions 02 through 33 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up Record Prints.
 - a. Submit one set of marked-up Record Prints. Electronically scan each Drawing, whether or not changes and additional information were recorded.
 - 1) Electronic Media: DVD-R.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.

2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect and Project Manager.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 018119

INDOOR AIR QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. This Section includes the following:

1. Microbial and fungal contamination control.
2. Indoor air quality and pollution control.
3. Heating, ventilating, and air conditioning.
4. Description of Indoor Air Quality (IAQ) Construction Plan.
5. IAQ Construction requirements.

- B. Related Sections:

1. Division 01 Section "Temporary Facilities and Controls" for temporary facility requirements.
2. Division 01 Section "Closeout Procedures" for final cleaning.

1.3 INDOOR AIR QUALITY

- A. Goals: The Owner has set the following goals to maintain indoor air quality for jobsite operations for this Project, within the limits of the construction schedule, Contract sum, and utilizing available materials, equipment, products, and services.

1. Protect workers on-site from undue health risks during construction.
2. Prevent residual problems with indoor air quality in the completed building.

- B. Product Emission Rate Standards: Test to ASTM D 5116 for Maximum Indoor Air Concentration Levels.

1. Formaldehyde:

- a. 0.03 parts per million where no other requirements are specified.
- b. 0.005 parts per million where products are specified as formaldehyde free.

2. Total VOC Emissions for Carpet Tile, Adhesives, and Sealers: 0.05 mg/m² per hour.
3. 4 Phenyl Cyclohexene (4-PC) Particulate Emissions for Carpet: 1 part per billion.
4. Total Particulate Emission Rate Levels: 50 ug/m³.

INDOOR AIR QUALITY REQUIREMENTS

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5. Primary and Secondary Regulated Pollutants: Conform to USEPA, Code of Federal Regulations, Title 40, Part 50 National Air Ambient Air Quality Standard. Refer to EPA Web Site: <http://www.epa.gov/epahome/rules.html#codified>.
 6. Other Pollutants not Listed: Not greater than 1/10 of Threshold Limit Value - Time Weighted Average (TLV-TWA) Industrial workplace standard.
- C. Architectural Coatings - Volatile Organic Compound (VOC) Content Limits: Conform to US Environmental Protection Agency (EPA) Federal Register 48886/Vol. 63, No. 176 Friday, September 11, 1998/Rules and Regulations. Refer to EPA Web Site: <http://www.epa.gov/>.

1.4 SUBMITTALS

- A. Indoor Air Quality Construction Plan: Within fourteen (14) days of Notice to Proceed, prior to any waste removal by the Subcontractor, the Subcontractor shall develop and submit for review an indoor air quality plan, including the following:
1. List of IAQ protective measures to be instituted on the site.
 2. Schedule for inspections and maintenance of IAQ measures.
- B. Moisture-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage, including delivery, handling, and storage provisions for materials subject to water absorption or water damage, discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged Work.
1. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- C. Dust-Control and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust-control and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. Locations of dust-control partitions at each phase of the work.
 2. HVAC system isolation schematic drawing.
 3. Location of proposed air filtration system discharge.
 4. Other dust-control measures.
 5. Waste management plan.
- D. Substitutions: If the Subcontractor elects to use procedures, materials, equipment or products that are not specified, but meet the intent of these specifications, submit an alternative solution for approval.

PART 2 - PRODUCTS

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2.1 MATERIALS

- A. Do not use products in combination with or in contact with other products that can be identified as combining to form toxic fumes or sustained odors.
- B. Do not use solvents within interior areas that may penetrate and be retained in absorptive materials such as concrete, gypsum board, wood, cellulose products, fibrous material, and textiles.

PART 3 - EXECUTION

3.1 GENERAL

- A. Protect construction materials from contamination and pollution from contact with construction dust, debris, fumes, solvents, and other environmentally polluting materials.
- B. Conduct regular inspection and maintenance of indoor air quality measures including ventilation system protection, and ventilation rate.
- C. Use low-toxic cleaning supplies for surfaces, equipment, and worker's personal use. Options include soybean-based solvents and cleaning options and citrus-based cleaners.
- D. Use safety meetings, signage, and subcontractor agreements to communicate the goals of the indoor air quality construction plan.
- E. Clean spills immediately involving solvents or cleaners.

3.2 HEATING, VENTILATING, AND AIR CONDITIONING

- A. The Contractor is required to meet or exceed the minimum requirements of the Sheet Metal and Air conditioning National Contractor's Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 1995, and the following:
 - 1. Do not run HVAC system during course of construction unless the Owner has authorized the use of the permanent heating system. Seal ductwork intake and exhaust vents.
 - 2. Heat, dehumidify and ventilate building during course of Work as necessary to maintain environmental conditions suitable for drying and curing materials and for prevention of conditions suitable for mold and mildew growth.
 - a. Ventilate building removing moisture, dust, fumes, and odors.
 - b. Temper and dehumidify air as needed to remove excess moisture.
 - c. Refer to Division 01 Section "Temporary Facilities and Controls" for temporary heating requirements.

3.3 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

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- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 - 1. Protect porous materials from water damage.
 - 2. Protect stored and installed material from flowing or standing water.
 - 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 - 4. Remove standing water from decks.
 - 5. Keep deck openings covered or dammed.

- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 - 2. Keep interior spaces reasonably clean and protected from water damage.
 - 3. Periodically collect and remove waste containing cellulose or other organic matter.
 - 4. Discard or replace water-damaged material.
 - 5. Do not install material that is wet.
 - 6. Discard, replace or clean stored or installed material that begins to grow mold.
 - 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 - 2. Use permanent HVAC system to control humidity.
 - 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record daily readings over a forty-eight hour period. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that can not be completely restored to their manufactured moisture level within 48 hours.

- E. Perform, schedule, and sequence Work as required to limit conditions supporting formations of microbes, molds, and fungi.
 - 1. Control water penetration, dampness, and humidity to prevent products not treated for exterior use from becoming soaked or damp.

- B. When visible formations are observed and when formations completely removed by non-abrasive surface cleaning:
 - 1. Remove and replace materials identified as food sources for microbes, molds, and fungi.
 - 2. Correct conditions supporting microbial, mold, and fungal growth.

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- C. Remove interior products and finishes, identified as food sources, that have absorbed sufficient moisture to become damp whether or not microbial, mold, or fungal growth is observed. Products may include, but not be limited to, the following:
 - 1. Gypsum board cores.
 - 2. Organic materials composed of cellulose fiber or paper.
 - 3. Materials containing sucrose or other binders identified supporting microbial growth.
- D. Remove fibrous insulation materials subject to retaining moisture such as duct liner, insulation, and other materials that are made wet or damp and cannot immediately be made dry.
- E. Repair or replace ductwork, pans, and other conditions where moisture condensation, water penetration, or drained water has caused damage to such materials.
 - 1. Remove conditions that have become an environment for microbes, molds, or fungi.
 - 2. Do not permit conditions leading to standing water.
- F. Remedial Action: Notify Owner, and Architect prior to beginning remedial action where continuation by hazardous chemicals, microbes, and fungi is suspected.

3.4 DUST CONTROL

- A. Prevent construction dust from entering Owner occupied areas. Erect temporary partitions in accordance with Division 01 Section "Temporary Facilities and Controls."
- B. Levels of airborne respirable dust in excess of 15pg/m³ are considered excessive. Should such levels be reached or exceeded, discontinue activities which are creating dust, clean all surfaces, and take action to reduce the level of dust being created to within acceptable limits.

END OF SECTION 018119

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections apply to the work of this Section.

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Demolition and removal of portions of concrete slabs, as indicated.
 - 2. Demolition and removal of interior partitions, and/or portions of interior partitions, as indicated.
 - 3. Demolition and removal of floor, wall and ceiling finishes, as indicated.
- B. This Section also includes the removal and disposal of Plumbing, HVAC and Electrical systems and equipment indicated by the General Contractor, except that all disconnections, shut-offs and drop to floor shall be performed by each Filed Subcontractor who customarily furnishes and installs such systems and work.
- C. Related Sections include the following:
 - 1. Divisions 22, 23, and 26 for fire protection, plumbing, HVAC and electrical demolition requirements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

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1.5 PRE-DEMOLITION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site. Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Locations of proposed dust- and noise-control temporary partitions and means of egress.
 - 5. Coordination of Owner's continuing occupancy of building.
 - 6. Means of protection for items to remain and items in path of waste removal from building.
- C. Predemolition Photographs or Video: Submit before Work begins.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
 - 1. Comply with requirements specified in Section 01 10 00 "Summary of Work / Site Location."
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

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- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: Hazardous materials may be present in construction to be selectively demolished. A report on the presence of hazardous materials is included in Division 00 Section "Existing Hazardous Materials Information." Examine report to become aware of locations where hazardous materials are present.
 - 1. If unidentified hazardous materials are encountered during the work, do not disturb hazardous materials or items suspected of containing hazardous materials. Stop all work on the project and immediately notify Architect.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

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1. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.
1. Comply with requirements for existing services/systems interruptions specified in Section 01 11 00 "Summary of Work / Site Location."
- B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 3. Disconnect, demolish, and remove fire-alarm systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
1. Comply with requirements for access and protection specified in Section 01 50 00 "Temporary Facilities / Signage."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

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1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities / Signage."
 6. Comply with indoor air quality requirements specified in Section 01 81 19 "Indoor Air Quality Construction Plan."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.

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4. Transport items to Owner's storage area designated by Owner.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.
- C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.
 1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them.
 1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property. Separate, salvage, recycle, and legally dispose of materials in accordance with the Commonwealth of Massachusetts Waste Ban, 310 CMR 19.017.
 1. Include cost of all transportation and disposal.

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2. Provide verification of all disposal trips.
3. Hazardous materials are to be handled and disposed of in accordance with all State, Local, and Federal regulations.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures and finishes for the following applications:
 - a. Slabs-on-grade.
 - b. Concrete equipment pads.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Install the following items as furnished by the designated Sections:
 - 1. Section 04 20 00 - UNIT MASONRY:
 - a. Dovetail slots for masonry anchors.
 - b. Reinforcing Dowels.
 - 2. Section 05 50 00 – METAL FABRICATIONS:
 - a. Lintels, sleeves, anchors, inserts, plates, and similar items for miscellaneous and ornamental metal.
 - 3. Section 22 00 00 - PLUMBING:
 - a. Blockouts, sleeves, anchors, inserts, sumps, and similar items for plumbing systems.
 - 4. Section 23 00 00 - HEATING, VENTILATING AND AIR CONDITIONING:
 - a. Blockouts sleeves, anchors, inserts, and similar items for heating, ventilating, and air conditioning systems.
 - b. Pipe and duct sleeves for placement into cast-in-place concrete openings.
 - 5. Section 26 00 00 - ELECTRICAL:
 - a. Sleeves, anchors, inserts, floor boxes, and similar items for electrical systems.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. See Division 1
- F. Hoisting Equipment: This subcontractor shall furnish, install and maintain in safe and adequate condition all mechanical hoisting equipment, operating personnel and rigging that is necessary for the proper execution of the Work of this Section.

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- G. Staging, Planking and Scaffolding: This subcontractor shall furnish, install and maintain in safe and adequate condition all staging, planking and scaffolding that is necessary for the proper execution of the Work of this Section.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
 - 2. Indicate amount of fly ash in the mix, minimum 25%.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include; bar sizes, lengths, material, strength grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - 1. Indicate coordination requirements for reinforcement locations with requirements of abutting disciplines.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer licensed in the Commonwealth of Massachusetts detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
 - 2. Block outs for Engineered Joint Systems: Indicate block outs and coordination with Engineered joint systems
- E. Formwork Inspection: Performed by Owner's Independent Inspector. Indicate compliance with approved shop drawings.
- F. Anchor Bolt Location: Performed by Owner's Independent Inspector. Indicate compliance with approved shop drawings.
- G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Indicate that proposed aggregates will not cause any deleterious effects to the proposed concrete mix, e.g. ASR.
 - 2. Concrete Mix Design.
- H. Material Certificates: For each of the following, provide materials certificates instead of materials laboratory test reports when permitted, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures. Provide certification that chloride content complies with Specification requirements. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

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3. Form materials and form-release agents.
 4. Steel reinforcement and accessories.
 5. Fiber reinforcement.
 6. Curing compounds.
 7. Floor and slab treatments.
 8. Portland cement base floor leveler
 9. Bonding agents.
 10. Adhesives.
 11. Vapor barriers/retarders.
 12. Semi-rigid joint filler.
 13. Joint-filler strips.
 14. Repair materials.
- I. Submit proposed curing procedures. Particular attention to be directed to coordination between concrete and adhered flooring trades on curing procedure and moisture control of concrete floors.
- J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances and requirements for applied finishes and materials, except as noted for slope to drains.
- K. Field quality-control test and inspection reports.

1.5 QUALITY ASSURANCE

- A. Work on this project shall conform to the requirements of Massachusetts State Building Code (MSBC), Ninth Edition, ACI 301 Standard Specifications for Structural Concrete, ACI 318-08 Building Code Requirements for Reinforced Concrete published by the American Concrete Institute (ACI) Detroit, Michigan and the recommendations of the Concrete Steel Reinforcing Institute (CRSI), except as modified by the requirements of these Contract Documents.
- B. Codes and Standards: Comply with the latest provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
1. Massachusetts State Building Code (MSBC), Ninth Edition
 2. American Concrete Institute (ACI)
 - a. ACI 117 Standard Specifications for Tolerances for Concrete Construction and Materials
 - b. ACI 211 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - c. ACI 212 Chemical Admixtures for Concrete
 - d. ACI 221 Guide for Use of Normal Weight Aggregates in Concrete
 - e. ACI 301 Specifications for Structural Concrete for Buildings
 - f. ACI 302 Guide for Concrete Floor and Slab Construction
 - g. ACI 304 Guide for Measuring, Mixing, Transporting and Placing Concrete
 - h. ACI 305 Hot Weather Concreting
 - i. ACI 306 Cold Weather Concreting
 - j. ACI 308 Standard Practice for Curing Concrete
 - k. ACI 315 Details and Detailing of Concrete Reinforcement
 - l. ACI 318 Building Code Requirements for Reinforced Concrete
 - m. ACI 347 Guide to Formwork for Concrete
 3. American Society for Testing and Materials (ASTM)
 - a. ASTM A185 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

- b. ASTM A615 Deformed and Plain Billet – Steel Bars for Concrete Reinforcement
 - c. ASTM A706 Low Alloy Steel Deformed Bars for Concrete Reinforcement
 - d. ASTM C31 Making and Curing Concrete Test Specimen.
 - e. ASTM C33 Concrete Aggregates
 - f. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens
 - g. ASTM C94 Ready-Mixed Concrete
 - h. ASTM C109 Test Method for Compressive Strength of Hydraulic Cement Mortars
 - i. ASTM C143 Standard Method for Slumps of Portland Cement Concrete
 - j. ASTM C150 Portland Cement
 - k. ASTM C171 Sheet Materials for Curing Concrete
 - l. ASTM C172 Sampling Freshly Mixed Concrete
 - m. ASTM C231 Air Content of Freshly Mixed Concrete by the Pressure Method
 - n. ASTM C260 Air-Entraining Admixtures for Concrete
 - o. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete
 - p. ASTM C330 Light Weight Aggregates for Structural Concrete
 - q. ASTM C494 Chemical Admixtures for Concrete
 - r. ASTM C618 Fly Ash and Raw or Calcinated Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete
 - s. ASTM D1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
 - t. ASTM D1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
 - u. ASTM D4397 Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
- 4. National Ready-Mixed Concrete Association
 - a. NRMCA CPMB 100 Concrete Plant Standards
 - b. NRMCA TMMB Truck Mixer and Agitator Standards
 - 5. Army Corps of Engineers (COE)
 - a. CRD-C572 Polyvinylchloride Waterstop
 - b. CRD-C621 Handbook for Concrete and Cement, Specification for Nonshrink Grout
- C. Concrete Testing Service:
- 1. Materials, measuring, mixing, transportation, placing and curing shall be subject to inspection by the Owner's Representative. However, such inspection, wherever conducted, shall not relieve the Contractor of his responsibility to furnish materials and workmanship in accordance with Contract requirements, nor shall inspector's acceptance of material or workmanship prevent later rejection of same by the Designer if defects are discovered.
 - 2. Concrete shall be sampled and tested for quality control as follows:
 - a. Sampling fresh concrete: ASTM C 172
 - b. Concrete test specimens: ASTM C 31
 - c. Slump: ASTM C 143
 - d. Air Content: ASTM C 231
 - e. Compressive strength: ASTM C 39
 - 3. Compression tests shall consist of four (4) cylinders for each test made, cured and tested by the laboratory during the progress of the job. Concrete for each set of cylinders shall be from one (1) sample representative of the entire batch. All cylinders shall be standard 6" x 12".
 - 4. The Designer may require core specimens taken from concrete and for testing in accordance with ASTM C 42. If these specimens do not meet strength requirements, the Designer will have the right to require additional curing, load tests, strengthening or removal and replacement of those parts of structure which are unacceptable, and in addition, removal of those parts of structure which are unacceptable, and in addition,

- removal of such portions of structure as necessary to ensure safety, appearance and durability of the structure. Additional testing, load tests, strengthening or removal and replacement of parts of structure shall be at the Contractor's expense.
5. Testing required because of changes requested by the Contractor in materials, sources of materials or mix proportions, and extra testing of concrete or materials because of failure to meet the Specification requirements shall be paid by the Contractor.
- D. Qualification of Welding:
1. All shop and field welding processes shall be qualified in accordance with the latest AWS – Standard Qualification Procedure. All shop and field welding operators shall hold current, valid certifications issued in accordance with the latest AWS – Structural welding Code for the type, position and process required. Shop and field welding processes and operators not meeting these requirements shall not be used in the welding of the items in this Section.
- E. Required Designs by Contractor:
1. Where “designs” are required of the Contractors by the Contract Documents, the designs shall be performed by competent, qualified, and experienced professional Engineers or Engineer, registered in the discipline of the designs they are performing in the Commonwealth of Massachusetts. Such designs shall be prepared in a design document format (not a shop drawing format), be stamped and signed by the professional designer who performed the design and, where specifically requested, be submitted to the Designer for record purposes only. Further, such submitted designs must carry a cover letter of certification stating that to the best of this engineer's knowledge, information and belief, the design (so supplied) is in conformance with the governing codes applicable to this work, and has been prepared in accordance with appropriate standards of professional practice, and with a view toward the safeguarding of life, health, property and public welfare, and that the certifying professional is responsible for the design. In addition, the professional Engineers or Engineers retained by the Contractor to perform the designs required by the Contract Documents shall review the shop drawings associated with their designs and visit the manufacturing facility or fabricating plant and the construction site to observe that the work is being performed in accordance with their designs. The costs associated with their designs, materials and labors shall be borne by the Contractor. The responsibility for designs required of the Contractors shall remain solely with the Contractors.
- F. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- G. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. A qualified testing agency for testing and inspection will be selected and shall be **paid directly by the Contractor**. The Contractor shall be responsible for coordinating all tests required by all governing laws and regulations and to assume the proper construction of the work.
 2. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 3. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

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- H. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Supply labor, materials, and equipment to the Project at such intervals to insure uninterrupted programs of work.
- B. Deliver, store and handle materials so as to eliminate contamination, segregation, damage and deformation. Store materials off the ground on wood dunnage of sufficient height to prevent surface water from coming into contact with materials. Materials shall be stored to provide drainage and protected from the elements with waterproofing covering, ventilated to avoid condensation.
- C. Materials that would be damaged by contact with water or sunlight shall be stored in a closed, protective environment.
- D. Do not deliver concrete to the Project until ready for concrete placement. General Contractor shall note the mix time limits referred to by this Section and arrange for deliveries accordingly.
- E. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Concrete:
 - 1. Portland Cement:
 - a. The cement shall be an approved brand of American manufactured Portland cement, Type I or II conforming to ASTM C150. The brand name and type of cement proposed for use shall be submitted to the Engineer for review immediately following award of contract. Only one color of cement shall be used throughout the project unless otherwise approved.
 - 2. Concrete conforming to the requirements listed below shall be used where indicated on the drawings. Unless otherwise indicated, concrete used as fill under foundations, and elsewhere approved by the Engineer, may be a 300 psi minimum strength mix.

TABLE 03 30 00-1

Minimum Comp. Strength at 28 days (psi)	Maximum Water/Cement Ratio (W/(C+P))	Cement Factor: 94 lb. Bags Per cubic yard minimum**
2500 (controlled fill)	0.62	4.3
4000	0.38	7.0

*Based on air-entrained concrete. If non-air-entrained concrete is called for, the listed maximum water/cement ratios may be increased slightly, as approved by the Engineer. The water is the total water in the mix, including free water on the aggregate.

**These are minimum amounts; increase as necessary to meet mix requirements.

3. Concrete shall conform to ASTM C94. One copy of the Certificate of Delivery required by ASTM C94 shall be delivered to the Engineer immediately upon arrival of each load of concrete at the site. The Contractor shall be responsible for the design of the concrete mixtures.
4. Standard compression tests in conformity with the provisions of ACI 318 of all proposed mixes shall be made by the testing laboratory or other satisfactory evidence shall be presented that the design mixes will attain the minimum strengths listed on the design drawings or called for herein, within the limitations of the ACI Code. No concrete shall be delivered to the job site until the Engineer has approved the design mixes.
5. All concrete (unless otherwise directed) shall contain an air-entraining agent. The air content shall be the responsibility of the testing laboratory and in accordance with ASTM C231.
6. All concrete shall contain a mid-range water reducer to minimize cement and water content of the mix, at the specified slump, in accordance with ASTM C494.
7. Slump for all concrete shall as called out in Table 03 30 00-5. Any concrete having a slump greater than those shown shall be promptly removed from the site.
8. No calcium chloride or admixtures containing calcium chloride shall be added to the concrete. No admixture other than those specified shall be used in concrete without the specific written permission of the Engineer in each case.
9. No additional water, except for the amount indicated by the design mix shall be added to the concrete without the prior permission of the Engineer.

B. Mixes

1. Development and testing of mix designs shall be by an independent testing laboratory acceptable to the Engineer engaged by and at the expense of the Contractor.
2. It is the sole responsibility of the General Contractor to provide concrete with the strength, durability, placeability, workability, consistency and finishing characteristics required by the Contract Documents. Review and acceptance of mix design submissions by the Engineer shall not relieve the General Contractor of their sole responsibility.

2.2 CURING MATERIALS:

- A. Liquid or spray curing compounds shall NOT be used as a curing/hardener compound for surfaces accepting water based adhesives, otherwise use of compounds such as Acurion by AntiHydro, Sikaguard Cure/Hard by Sika, Super Diamond Clear by Euclid or approved equal may be used. Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309 Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil.

1. Subject to compliance with requirements, products which may be incorporated in the work, include the following:
 - a. "Masterseal" by Master Builders
 - b. "Ecocure" by Euclid Chemical Co.
 - c. "L&M Cure" by L & M Const. Chemical Co. or approved equal.

- B. Where liquid or spray curing compounds may not be used, employ curing paper composed of a fiber-reinforced laminated Kraft bituminous product, polyethylene film or white burlap-polyethylene sheeting, all conforming to the requirements of ASTM C171.
 - 1. Curing paper shall meet ASTM C171, based upon UltraCure NCF, a disposable wet cure blanket of natural colored cellulose fabrics with a 3 mil white reflective impervious coating, or Transguard 4000, a reusable wet cure synthetic fiber mat with a polyethylene backing.

2.3 CONCRETE SEALER

- A. Concrete sealer shall be one of the following products or equal:
 - 1. Euco Diamond Hard sealer by Euclid Chemical.
 - 2. Sikafloor-CureHard-24, a transparent surface hardener, dustproofed, densifier, sealer by Sika.
 - 3. Consolideck "LS", a lithium-silicate sealer, hardener, densifier by Prosoco.

2.4 CONCRETE MIXES

- A. Design
 - 1. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer engaged by and at the expense of the Contractor.
 - 2. Select properties of ingredients to meet the design strength and materials limits specified in Tables 03 30 00-2 and 03 30 00-3 and to produce concrete having proper placeability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.
 - 3. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, be developed by laboratory test. Water content of the concrete shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 days compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the compressive strength specified, without extrapolation. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratios and net minimum cementitious content as specified in Table 03 30 00-2.

TABLE 03 30 00-2

Design Strength*	Minimum Lab Strength at 7 Days
2500 psi	1800 psi
4000 psi	2800 psi

*Specified compressive strength at 28 days.

In no case, however, shall the resulting mix conflict with the limiting values for maximum water content and net minimum cement factor specified in Table 03 30 00-3.

- 4. The limiting strengths, cement factors and water contents for each mix shall be in accordance with Table 03 30 00-3.

TABLE 03 30 00-3

Minimum 28 Day Design Strength	Net Minimum Cement Factor* Content in (gals/100 lb. (100 lb./cy) of Cement)	Maximum Water Content **	Maximum Water-Cementitious Materials Ratio (by weight)
2500	4.3	7.4	0.62
4000	7.0	4.3	0.38

*Minimum. Increase as necessary to meet other requirements. These cement factors apply to "controlled" concrete subject to specific inspection.

5. Compression Test: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
6. Shrinkage Test: Perform shrinkage tests on the design mix for Class C concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete, not mortar, specimens shall be used.
7. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.
8. Entrained air, as measured by ASTM C231, shall be shown as Table 03 30 00-4.

TABLE 03 30 00-4

Concrete Placement	Total Air Measured at Discharge from Truck (Percent)
Trowel finished slabs	3.5 maximum
All other concrete	4-6

9. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 03 30 00-5. If Plasticizer is used, the slump indicated shall be that measured before Plasticizer is added. Plasticized concrete shall have a slump ranging from seven to ten inches.

TABLE 03 30 00-5

Portion of Structure	Slump (inches) Recommended	Range
Pavement and slabs on ground	2	1-3
Plain footings, slabs, pads and curbs	2-3	1-4
Foundation Walls and Footings	3-4	2-5

10. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in

combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

B. Aggregates:

1. Except as otherwise noted, aggregates shall conform to the requirements of ASTM C33.
2. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM C33.
3. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Size numbers for the concrete mixes shall be as shown in Table 03 30 00-06.

TABLE 03 30 00-06

Description	Maximum Coarse Aggregate	Size Number (ASTM C33 Table 2)
24-in thick or less	¾-in	67
Peastone mix	3/8-in	8

4. All aggregates shall be from a single source throughout the Project. Aggregates shall not contain any substance that may be deleteriously reactive with the alkaline portion in the cement.

C. Water:

1. Water shall be potable. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

D. Admixtures: The following admixture products shall be made a part of the mix design unless specifically noted otherwise.

1. Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures.
 - a. Air entraining agent shall be in accordance with ASTM C260. Proportioning and mixing shall be in accordance with the manufacturer's recommendations.
 - i. Subject to compliance with requirements, products which may be incorporated in the work include the following:
 - "Sika AER" by Sika Corp.
 - "MB-VR or MB-AE" by Master Builders
 - "Darex AEA" or "Daravair" by W. R. Grace or approved equal.
 - b. Water reducing agent shall be a mid-range water reducer meeting ASTM C494, Type A, and contain no more than .05% chloride ions. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 - i. Subject to compliance with requirements, products that may be incorporated in the work include the following:
 - "Plastocrete 161" by Sika Chemical Corp.
 - "Pozzolith Normal" by Master Builders
 - "WRDA" by W. R. Grace or approved equal.
 - c. Superplasticizer agent shall be in accordance with ASTM C494, Type D and contain no more than 0.05% chloride ions. Product may be plant added or field added based on the best application considering distance, temperature and time. The treated concrete shall be capable of maintaining plastic state for two hours or longer

depending on application. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

Subject to compliance with requirements, products that may be incorporated in the work include the following:

- "Sikament 300" by Sika Chemical Corp.
 - "Rheobuild" by Master Builders
 - "WRDA 19" or "Duracem" by W. R. Grace or approved equal.
2. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
 3. Prohibited admixtures: Calcium chloride, thiocyanates, and admixtures containing more than 0.05% chloride ions are not permitted.
 4. Fly Ash: ASTM C618

E. Form Materials:

1. Forms for exterior and interior surfaces which will be exposed to view after the work is completed, whether such surfaces are painted or unpainted, shall be new plywood stock, steel, tempered masonite, or other materials which will provide smooth concrete surfaces without subsequent surface plastering. Plastic or plastic-faced forms shall not be used, except with prior approval.
2. Form release agent shall be a non-staining, non-yellowing, non-toxic liquid free from kerosene and resins of the type recommended by the manufacturer of the forming system being used.
3. For securing forms where surfaces will be exposed in the finished work, use tie screws with removable plastic cones. No metal shall be closer than 2" from the finished concrete surface, unless otherwise indicated on the drawings.
4. Unless otherwise noted on the drawings, all exposed edges of concrete elements either from a casting operation or demolition to open a concrete slab, shall have a $\frac{3}{4}$ " chamfer.
5. Where steel adjacent to vertical faces of forms cannot be otherwise secured, concrete bricks or mortar doughnuts shall be used to prevent steel from lying too close to the finish vertical faces of the concrete.

F. Reinforcing Materials:

1. Reinforcing Steel: ASTM A615, Grade 60
2. Reinforcing Steel to be welded: ASTM A706, Grade 60
3. Welded Wire Mesh: ASTM A185; supplied in sheets.
4. Supports for Reinforcement:
 - a. Provide support bars, spreader bars, precast concrete blocks, bolsters, chairs, side form spacers, tie wire and other accessories necessary to secure the reinforcing and welded wire mesh accurately in position in accordance with CRSI "Placing Reinforcing Bars".
 - b. Tie Wire shall be 16-gauge minimum, black, soft-annealed wire.
 - c. Bar Support Class:
 - i. Use CRSI Class 1 bar supports in all concrete exposed to moisture.
 - ii. Use CRSI Class 2 Type A bar supports in all interior concrete where the legs of the support will be in contact with an exposed-to-view concrete surface.
 - iii. CRSI Class 3 bar supports may only be used where CRSI Class 1 and CRSI Class 2 are not required.
 - iv. For slabs-on-grade, use precast concrete blocks or bar supports with sand plates or horizontal runners where base material will not support chair legs.

G. Concrete Curing:

1. Clear, waterborne, membrane-forming curing compound shall comply with ASTM C309, Type 1, Class B. Compound shall not reduce the adhesion of any material to be applied

- to the concrete. Coordinate the use and application of this compound with the use and application of the penetrating liquid hardener and sealer compound.
2. Moisture-retaining cover shall be polyethylene-coated burlap conforming to ASTM C171 employed where adhesion of floor elements may be compromised.
- H. Vapor Retarder: When specified by the architect.
1. Under-slab vapor barrier shall be 15 mil multi-layered plastic sheets made from virgin resins meeting or exceeding requirements of ASTM E1745 Class A specifications on vapor permeance, tensile strength and puncture resistance.
 2. Protection board, if required during installation over the crushed stone sub-base or compacted earth, will be provided to avoid puncture and damage.
 3. All seams, penetrations and tears shall be repaired using compatible tape and mastic.
 4. Installation shall be in strict adherence to the manufacturer's printed specification.
- I. Adhesive Anchor System:
1. Adhesive anchor system is used for reinforcement dowels and anchor bolts as shown on the drawings.
 2. Adhesive anchor system shall be SET-XP by Simpson Strong-Tie, HIT RE 500 epoxy adhesive by Hilti, PE1000+ by Powers or approved equal.
- J. Grout:
1. Grout shall be mixed in the proportions of 1 part Portland Cement (ASTM C150, Type I or Type III) to 2 parts clean, uniformly graded natural sand (ASTM C404, Size No. 2), by volume. Only sufficient water shall be used to enable grout to barely hold its shape when squeezed into a ball in the hand. Aggregate used for grout mixes shall conform to the requirements of the reference specification for concrete. Prior approval shall be obtained for the use of proprietary grouts, and the instructions of the Manufacturer shall be followed in their use.
 2. Non-metallic, non-shrink grout shall be pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensation agents, plasticizing and water reducing agents, complying with CRD-C621 with a minimum ultimate compressive strength of 5,000 psi at the end of 28 days as determined by ASTM C1019.
 - a. Subject to compliance with requirements, products that may be incorporated in the work include the following non-metallic grouts:
 - i. "Set Grout" by Master Builders
 - ii. "Crystex" by L & M Const. Chemical Co.
 - iii. "Five Star Grout by U.S. Grout or approved equal.
- K. Bonding Agents:
1. Prior to casting any cast-in-place concrete or pre-blend, all contact surfaces shall be coated with a bonding agent. Acceptable products:
 - a. Armatec 110 EpoCem by Sika
 - b. Diralprep A.C. by Euclid Chemical
 - c. Right Poxy by Right Pointe
 - d. Polyweld-EPX by ChemMasters
 - e. Planibond 3C by MAPEI
 - f. Bonders shall provide corrosion inhibitors and a minimum open-form of at least 24 hours or greater.

2.5 MECHANICAL REINFORCING BAR SPLICER

- A. Mechanical reinforcing bar splicer hardware may be required for this work and should it be necessary by found site conditions, the splicer shall be a full tension and compression device which provides structural continuity between reinforcing bars. It shall develop a minimum of 125% specified yield strength of the reinforcing bar. Acceptable manufacturers:
1. Barlock
 2. OS Splice Clip by Splice Sleeve North America (small bars to #6)
 3. Bar-Grip Couplers by BarSplice

2.6 REINFORCEMENT FABRICATION

- A. Reinforcement shall be fabricated, cut to length, bent, radial pre-fabricated, hooked, marked, bundled and tagged in accordance with CRSI's "Placing Reinforcing Bars". Tolerances in fabrication shall be in accordance with CRSI's "Placing Reinforcing Bars".
- B. Reinforcing Steel Bars: shall be newly rolled billet steel conforming to ASTM A615 Grade 60. Bars shall be bent cold.
- C. Welded Wire Fabric: shall conform to ASTM A185.
- D. All structural steel reinforcement and embedded items shall be hot-dip galvanized after fabrication in accordance with ASTM A123.
1. All hot-dip galvanized steel shall be inspected for compliance with ASTM A123 and shall be marked with a stamp that indicates the number of ounces of zinc per square foot of steel. After galvanizing, the bars shall be dipped in a 0.2 percent chromic acid solution. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer.
- E. Reinforcing Materials:
1. Reinforcing Steel: ASTM A615, Grade 60
 2. Reinforcing Steel to be welded: ASTM A706, Grade 60
 3. Welded Wire Mesh: ASTM A185; supplied in sheets.
 4. Supports for Reinforcement:
 - a. Provide support bars, spreader bars, precast concrete blocks, bolsters, chairs, side form spacers, tie wire and other accessories necessary to secure the reinforcing and welded wire mesh accurately in position in accordance with CRSI "Placing Reinforcing Bars".
 - b. Tie Wire shall be 16-gauge minimum, black, soft-annealed wire.
 - c. Bar Support Class:
 - i. Use CRSI Class 1 bar supports in all concrete exposed to moisture.
 - ii. Use CRSI Class 2 Type A bar supports in all interior concrete where the legs of the support will be in contact with an exposed-to-view concrete surface.
 - iii. CRSI Class 3 bar supports may only be used where CRSI Class 1 and CRSI Class 2 are not required.
 - iv. For slabs-on-grade, use precast concrete blocks or bar supports with sand plates or horizontal runners where base material will not support chair legs.
- F. Adhesive Anchor System:
1. Adhesive anchor system is used for reinforcement dowels and anchor bolts as shown on the drawings.
 2. Adhesive anchor system shall be SET-XP by Simpson Strong-Tie, HIT RE-500 by Hilti, PE1000+ by Powers or approved equal.

- G. Epoxy Adhesive:
 - 1. Epoxy adhesive shall comply with ASTM C881, two component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements. Subject to compliance with requirements, products which may be incorporated in the work include the following:
 - a. "Thiopoxy" by W. R. Grace
 - b. "Sikadur Hi-Mod" by Sika Chemical Corp.
 - c. "Euco Epoxy 452 or 620" by Euclid Chemical Co. or approved equal.
- H. Waterstops – shall be used in the elevator pit foundation for all construction below the level of the boiler room. All waterstops to be of PVC with a minimum width of 6". Acceptable fabricators:
 - 1. Greenstreak
 - 2. BoMetals Inc.
 - 3. Fosroc

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine all work prepared by others to receive work of this Section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
 - 1. Verify site conditions
 - 2. Verify requirements for concrete cover over reinforcement.
 - 3. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS

- A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.

3.3 PREPARATION

- A. Before placing concrete, forms and the space to be occupied by the concrete shall be thoroughly cleaned, and reinforcing steel and embedded metal shall be free from dirt, oil, mill scale, loose rust, paint or other material which would tend to reduce the bond.
- B. Unless otherwise indicated, a moisture barrier shall be used under interior slabs placed on the ground. Sheets shall be lapped 6-inches at joints and sealed with 2-inch wide pressure sensitive tape compatible with the membrane. Strictly follow manufacturer's written recommendation for preparation and installation of the vapor barrier.
- C. When joining fresh concrete to concrete which has attained full set, the latter shall be cleaned by chipping and washing off all debris and laitance. It then shall be moistened prior to placing new concrete.

1. Concrete surfaces that act as a seat for structural members (other than those resting on grout) shall be troweled to an extremely flat and level surface. If necessary, such surfaces shall be ground off to achieve the required flatness and level.

D. Grout when required:

1. Grout shall be placed over concrete that has attained its full design strength unless otherwise approved.
2. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints, and free of all loose material or foreign matter which may affect the bond or performance of the grout.
3. Roughen concrete surfaces by chipping, sand blasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
 - a. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.
4. Remove all loose rust, oil or other deleterious substances from metal embedment or bottom of base plates prior to the installation of the grout.
5. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementations or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface or other acceptable method. Upon completion of the 24-hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved for each specific location of grout installation.
6. Construct grout forms or other leak proof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place, and shored to resist the forces imposed by the grout and its placement.

3.4 ERECTION OF FORMWORK, SHORING AND RESHORING

- A. The General Contractor shall set and maintain formwork and provide the necessary finishing operations to insure that the final concrete lines are within the tolerances listed in ACI 117 and as follows:
1. The offset between adjacent pieces of formwork facing material shall not exceed: Class C
 2. Provide floor finish tolerances as measured in accordance with ASTM E1155 Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound units)
 3. Provide floor flatness and levelness tolerances as recommended by the finish floor manufacturers. In areas with more than one finish floor type or system, the most restrictive manufacturer's recommendation shall govern the entire area.
 4. Default Criteria: Where no finish floor is specified or where the finish floor manufacturer does not recommend flatness and/or levelness tolerance criteria, provide the following as a minimum:
 - a. Overall:
 - i. Flatness (FF) 30
 - ii. Levelness (FL) 20
 - b. Minimum Local:
 - i. Flatness (FF) 15
 - ii. Levelness (FL) 10

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- B. The FL levelness tolerance does not apply to slabs placed on un-shored form surfaces and/or shored form surfaces after the removal of shores. FL levelness tolerance does not apply to cambered or inclined surfaces and shall be measured with 72 hours after slab concrete placement.
- C. The General Contractor shall place and secure the reinforcing bars and welded wire mesh such that the final position of the reinforcing bars and the welded wire mesh in the concrete is within the limits set forth in ACI 117, CRSI's "Placing Reinforcing Bars," and as specified in Section 3.5.
- D. Anchor Bolt, Bearing Device and Embedded Item Setting tolerances shall be in accordance with the American Institute of Steel Construction's Code of Standard Practice for Steel Buildings and Bridges.
- E. Verify that all formwork completely encloses concrete to be poured and is securely braced prior to concrete placement. Remove ice, excess water, dirt and other foreign materials from form.
- F. Set and maintain formwork to insure complete concrete work within tolerance limits listed in ACI 117 latest edition, "Recommended Practice for Concrete Formwork", and with following additional requirements:
 - 1. Maximum variations from plumb:
 - a. In surfaces of columns and walls:
 - i. In any 10 feet of length 1/4 inch
 - ii. Maximum for entire length 1/2 inch
 - 2. Maximum variations from established position in plan shown on the drawings:
 - a. Column 1/2 inch
 - b. Walls 3/4 inch
 - 3. Variations in cross-sectional dimensions of columns and beams and in thickness of slabs and walls.
 - a. Minus 1/8 inch
 - b. Plus 1/4 inch
- G. For a minimum of one hour prior to concrete placement, wet forms continuously with water to swell forms in order to prevent leakage of concrete matrix and to minimize absorption of concrete matrix water by form materials. This requirement may be waived for those specific cases where Designer deems it unnecessary or impractical. Care must be exercised to prevent a build-up of water at base of forms.
- H. Before form materials can be re-used, surfaces that will be in contact with freshly cast concrete shall be thoroughly cleaned, damaged areas repaired and projecting nails withdrawn. Re-use of form material shall be subject to approval by Designer.

3.5 PLACING OF REINFORCEMENT

- A. Reinforcement shall be placed in accordance with requirements of CRSI 93, "Recommended Practice for Placing Reinforcing Bars" and CRSI 93, "Recommended Practice for Placing Bar Supports" and with further requirements below.
- B. Reinforcement shall be accurately placed in accordance with Contract Documents and shall be firmly secured in position by wire ties, chairs, spacers, and hangers, each of type approved by Designer. Accurately position, support and secure reinforcement against displacement by construction and concrete placement operations. Locate and support reinforcement by

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support bars, spreader bars, chairs, bolsters, precast concrete blocks, side form spacers, tie wire and other accessories necessary to secure the reinforcement accurately in position.

- C. Place all reinforcement to obtain minimum coverage in accordance with ACI 318 "Building Code Requirements for Reinforced Concrete and Commentary, including the General Notes in the Structural Contract Documents. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Bending, welding or cutting reinforcement in field in any manner other than as shown on Drawings, is prohibited, unless specific approval for each case is given by Designer.
- D. Reinforcement shall be continuous through construction joints unless otherwise indicated on Drawings.
- E. Reinforcement shall be spliced only in accordance with requirements of Contract Documents or as otherwise specifically approved by Designer. Splices of reinforcement at points of maximum stress shall generally be avoided. Welded wire fabric shall lap six inches or one space plus two inches whichever is larger, and shall be wired together.
- F. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond requirements. Reinforcement expected to be exposed to weather for a considerable length of time shall be painted with a heavy coat of cement grout. Protect stored materials so as not to end or distort bars in any way. Bars that become damaged will be rejected.
- G. Before concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Documents and approved Shop Drawings. Such checking shall be done only by qualified experienced personnel.
- H. Where continuous reinforcing bars are called for, indicated or required, they shall be run continuously around corners, standard hooks at discontinuous ends and spliced only where absolutely necessary. Splices in adjacent bars shall be staggered. If beam or slab reinforcing must be spliced, the splice shall occur at mid span for top and middle bars and over the supports for bottom bars. If column reinforcing must be spliced, the splice shall occur directly above a framed level. Lap and development lengths for concrete reinforcing shall be in accordance with the schedules or details included in the Structural Contract Drawings.
- I. Lace end and edge splices in welded wire mesh with tie wire at each cross-bar. Stagger end and edge laps in adjacent pieces. All lap lengths for welded wire mesh shall be 8 inches minimum measured from the first cross-bar.
- J. Install masonry wall dowels while concrete is still plastic and tie and secure as required to prevent misalignment.
- K. Drill holes for dowels into existing concrete. Mix, transport and place epoxy grout in accordance with the manufacturer's instructions and install dowels.
- L. Install additional reinforcing around all openings and embedded items in the concrete elements as specified in the Structural Contract Drawings. Note that openings and embedded items required in the concrete elements, including but not limited to: pipe sleeves, conduit and ducts, not specifically shown in the Structural Contract Drawings shall only be installed with the specific approval of the Designer and additional reinforcing shall be provided..

3.6 JOINTS

- A. Construction and control joints indicated on Drawings are mandatory and shall not be omitted.
- B. Joints not indicated or specified shall be placed to least impair strength of structure and shall be subject to approval of Designer.
- C. All types of concrete elements, including but not limited to slabs, walls, beams, footings and columns shall be placed without horizontal construction joints, except where shown in the Structural Contract Drawings. Joints not shown in the Structural Contract Documents shall not be added without the approval of the Engineer. The Structural Contract Drawings shall be referred to for locations of control and expansion joints. Construction joints and stops in the concrete work shall coincide with a defined control joint location.
- D. Surfaces of construction and control joints shall be cleaned, laitance removed and immediately wetted and standing water removed prior to pouring new concrete.
- E. Slab saw cut control joints shall be sawn within 8 hours after slab finishing without dislodging aggregate or raveling edges of cut.
- F. Where keyways are shown in the Contract Drawings provide 1-1/2" deep by 3-1/2" wide tapered keyways, unless otherwise noted.
- G. Form construction and control joints perpendicular to the main reinforcement. Continue reinforcement across the joints for a distance that shall satisfy the minimum lap length requirements specified herein.
- H. Construct isolation joints at points of contact between slabs-on-grade and vertical surfaces, such as foundation walls, and elsewhere as shown in the Contract Drawings with pre-molded joint fillers.
- I. All openings through concrete beams shall occur within the middle third of the span and at the neutral axis.

3.7 INSTALLATION OF EMBEDDED ITEMS

- A. Conform to requirements of ACI 318, "Conduits and Pipes Embedded in Concrete", and as specified below.
- B. Install steel sleeves, embedded wall plates and similar items, furnished by other trades, at locations shown on the drawings.
- C. Set and build into work by templates, temporary supports and other accessories necessary to secure bearing plates, sleeves and all other items embedded in the concrete work to the established positions and grades within the tolerance specified herein. Use setting drawings, diagrams, instructions and directions provided by trades and suppliers or items to be embedded.
- D. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

- E. Anchor bolts for any element shall be installed with templates provided. Vertical alignment and plan locations shall be maintained within one-sixteenth inches of the locations shown on the drawings.

3.8 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE

- A. Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with National Ready-Mix Concrete Association (NRMCA) and Truck Mixer Manufacturers' Bureau (TMMB). Ready-mix plant equipment and facilities shall be certified in accordance with NMRCA QC 3. Site-mixed concrete shall be mixed in accordance with ACI 301. On-site plant shall conform to the MRMCA CPMB 100.
- B. No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch except when on arrival at the jobsite, the slump of the concrete is less than that specified. Water added to bring the slump within the specified range shall not change the total water in the concrete to a point that the approved water-cement ratio is exceeded. The drum shall be turned an additional 30 revolutions, or more, if necessary, until the added water is uniformly mixed into the concrete. Water shall not be added to the batch at any later time.
- C. Ready-mix or transit-mixed concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities for the respective conditions as stated on the nameplate. Discharge at the site shall be within 1-1/2 hours after cement was first introduced into the mix. Central mixed concrete shall be plant-mixed a minimum of 1-1/2 minutes per batch and then shall be truck-mixed or agitated a minimum of 8 minutes. Agitation shall begin immediately after the pre-mixed concrete is placed in the truck and shall continue without interruption until discharge. Transit-mixed concrete shall be mixed at mixing speed for at least 10 minutes immediately after charging the truck, followed by agitation without interruption until discharged.
- D. All central plant and rolling stock equipment and methods shall conform to the latest Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready-Mixed Concrete Association, as well as ACI 304 and ASTM C94.
- E. Attention is called to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.
- F. Concrete shall be discharged within 1-1/2 hours after introduction of the cement to the aggregates, except that when the concrete temperature exceeds 85°F, this time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.
- G. Temperature and Mixing Time Control:
 - 1. In cold weather, maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 03 30 00-1.
 - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90°F.
 - 3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90°F. If necessary, substitute well-crushed ice for all or part of the mixing water.

4. The maximum time interval between the addition of mixing water and/or cement to the batch, and the placing of concrete in the forms shall not exceed the following:

TABLE 03 30 00-07

AIR OR CONCRETE TEMPERATURE (whichever is higher)	MAXIMUM TIME
80°f to 90°f	45 minutes
70°f to 79°f	60 minutes
40°f to 69°f	90 minutes

5. If an approved mid or high range water reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes or other appropriate time such that workability and Contractor's ability to properly place the concrete will not be adversely compromised.

H. Grout:

1. Mix products in strict compliance with the manufacturer's recommendations and these Specifications.
2. Have sufficient manpower and equipment available for rapid and continuous mixing. Keep all necessary tools and materials ready and close at hand.
3. Immediately prior to placement of the mortar or concrete, the clean surface shall be thoroughly wetted for a period of not less than one hour. All standing water in depressions, holes or areas of concrete removal shall be blown out with compressed air. The mixture shall be placed and struck-off to approximately 1/4" above final grade. It shall then be consolidated and finished at final grade with the vibrating devices. Spud vibration shall be used at the edges and adjacent to joint bulkheads. Hand finishing with a float may be required along the edge of the placement or on small areas of repair. Edge tooling will be required at all joints. Screed rails and/or construction bulkheads shall be separated from the newly placed material by passing a pointing trowel along their inside face. Metal expansions dams shall not be separated from the wearing surface. Care shall be exercised to ensure that this trowel cut is made for the entire depth and length of rails after the mixture has stiffened sufficiently. All operations behind the screeds shall be conducted from work bridges suspended above the wearing surface. The bridges shall be of rigid construction and shall not be in contact with the surface of the mortar or concrete in any manner. Straight-edging and edging shall be accomplished while the mortar or concrete is still workable.

3.9 PLACING CONCRETE

- A. No concrete shall be placed by pumping methods without the prior submission of a pumping mix and written approval. Should the Contractor be allowed to place concrete by pumping methods, procedures, mix design of concrete, and all other precautions shall be in accordance with ACI 304.2R and as approved by the Engineer.
- B. Pumps: Concrete may be conveyed by positive displacement pumps when approved. The concrete mix shall be designed for pumping. The pump shall be the piston or squeeze pressure type. The pipeline shall be steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. The distance to be pumped shall not exceed the limits recommended by the pump manufacturer. The concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the

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concrete in place. After each operation, the equipment shall be thoroughly cleaned, and flushing water shall be wasted outside the forms.

- C. Concrete shall be placed in alternate areas, as defined by the construction and control joints indicated on the design drawings. A minimum of 3 days shall elapse between placements of adjacent sections.
- D. Deposit concrete as near its final position as possible to avoid segregation. Should any segregation occur, before the concrete is placed it shall be remixed. Concrete shall be placed in the forms in horizontal layers not over 1 feet. Concrete shall not be allowed to drop freely more than 4 feet. If the free drop to the point of placement must exceed 4 feet, the Contractor shall obtain approval for the proposed method of depositing the concrete. The concrete shall not be required to flow over distances greater than 3 feet in any direction in the forms or on the ground, unless otherwise permitted.
- E. Do not place concrete for supported elements until concrete previously placed in the supporting element (column, slabs and/or walls) has reached 70% of its 28-day strength.
- F. Slabs and beams shall be cast monolithically, unless detailed otherwise on the drawings.
- G. Unless otherwise noted, the work begun on any day shall be completed in daylight of the same day.
- H. "Cold Joints" are to be avoided, but if they occur, they are to be treated as bonded construction joints.
- I. Chutes for conveying concrete shall be of U-shaped design and sized to insure a continuous flow of concrete. Flat (coal) chutes shall not be employed. Chutes shall be metal or metal-lined and each section shall have approximately the same slope. The slope shall not be less than 25 or more than 45 degrees and shall be such as to prevent segregation of the ingredients. The discharge end of the chute shall be provided with a baffle plate or spout to prevent segregation. If the discharge end of the chute is more than 5 feet above the surface of the concrete in the forms, a spout shall be used and the lower end maintained as near the surface of deposit as practicable. When the operation is intermittent, the chute shall discharge into a hopper. Chutes shall be thoroughly cleaned before and after each run, and the debris and any water shall be discharged outside the forms. Concrete shall not be allowed to flow horizontally more than 5 feet.
- J. Concrete slabs on the ground shall be well-tamped into place and foundation material shall be wet, tamped, and rolled until thoroughly compacted prior to placing concrete.
- K. Belt conveyors: Belt conveyors may be used when approved. Conveyors shall be designed and operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar, and shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement
- L. Concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete that has hardened sufficiently to cause the formation of seams and planes of weakness within the section. If a section cannot be placed continuously, construction joints may be located at points as provided for in the drawings or approved by the Engineer.
- M. Concrete Placing During Cold Weather:

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1. For this Specification, cold weather is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40°F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight
 2. Concrete placed during cold weather shall be batched, delivered, placed, cured and protected to compliance with the recommendations of ACI 306R and the additional requirements of this section.
 3. All details of Contractor's handling and protecting of concrete during freezing weather shall be subject to approval. All procedures shall be in accordance with provisions of ACI 306. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.
 4. Concrete shall not be placed on frozen ground, and no frozen material or material containing ice shall be used. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40°F, or is expected to fall to below 40°F, within 72 hours, and the concrete after placing shall be protected by covering, heat, or both. No accelerant shall be used to prevent freezing.
 5. The temperature of concrete surfaces shall not be permitted to drop below 50°F for at least 7 days after placement of the concrete.
- N. Concrete placing During Hot Weather:
1. For this Specification, hot weather is defined as any combination of high air temperatures, low relative humidity, and wind velocity that produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour.
 2. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. The Contractor shall make every effort to minimize delays, which will result in excessive mixing of the concrete after arrival on the job.
 3. During periods of excessively hot weather (90°F or above) ingredients in the concrete shall be cooled as much as practical before mixing and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305. Any concrete with a temperature above 90°F when ready for placement will not be acceptable, and will be rejected. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. The record shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.
 4. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 5. Wet form, particularly metal deck, before placing concrete.
- O. Temperature records shall be kept for all concrete placements that record date and outside temperature during the work. Thermometer reading shall be taken at start of work in morning, at noon, and again late in afternoon. Locations of concrete placed during such periods shall likewise be recorded, in such manner as to show any effect temperatures may have had on construction. Copies of temperature record shall be distributed daily to the Engineer.
- P. Concrete during and immediately after depositing shall be thoroughly compacted by means of suitable tools. Internal type mechanical vibrators shall be employed to produce the required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents or "pumping" or migration of air. All

vibrators shall be supplemented by proper wooden spade puddling adjacent to forms to remove included bubbles and honeycomb. This is essential for the top lifts of walls. All vibrators shall travel at least 10,000 rpm and be of adequate capacity. At least one vibrator shall be used for every 10 cu. yd. of concrete per hour. In addition, one spare vibrator in operating condition shall be on the site.

- Q. Do not use vibrators to transport concrete within forms. Insert vibrators and withdraw at points from 18-in to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from five to 15 seconds. Do not over vibrate so as to segregate.
- R. Pipes and embedded metals:
1. Special care shall be taken to bring the concrete into solid contact with pipes and iron work embedded in the walls and floors, particularly underneath and around all pipes where a head of water exists, making watertight joints.
 2. In general, such embedded items are not shown on the structural design drawings. Design drawings of the other trades shall be consulted for their location and details.
 3. Anchor bolt location, size and details shall be verified with the equipment manufacturer's certified drawings before installation.
 4. Anchor bolts, reglets, sleeves, edge angles and similar embedded items will be provided, delivered to the site under other Sections of the specification, for installation under this Section.
 5. Where edge angles, etc., have nuts welded on to receive machine screws, the threads of the nuts shall be protected from concrete, and the concrete shall be excluded from the space to be occupied by the screw, by the use of wood plugs or other effective means.
 6. Inserts required for hanging mechanical and electrical items will be provided and installed in the forms under the mechanical and electrical Sections of the specification.
 7. Should the Contractor be allowed to leave openings in the concrete for pipes or ironwork, to await the arrival of items that would delay the prosecution of the work, the openings shall be subject to approval. Appropriate construction joints shall be provided. In filling any such openings with concrete, a mixture of 1: 1-1/2 : 3 shall be used and a watertight bond shall be secured between the old and new concrete.
 8. In bolting miscellaneous items to concrete after the concrete has set, expansion bolts of an approved pattern and type shall be used. The Contractor shall submit for approval, the types of expansion bolts. Expansion bolts shall not be used until they are approved.

3.10 FINISHING of UNFORMED CONCRETE SURFACES

- A. Floors and slabs shall be compacted with internal vibrators and screeded to the established grades. Unless designated otherwise, concrete floors shall have a troweled finish as specified in Section II.7 of ACI 30I. Troweled finishes shall conform to the requirements of "Class A Tolerances," Section II.9 as specified in ACI 30I.
- B. Following screeding as specified above, float the slabs. The floating operation shall be continued until sufficient mortar is brought to the surface to fill all voids. The surfaces shall be tested with a straightedge to detect high and low spots that shall be eliminated. Excessive floating shall be avoided.
- C. The excessive use of "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate away from the surface and allowing a layer of mortar to accumulate will not be permitted on any slab finish. The dusting of surfaces with dry materials will not be permitted. All edges of slabs and tops of walls shall be rounded off with a steel-edging tool. Steel edging tool radius shall be ¼ inch for all slabs subject to wheeled traffic.
1. Steel Trowel Finish

- a. Finish by screeding and floating with straightedges to bring the surfaces to the required elevations. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated to a true, even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood floats to bring moisture to the surface. After surface moisture has disappeared, the concrete shall be hand steel troweled to produce a smooth, impervious surface, free from trowel marks. An additional troweling shall be given the surface for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Dry cement or additional water shall not be used in troweling, not will excessive troweling be permitted.
 - b. The slab finish tolerances and slope tolerances and/or repairs shall be as herein before specified. Floor flatness measurements will be made the day after a concrete floor is finished and before the shoring is removed, in order to eliminate any effects of shrinkage, curling, and deflection. A 12-ft long straightedge shall be supported at each end with steel gauge blocks whose thickness is equal to tolerance specified. Floor surface shall not have crowns so high as to prevent 12-ft straightedge from resting on the two end locks, nor low spots so low that a third block of twice the tolerance in thickness can easily pass under the supported straightedge.
 - c. Compliance with the designated limits in four of five consecutive measurements will generally be satisfactory, unless obvious faults are observed. A check for adequate slope and drainage will also be made to confirm compliance with Project requirements.
 - d. On areas to received adhered flooring, coordinate with flooring subcontractor on the compatibility of steel trowel slab finish with the flooring system.
2. Wood Float Finish. Slabs shall be finished by screeding with straightedges to bring the surface to the required finish plane. Slab shall be wood floated to compact and seal surface. All laitance shall be removed and the surface left clean.
 3. Light Broomed Finish. Steel trowel finish the concrete as specified above, except that the final troweling shall be omitted and the surface shall be finished by drawing a fine-hair broom lightly across the surface. All brooming shall be in the same direction and parallel to expansion joints or in the case of inclined slabs, perpendicular to the slope except as directed otherwise.
 4. Heavy Broomed Finish. Steel trowel finish the concrete as specified above, except that the final troweling shall be omitted and while the concrete is still soft enough, the surface shall be finished by a steel wire broom or a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the Engineer.
 5. Sidewalk Finish. Walks adjacent to structures shall slope down $\frac{1}{4}$ inch per foot away from structures, unless otherwise shown. The surface shall be struck off by means of a strike board and floated with a wood or cork float to a true plane, then flat steel troweled before heavy brooming. The surface shall be broomed at right angles to the direction of traffic. Sidewalk surfaces shall be laid out in blocks as shown or as directed.
 6. Power Machine Finish. In lieu of hand steel trowel finishing, an approved power machine for finishing concrete floors and slabs may be used in accordance with the directions of the machine manufacturer. The use of a power machine will not be allowed when the concrete has not attained the necessary set to allow finishing without introducing high and low spots in the slab. Hand steel trowel the areas of slabs not accessible to power equipment. A final steel troweling shall be done by hand over all areas.

3.11 FINISHING of FORMED CONCRETE SURFACES

- A. Concrete shall not be stripped and shores shall not be removed before the concrete has been cured and attained required strength.

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- B. Care shall be exercised to prevent damaging edges or obliterating the lines of chamfers, rustications, or corners when removing the forms or doing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- D. Off-Form Finish – For concrete not exposed to view - Fins and other projections shall be removed, dull sharp edges, and tie cones and defects filled.
- E. Rubbed Finish
 - 1. In addition to scraping, concrete surfaces which will be exposed to view and concrete surfaces which are to be prepared and painted as specified in Section 09 91 00, PAINTING, shall receive a smooth rubbed finish, in accordance with ACI 301 and as described below.
 - 2. Form tie holes and other voids and faults shall be patched. Voids shall be cleaned out, roughened, thoroughly wetted, coated with neat cement paste, and filled with mortar of cement and sand in the same proportions, materials, and color as used in the concrete. The surface of the patch shall be flush with the surrounding surface after finishing operations are complete. Surface shall be kept continuously damp until patches are firm enough to be rubbed without damage.
 - 3. Immediately upon stripping forms and before concrete has changed in color, all fins shall be carefully removed with a hammer. While the wall is still damp apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat with all pits, air holes or blemishes in the parent concrete; avoid coating large areas of the finished surface with this slurry
 - 4. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout consisting of one volume cement to 1-1/2 volumes of clean masonry sand having a fineness modulus of approximately 2.25 and complying with the gradation requirements of the ASTM for such a material. Grout shall be uniformly applied by means of camp (neither dripping wet nor dry) pads of coarse burlap approximately 6-in square used as a float. Grout shall be well scrubbed into the pits and air holes to provide a dense mortar in the imperfections to be patched.
 - 5. Allow the mortar to partially harden for one or two hours depending upon the weather. If the air is hot and dry, keep the walls damp during this period using a fine fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the perpendicular edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. Grout allowed to remain on the wall to long will get too hard and will be difficult to remove.
 - 6. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout should remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cut with the trowel so it can be wiped off clean with the burlap.
 - 7. On the day following the repair of pits, air holes and blemishes, the walls again shall be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild-abrasive. After this treatment, there shall be no built-up firm remaining on the parent surface. If, however, such is present a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without working up a lather or mortar or change the texture of the concrete. Rubbing shall be performed while the surface is wet using a Carborundum or cement sand brick, to achieve a smooth uniform, even textured finish. Patched and chipped areas shall be blended to match as closely as possible the appearance of the rest of the surface. No cement wash or plastering will be permitted, and no mortar shall be used except as required above.

8. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operation in order that no extraneous materials remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.

3.12 CONCRETE FINISH SCHEDULES

- A. Finishes to the base concrete for the following conditions shall be as scheduled below and further specified herein:
 1. Concrete to receive dampproofing or sheet membrane waterproofing – off-form finish
 2. Exterior concrete excluding slabs and walking surfaces and exposed interior concrete – Rubbed finish.
 3. Concrete to receive seamless flooring – Once-over steel trowel finish.
 4. Exposed interior concrete including underside slabs, beams and stairs and sides of openings, beams and stairs – Rubbed finish.
 5. Concrete to receive cementitious finish or fill – off-form finish.
 6. Exposed interior concrete slab – Light broom finish.
 7. Electrical and mechanical rooms and at interior stair with exposed concrete – wood float.
 8. Concrete for exterior stairs and walking surfaces – Heavy broomed finish, non-slip perpendicular to direction of travel.
 9. Concrete not exposed in the finished work and not scheduled to receive an additional applied finish or materials – off-form finish at vertical surfaces, consolidate and screed to grade at horizontal surfaces.
 10. Concrete to receive capillary waterproofing – off-form finish.
 11. Concrete to receive paint – Rubbed finish.
 12. Top of curbs and pads – Steel trowel finish.
 13. Concrete to receive ceramic and quarry tile – Heavy broomed finish as approved.
 14. Concrete to receive entrance mat and resilient tile flooring – Steel trowel finish.

3.13 CONCRETE TO RECEIVE ADHERED FLOOR FINISH

- A. Concrete to receive adhered floor finish shall be cured only by the application of waterproof sheet materials. Do not use water or membrane curing compound. Curing shall be carried out for a minimum of 7 days or as required by the mix design.
- B. Coordinate with adhered flooring technical representative and subcontractor on the means and methods of curing, protection of concrete and moisture control of concrete for proper adhesion of the floor finish.
- C. Allow concrete to cure and dry adequately. Unless otherwise agreed upon with the flooring technical representative and subcontractor, drying time for normal weight concrete will take about 90 days and 180 days for light weight concrete. Drying time will vary with the mix design.
- D. Upon satisfactory curing and drying time of the concrete floor, moisture density testing will be carried out by the flooring subcontractor.
- E. Additional mitigation to the concrete surface for compatibility with the adhesive and flooring material e.g. Blastrac surface and application of moisture control coating, shall be carried out by the flooring subcontractor.

3.14 REPAIRING of UNFORMED CONCRETE SURFACES

- A. As soon as the forms have been stripped and the concrete surfaces exposed fins and other projections shall be removed, recesses left by the removal of form ties shall be filled, and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- B. Tops of slabs and walls shall be repaired by using either same material as originally cast or by use of dry-pack material, as approved by Designer. Areas affected shall be chipped back square and to depth of one inch minimum. Hole shall then be moistened with water for a minimum of two hours, followed by brush coat of 1/16 inch thick cement paste. Immediately plug hole with concrete, or with dry pack material consisting of 1:1.5 mixture of cement and concrete sand mixed slightly damp to touch. Hammer dry-pack into hole until dense, and excess paste appears on surface. Finish patch flush and to same texture as surrounding concrete. For large repairs employ 1-1-2 mixture of cement, concrete sand and pea gravel at same dry-pack consistency.

3.15 CURING AND PROTECTION

- A. When concrete is placed at or below ambient air temperatures of 40°F. or whenever in opinion of Designer, such or lower temperatures are likely to occur within 48 hours after placement of concrete, cold weather concreting procedures, according to ACI 306 and as specified herein, shall be followed. To this end, entire area affected shall be protected by adequate housing or covering, and heating. No salt, chemicals or other foreign materials shall be used in the mix to lower freezing point of concrete.
- B. Protect concrete work against injury from heat, cold, and defacement of any nature during construction operations.
- C. Concrete shall be treated and protected immediately after concreting or cement finishing is completed, to provide continuous moist curing above 50°F. for at least seven days, regardless of ambient air temperatures.
- D. Keep permanent temperature records showing date and outside temperature for concreting operations. Thermometer readings shall be taken at start of work in morning, at noon, and again late in afternoon. Locations of concrete placed during such periods shall likewise be recorded, in such manner as to show any effect temperatures may have had on construction. Copies of temperature record shall be distributed daily to Designer.
- E. Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. All materials and equipment needed for adequate curing and protection shall be available and at the placement prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods or combination thereof, as approved. Concrete curing shall be performed as specified in ACI 301 and as stated herein. All curing procedures shall have prior approval.
- F. Concrete Floors which are to receive paint, concrete fill, mortar setting beds, grout fill, or any other subsequent finish shall be cured by one of the following procedures immediately after completion of placement and finishing:
 - 1. Ponding or continuous sprinkling. Moist curing: concrete to be moist cured shall be maintained continuously wet for the entire curing period. If water or curing materials used

- stains or discolors concrete surfaces that are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated polyethylene-coated burlap or saturated burlap.
2. Application of absorptive mats or fabric kept continuously wet. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and end lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Application of waterproof sheet materials conforming to ASTM C171.
 4. Application of curing compounds conforming to ASTM C309, if it can be demonstrated that the compound is applicable and that it will not prevent bonding of the subsequent finish to be received. Compound shall be placed at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
 5. Curing procedure shall be continued for at least 7 days.
 - a. Moisture loss from surface placed against metal or wood forms shall be minimized by keeping forms wet until removal.
 - b. When forms are removed during the curing period, surfaces shall be cured by spraying or by the use of a curing compound as previously specified.
 - c. Surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary, 1/2-inch thick plywood sheets shall be used to protect the exposed surface.
 6. Bracing and Supports:
 - a. All concrete members shall be adequately and safely supported and braced until the permanent supports and braces are installed.
 - b. Backfilling against exterior walls shall not be done until supporting slabs are in place and have attained 70 percent of design strength, otherwise walls shall be braced against earth lateral pressure, using a system approved by the Engineer.
 - c. Backfilling against retaining walls shall not commence until the wall concrete has reached its 28 day strength.
- G. Concrete Floors which are exposed to view shall be moist/water cured as described above. No curing compound shall be used unless in combination with sealer/hardener.
- 3.16 SEALER – install according to manufacturer's written instructions.
- 3.17 REMOVAL OF FORMWORK, SHORING AND RESHORING
- A. Contractor shall be responsible for proper removal of formwork, shoring, and reshoring.
 - B. Forms shall be removed only after concrete has attained sufficient strength to support its shown weight, construction loads to be placed thereon and lateral loads, without damage to structure or excessive deflection.
 - C. Forms and supports shall remain in place for not less than minimum periods of time noted below. These periods represent cumulative number of days or fractions thereof, consecutive unless otherwise approved by Designer during which time mean daily air temperature at surfaces of concrete is above 50°F.
 1. Vertical surfaces: concrete shall have reached 100 day-degrees and shall have attained strength of not less than 50 percent of F'c. Where such forms also support formwork for slab or beam soffits, removal times for latter shall govern.

- 2. Horizontal surfaces: except as noted below, concrete shall have reached 500 day-degrees of curing and attained strength of not less than 70 percent of F'c and also sufficient strength to support safely its own weight and the construction loads upon it.
 - a. Soffits of beams or girders shall remain supported and in place until concrete has attained 600 day-degrees.
 - b. Forms and supports of floor slabs shall remain in place until concrete has reached 500 day-degrees.
 - 3. Definition of day-degrees: Total number of days, times mean daily air temperature at surfaces of concrete. For example, five days at temperature of 60°F equals 300 day degrees. Days or fractions of days in which temperature is below 50°F shall not be included in calculation of day-degrees.
- D. Form removal shall be so performed that reshores are placed at same time as stripping operations, and that no area larger than one-fourth of a slab panel is unsupported at any time.
 - E. Any test cylinders required to verify the specified minimum strengths for form removal shall be field cured under the same conditions as the concrete they represent. Such cylinders and testing shall be at the Contractor's expense.
 - F. Backfill against cantilever retaining wall shall not commence until concrete has reached its 28-day strength.

3.18 REPAIRING AND FINISHING of FORMED AND ENGINEERED CONCRETE SURFACES

- A. In accordance with the provisions of ACI 301, Chapter 10, all concrete shall have "smooth form finish".
- B. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes. However, where patching is acceptable to Designer, procedure described below shall be followed.
- C. Defective concrete and honeycombed areas shall not be patched unless examined and approval is given by Designer. If such approval is received by Contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to afford proper ultimate bond thereto. For areas less than one and one-half inches deep, patch shall be made in same manner as described above for filling unformed concrete surfaces, care being exercised to use crumbly-dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs shall require build-up in successive days, each layer being applied as described. To aid strength and bonding of multiple layer repairs, non-shrink, non-metallic aggregate shall be used as an additive as follows:

Materials	Volumes	Weights
Cement	1.0	1.0
Non-Metallic Aggregate	0.15	0.25
Sand	1.5	1.55

For very heavy (generally, formed) patches, pea gravel may be added to mixture and proportions modified as follows:

Materials	Volumes	Weights
Cement	1.0	1.0
Non-Metallic Aggregate	0.2	0.33
Sand	1.0	1.0
Pea Gravel	1.5	1.55

After hardening, rub lightly as described above for form tie holes.

1. Mortar for patching shall be same mix as above except aggregate shall pass a No. 14 sieve.
 2. For all concrete to receive "smooth" finish, remove formwork fins and clean entire surface of grease, form oil, laitance, dust, and other foreign matter.
 3. "Smooth" finish shall consist of having all fins removed, joint marks smoothed off, blemishes removed, and surfaces left smooth and unmarred.
 4. Begin finishing operations as soon as practicable after removal of forms, continue with curing operations after finishing is completed. After concrete has been well cured, carefully inspect surfaces. Remove any fins, rough spots, streaks, hardened mortar or grout and other foreign material. Patch defects with finishing mortar as specified above, to satisfaction of Designer.
- D. Patches which become crazed cracked, or sound hollow upon tapping shall be removed and replaced with new material at Contractor's expense.

3.19 REPAIRING AND PATCHING of EXISTING CONCRETE SURFACES

- A. When cutting through existing concrete slab and/or floors, care shall be taken to avoid over-cut at corners. Prior to cutting operation, corners of the penetration shall be cored through. Cutting of the penetration shall then be brought to the corner cores. Hand chipped corners as required should square corners be desired.
- B. Repairing and patching of existing concrete surfaces damages and/or affected this Project shall be done in similar method as described in previous paragraph.

3.20 CLEANING

- A. Concrete surfaces shall be cleaned of objectionable stains as determined by the Designer. Materials containing acid in any form or methods which will damage "skin" of concrete surfaces shall not be employed, except where otherwise specified.

3.21 FAILURE TO MEET REQUIREMENTS:

- A. The Designer shall have the right to reject concrete represented by low strength tests or to agree to further testing of the concrete. Rejected concrete shall be promptly removed and replaced with concrete conforming to the specification. The decision as to whether substandard concrete is to be accepted or rejected or additional tests shall be conducted shall be final. All direct and indirect costs associated with further curing and testing of the concrete shall be at the Contractor's expense.

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- B. If the Designer agrees to consider further curing and/or testing of the concrete before making a final decision, the Contractor shall submit a detailed plan, including proposed criteria for acceptance of the concrete. The plan may include additional curing of the concrete, drilling and testing of cores, load testing of the structure, or a combination.
- C. If additional curing is permitted before further inspection and testing, the Contractor shall provide any necessary materials and labor to further cure the suspect concrete.
- D. If drilling and testing of cores is permitted, the Contractor shall be responsible for obtaining the cores; including provision of ladders, scaffolding, and such incidental equipment as may be required. If additional curing is permitted, cores shall be drilled after the curing period, and shall be in accordance with ASTM Methods C39 and C42. The Contractor shall repair all core holes.
- E. The burden of proof, including, but not limited to the work of cutting and testing the cores, inspection, evaluation, repair of the holes, or removal and replacement of the concrete in question, and all associated costs, shall be at the expense of the Contractor.
- F. If load testing of the concrete is permitted, and if not otherwise indicated, slabs or beams under load test shall be loaded with their own weights plus a superimposed load of 2 times the design live load. The load shall be applied uniformly over the portion being tested in the approved manner and left in position for 24 hours. The structure shall be considered satisfactory if deflection "D" in feet, at end of 24-hour period, does not exceed the following value:

D equals $0.001 (L \times L)/t$

in which "L" is span in feet, "t" is depth of slab, or beam in inches. If deflection exceeds "D" in the above formula, the concrete shall be considered faulty unless within 24 hours after removal of the load, the slab, or beam under test recovers at least 75 percent of the observed deflection.
- G. If the suspect concrete still fails to meet specification requirements, the Engineer shall have the right to reject the concrete, have it removed and replaced, in accordance with paragraph A above, or to require mechanical strengthening of the concrete to satisfy project requirements. The Contractor shall submit a removal and replacement plan for review.

END of SECTION 03 30 00

SECTION 051200

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Structural Steel for this Project is that work defined in the 6/10/92 edition of AISC's – Code of Standard Practice for Steel Buildings and Bridges, Section 2.1 in its entirety plus the following:
 - a. Structural steel.
 - b. Metal parts that are to be shop attached to structural steel, including but not limiting to: exterior metal panel connection plates and shapes, Light gauge metal wall framing connection plates, metal deck connection plates, miscellaneous plates, fittings and holes required for the assembly or erection of materials and equipment supplied by trades other than structural steel. Coordinate shop attached items required and details with the other affected trades.
 - c. Metal parts and connectors shown on the Structural Contract Drawings, except those normally supplied/installed by another trade. The work includes steel elements of structural steel frame essential to support design loads and consisting of material shown on Drawings and described as follows:
 1. Bases or Bearing Plates
 2. Beams, Girders
 3. Columns, Posts
 4. Bracings
 5. Connecting Material for Framing Structural Steel to Structural Steel, Metal Deck to Structural Steel, Structural Steel to Concrete, Structural Steel to Light Gauge Metal Framing System and Wood to Structural Steel.
 6. Fasteners for connecting exterior and interior finishes to Structural Steel
 7. Secondary framing shown on structural drawing.
 - d. Secondary framing for roof openings.
 - e. Secondary framing for support of equipments, including roof mounted mechanical equipments and finishes shown on the Contract Drawings.
 - f. Coordination, fabrication and installation of openings (reinforced and unreinforced) through the structural steel to accommodate materials and equipment of other respective trades.
 - g. Shop primer and field touch up for structural steel.
2. Design of all steel connections by a professional structural engineer registered in the

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3. Furnish all labor, material, plant, transportation, equipment accessories, appurtenances, and services necessary and/or incidental to the proper completion of all steel work shown on the Contract Drawings, described in the specifications, or as reasonably inferred from either, in the opinion of the Architect, as being required.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: None anticipated.
- D. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections
1. Section 033000 - CAST-IN-PLACE CONCRETE.
 - a. Lintels, sleeves, anchors, inserts, embedded wall plates, loose leveling plates, and similar items.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 099000 - PAINTING AND COATING for finish painting of exposed structural steel not shop painted under this Section.
- F. Hoisting Equipment: This Contractor shall furnish, install and maintain in safe and adequate condition all mechanical hoisting equipment, operating personnel and rigging that is necessary for the proper execution of the Work of this Section.
- G. Staging, Planking and Scaffolding: This Contractor shall furnish, install and maintain in safe and adequate condition all staging, planking and scaffolding that is necessary for the proper execution of the Work of this Section.
- H. Sustainable Design Requirement: Structural steel shall be produced using on average min. 95% recycled materials and shall be milled and fabricated within 500 miles of the project site.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Contractor: All Trades involved in the execution of this section of the specifications.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
 1. Use Allowable Stress Design (ASD) for design of connections with un-factored reactions.
 2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.
- B. Construction: Type PR, partially restrained.

STRUCTURAL STEEL FRAMING

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- C. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load and Concentrated Loads: As required by Code.
 - 2. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 3. Limit deflection of treads, platforms, and framing members to $L/360$ or $1/4$ inch, whichever is less.
 - 4. Seismic Performance of Stairs: Provide metal stairs capable of withstanding the effects of earthquake motions determined according to Code.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Any accompanying connection design calculation will be submitted for record purposes only and will not be reviewed for its completeness and accuracy.
 - 6. Prior to submittal to the Architect, all shop drawings shall be reviewed by the Contractor for general conformance to the Construction Documents and for coordination with other disciplines/trades. All non-conformance drawings shall be sent back to the steel fabricator for correction prior to submittal to the Designer. Interferences with other disciplines/trades shall also be noted to the shop drawings.
- C. Welding certificates.
 - 1. Submit welding procedures and processes to be used on this Project per AWS D1.1.
 - 2. Provide welder certifications for all welders to be employed on this Project. Certification of welders shall be the responsibility of the Contractor.
- D. Qualification Data: For Installer, fabricator, professional engineer, testing agency.
 - 1. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements: Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Direct-tension indicators.
 - 4. Tension-control, high-strength bolt-nut-washer assemblies.
 - 5. Shop primers.
 - 6. Nonshrink grout.
- E. Source quality-control test reports.
- F. Sustainable Design Documentation:

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1. Material costs for structural steel, distance from producer/manufacturer/fabricator to project site, recycled material content as required by Contract Specification Requirements
2. Pre-consumer and post-consumer recycled content, based on weight and cost, per LEED credit MR-4.
3. Obtain where available, and document the weight and cost of regional materials, in accordance with LEED point MR-5.

1.6 QUALITY ASSURANCE

- A. The work shall be performed in accordance with the requirements of the Massachusetts State Building Code (MSBC), Eight Edition, 2009 International Building Code, American Institute of Steel Construction (AISC), and OSHA regulations, supplemented by the Contract documents.
- B. Reference Standards:
 1. American Institute of Steel Construction
 - a. Code of Standard Practice for Steel Buildings and Bridges
 - i. Paragraph 4.2.1 of code is modified by deletion of following sentence: "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any connections designed by the fabricator as part of his preparation of these shop drawings."
 - b. Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings, including Commentary and Supplements as issued.
 - c. AISC Specifications for Structural Joints using ASTM A325 or A490 Bolts, approved by Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
 2. American Welding Society
 - a. AWS D1.1 Structural Welding Code
 3. American Society for Testing and Materials
 - a. ASTM A36 Structural Steel
 - b. ASTM A108 Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
 - c. ASTM A123 Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
 - d. ASTM A143 Standard Practice for Safeguarding Against Embrittlement of Hot Dip Galvanized Structural Steel Products and Procedure for Determining Embrittlement.

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- e. ASTM A307 Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
- f. ASTM A325 High Strength Bolts for Structural Steel Joints
- g. ASTM A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing Structural Steel Assemblies.
- h. ASTM A385 Standard Practice for Providing High Quality Zinc Coating (Hot Dip).
- i. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
- j. ASTM A572 High-Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
- k. ASTM A576 Specifications for Steel Bars. Carbon, Hot-Wrought, Special Quality
- l. ASTM F436 Specification for Hardened Steel Washers

C. Qualifications:

- 1. Fabrication:
 - a. Company specializing in performing the work of this section with minimum 10 years of experience.
 - b. A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd.
- 2. Erector:
 - a. Company specializing in performing the work of this section with minimum 10 years' experience.
 - b. A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- 3. Steel Connections:
 - a. Design connections not detailed on the drawings under direct supervision of a professional structural engineer registered in the Commonwealth of Massachusetts and experienced in design of this work.
- 4. Welding Work:
 - a. Qualify welding processes and welding operators according to AWS Standard Qualification Procedure.
 - b. Provide certification welders to be employed in Work have satisfactorily passed AWS qualification tests.
 - c. If recertification of welders is required, retesting will be Contractor' responsibility and at no cost to the owner.

D. Required Designs by Contractor:

- 1. Where "designs" are required of the Contractors by the Contract Documents, the designs shall be performed by competent, qualified and experienced professional Structural Engineers, registered in the Commonwealth of Massachusetts. Such designs shall be prepared in a design document format (not a shop drawing format), be stamped and signed by the professional Engineer who performed the design and, where specifically requested, be submitted to the Architect for record purposes only. In addition, the

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professional Engineers retained by the Contractor to perform the designs required by the Contract Documents shall review the shop drawings associated with their designs and visit the manufacturing facility or fabricating plant and the construction site to observe that the work is being performed in accordance with their designs. The costs associated with their designs, materials and labors shall be borne by the Contractor. The responsibility for designs required of the Contractors shall remain solely with the Contractors.

- E. Source Limitations:
 - 1. Sustainable Design Requirement: Structural steel shall be produced using on average min. 90% recycled materials and shall be fabricated within 500 miles of the project site.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. Materials:
 - 1. All materials shall be new and un-spliced.
 - a. For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
 - b. Remove such blemishes by grinding, or by welding and grinding, before cleaning, treating, and application of surface finishes.

- B. W-Shapes: ASTM A 572/A 572M, Grade 50.
- C. Channels, Angles, M, S-Shapes: ASTM A 572/A 572M, Grade 50.
- D. Plate and Bar: ASTM A 36/A 36M
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
- G. Medium-Strength Steel Castings: ASTM A 27/A 27M, Grade 65-35 carbon steel.
- H. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-50, carbon or alloy steel.
- I. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.
- C. Washers for anchor bolts and fasteners: Flat circular hardened washers, square or rectangular hardened beveled washers and square or rectangular flat plate washers as follows:
 - 1. Hardened steel washers: ASTM F436, used where standard or short slotted holes are in the outer plies of the connections.
 - 2. Plate washers: ASTM A36, 5/16" minimum thick with standard holes used where oversized or long slotted holes are in the outer plies of the connections. Size plate washers to completely cover holes
- D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- E. Anchor Rods: ASTM F 1554, grade as applicable, hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- F. Threaded Rods: ASTM A 193/A 193M, grade as applicable, hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- G. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

- H. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" [and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design"].
 - 1. Camber structural-steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Fabricate for delivery sequence that will expedite erection and minimize field handling of materials.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
 - 6. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions. No manual welding of shear connector to structural steel is allowed.
- F. Holes for other works: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.5 SHOP CONNECTIONS

- A. Connections not shown on the Structural Drawings shall be designed by a professional structural engineer registered in the Commonwealth of Massachusetts and well versed in steel connection design and retained by the steel fabricator. Use Allowable Stress Design (ASD) when design of connection includes one or more un-factored reactions.
1. Weld or bolt shop connections, as indicated.
 2. Bolt field connections, except where welded connections or other connections are indicated.
 3. Provide high-strength threaded fasteners for principal bolted connections, except where unfinished bolts are indicated.
 4. Provide unfinished threaded fasteners for only bolted connections of secondary framing members to primary members, including purlins, girts and other framing members taking only nominal stresses, and for temporary bracing to facilitate erection.
- B. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened
- C. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.6 STEEL PRIMERS AND FINISHES

- A. Shop Primer:
1. Primer: One-component aromatic polyurethane containing iron oxide and zinc filled primer such as PerimePrime Series 394 by TNEMEC, or approved equivalent, compatible with selected finish paint coats and/or fire proofing. Refer to Painting and Coating Section 099000 for finish paint coat systems.
 2. Primer color shall be GRAY.
- B. Primer touch up paint: Shall be compatible with shop primer and shall not exceed the VOC content limit of 250 g/L.

- C. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for The Society for Protective Coatings (SSPC) surface preparation specifications and environmental exposure conditions of installed metal fabrications:
1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 10/NACE No. 2, "Near White Metal Blast Cleaning."
 2. Interiors (SSPC Zone 1A): SSPC-SP 6, "Commercial Blast Cleaning."
 3. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 4. Comply with SSPC-PA 2, "Measurement of Dry Coating Thickness with magnetic Gages."
- E. Galvanizing: For steel exposed to the elements, weather or corrosive environments and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process. Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware. Provide thickness of galvanizing specified in referenced standards. The galvanizing bath shall contain high grade zinc and other earthly materials. Fill vent holes and grind smooth after galvanizing.
1. Galvanizing shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments.
 2. Surface blasting prior to application of factory-applied post galvanizing wet coatings will produce a high rugosity and shall not be acceptable.
- F. Shop Priming for Galvanized Steel: For steel indicated to be galvanized and primed, provide hot-dip galvanizing and factory-applied polyamide epoxy primer, 2.0 to 4.0 mils dry film thickness, certified OTC/VOC compliant less than 2.8 lbs/gal. and conforming to EPA and Commonwealth of Massachusetts requirements. Apply primer within 12 hours after galvanizing at the galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the coating manufacturer.
1. Basis of Design: Duncan Galvanizing; Primergalv system.
- G. Shop Priming and Finish for Galvanized Steel: For steel indicated to be galvanized, shop primed and topcoated, provide factory-applied architectural coating over primed galvanized steel as previously referenced. Apply coating at the galvanizer's plant, in a controlled environment meeting applicable EPA and Commonwealth of Massachusetts regulations. Apply the galvanizing and coating within the same facility and provide single-source responsibility for galvanizing, priming and finish coating.

1. Basis of Design: Duncan Galvanizing; Colorgalv 10 system.

H. Galvanizing Repair Paint: ASTM A780.

2.7 SOURCE QUALITY CONTROL

A. Fabricator to engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports. Alternatively, the fabricator may submit valid plant certification by a recognized certifying agency, e.g. AISC. Such certification shall be not more than two years old.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and other inspection procedures, at testing agency's option.

1. All Welds – 100% visual. Acceptance criteria AWS D1.1 Table 6.1

2. Moment connections, full penetration welds – 50% UT of each weld. Acceptance criteria – AWS D1.1, Table 6.2.

3. Tension butt splices, full penetration welds – 100% UT. Acceptance criteria – AWS D1.1, Table 6.2.

4. Partial penetration welds – 25% UT of each weld. Acceptance criteria – AWS D1.1, Table 6.2.

5. Fillet welds – One 6 inch test per 50 linear feet of weld deposited by each welder. Alternately use MT and DPT. Acceptance criteria – AWS D1.1, paragraph 6.10.

6. Stud Welding – AWS D1.1, paragraphs 7.6, 7.7, and 7.8 for destructive and non-destructive

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.

2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

F. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures to meet specified requirements.

G. Promptly remove and replace materials or fabricated components that do not comply.

H. Design of Members and Connections:

1. Details shown are typical; similar details apply to similar conditions, unless otherwise indicated.
2. Verify dimensions at site whenever possible without causing delay in Work.
3. Promptly notify Architect whenever design of members and connections for any portion of structure are not clearly indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
 1. Elevations shall be verified by a surveyor licensed in the Commonwealth of Massachusetts.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- B. Base and Bearing Plates: Clean concrete bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of base plate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection unless approved by Designer. Finish thermally cut sections within smoothness limits in AWS D1.1.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.
5. All field welds that are exposed to view shall be continuous and be ground smooth.
 - a.

3.5 FIELD QUALITY CONTROL

- A. Owner Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by the Awarding Authority for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- B. Cooperate with field quality control personnel. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
- C. Additional inspections and retesting of materials which fail to comply with specified material and installation requirements shall be performed at Contractor's expense.
- D. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. Welded Connections: Dimensional tolerances for welded construction, details of welds, and quality of welds shall be in accordance with the applicable requirements of AWS D1.1 and the contract drawings. Nondestructive testing shall be by visual inspection, and ultrasonic, magnetic particle, or dye penetrant methods.
 1. All Welds – 100% visual. Acceptance criteria AWS D1.1 Table 6.1
 2. Moment connections, full penetration welds – 50% UT of each weld. Acceptance criteria – AWS D1.1, Table 6.2.
 3. Tension butt splices, full penetration welds – 100% UT. Acceptance criteria – AWS D1.1, Table 6.2.
 4. Partial penetration welds – 25% UT of each weld. Acceptance criteria – AWS D1.1, Table 6.2.
 5. Fillet welds – One 6 inch test per 50 linear feet of weld deposited by each welder. Alternately use MT and DPT. Acceptance criteria – AWS D1.1, paragraph 6.10.
 6. Stud Welding – AWS D1.1, paragraphs 7.6, 7.7, and 7.8 for destructive and non-destructive.
- F. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

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- G. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Defective Work:

- 1. Correct deficiencies in structural steel Work that inspections and laboratory test reports have indicated does not meet requirements at no expense to the owner.
- 2. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any noncompliance of original Work, and as may be necessary to show compliance of corrected Work.

- B. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

- C. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

- 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 05 12 00

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 070001 ROOFING AND FLASHING FILED SUB BID

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections apply to the work of this Section.

1.3 SUMMARY

- A. Section includes:
 - 1. Wood blocking in partition framing, including wood blocking for mounting toilet accessories.
 - 2. Door hardware installation.
- B. Related Sections include the following:
 - 1. Section 07 53 23 "EPDM Roofing".

1.4 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.

1.5 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

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- physical properties of treated materials based on testing by a qualified independent testing agency.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Fire-retardant-treated wood.
 2. Power-driven fasteners.
 3. Powder-actuated fasteners.
 4. Expansion anchors.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Plywood: DOC PS 1.
1. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
 2. Factory mark panels to indicate compliance with applicable standard.

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

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- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:
 - 1. Dricon.
 - 2. Hoover Treated Wood Products, Inc.
 - 3. Koppers Performance Chemicals.
- C. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- D. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- F. Application: Treat items indicated and the following:
 - 1. Concealed blocking in wall framing.

2.3 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Furring.
- B. For items of dimension lumber size, provide Construction or No. 2 lumber with 15 percent maximum moisture content and the following species:
 - 1. Hem-fir (north); NLGA.
- C. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.4 PLYWOOD BACKING PANELS

- A. Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

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2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, fire retardant treated, or in area of high relative humidity, provide fasteners of with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Where wood-preserved-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated.
- E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with

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function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2305.2, "Fastening Schedule," in the Massachusetts State Building Code.
- G. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood: Install 1-by-3-inch nominal- size furring vertically 24 inches o.c.

3.4 FIRE-RETARDANT-TREATED (FRT) MATERIALS INSTALLATION

- A. Cutting to length, drilling holes, joining cuts and light sanding are permissible. It is not necessary to field treat cut ends to maintain flame spread rating.
 - 1. Ripping, milling, and surfacing of FRT lumber is not permitted.
 - 2. FRT plywood can be cut in either direction without loss of fire protection.

3.5 FINISH HARDWARE INSTALLATION

- A. General: Comply with requirements indicated below and in Section 08 71 00 "Door Hardware."
- B. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be

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painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3.6 PROTECTION

- A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 070001

ROOFING AND FLASHING FILED SUB BID

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, entitled “Related Documents.”

1.3 REQUIREMENTS FOR FILING SUB-BIDS

- A. Time, Manner and Requirements for Submitting Sub-Bids:
 - 1. Sub-bids for work under this Section shall be for the complete work and shall be submitted electronically as stipulated in the “Instructions to Bidders.”
 - 2. Sub-bidders must be DCAMM Certified in the listed trade and shall include a current DCAMM sub-bidder Certificate of Eligibility and Update Statement with the bid.
 - 3. Each sub-bid submitted for work under this Section shall be on forms furnished by the Awarding Authority as required by Section 44F of Chapter 149 of the General Laws, as amended.
 - 4. Sub-bids filed with the Awarding Authority shall be accompanied by Bid Bond, Cash, Certified Check, Treasurer’s Check, or Cashier’s Check issued by a responsible bank or trust company payable to the City of Waltham in the amount of 5 percent of the sub-bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
- B. Sub Sub-Bid Requirements: None required under this Section.

1.4 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including the following Specification Sections:
 - 1. Section 061053 “Miscellaneous Rough Carpentry” for partial work of this Section.
 - 2. Section 075323 “EPDM Roofing.”
 - 3. Section 076200 “Sheet Metal Flashing and Trim.”
- B. The Work of this Section is shown on the following Drawings:

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T-1	Title Sheet
AD-4	Roof Plan - Demo
A-1	Roof Plan – Proposed
A-2	Test Cuts / Details
A-3	Details

The Trade Contractor shall also review all other Drawings and all other Sections of the Specifications for coordination requirements therein affecting the Work of this Section, not just those pertaining to this Sub-trade.

- C. Alternates: Refer to Division 01 Section “Alternates.”

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 07 00 01

SECTION 07 53 23

ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 070001 ROOFING AND FLASHING FILED SUB BID

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. BIDDING AND CONTRACT REQUIREMENTS, DIVISION 00, and the GENERAL REQUIREMENTS, DIVISION 01, are hereby made a part of this Section.
- B. Examine all Drawings and all Sections of the Specifications and requirements and provisions affecting the work of this Section.

1.3 SUMMARY

- A. Section includes the following:

1. Adhered EPDM membrane roofing system.
2. Roof insulation, tapered insulation, and crickets.
3. Vapor Retarder.
4. Cover board.
5. Membrane base flashing.
6. Pitch pockets.
7. Sheet metal flashings and trim.
8. Furnish and install joint sealants for joints associated with roofing and flashing.
9. All hoisting and scaffolding necessary for the completion of the roofing work.
10. Waste disposal.

- B. Related Sections:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, blocking, and plywood.
2. Section 076200.01 "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter-flashings.
3. Section 079200 "Joint Sealants."

1.4 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation layout, including slopes.
 - 3. Insulation fastening patterns.
 - 4. Expansion joints.
- C. Samples for Verification: For the following products:
 - 1. 6-by-6-inch square of sheet roofing, of color specified, including T-shaped side and end lap seam.
 - 2. 6-by-6-inch square of roof insulation.
 - 3. 6-inch length of metal termination bars.
 - 4. Six insulation fasteners of each type, length, and finish.
 - 5. Six roof cover fasteners of each type, length, and finish.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer.
- B. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system. Certification is required to be issued by manufacturer not less than one year prior to start of work.
- C. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of meeting performance requirements.
 - 2. Submit certificate of roof membrane sheet thickness specified, signed by manufacturer's control manager. ASTM +/- tolerance for membrane thickness is not acceptable.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
- E. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- F. Field quality-control reports.
- G. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

H. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For membrane roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

1. The Installer shall be doing business under the same name for a minimum of 5 years prior to January 1, 2023, and have applied similar roofing systems on 10 or more projects which have been completed for more than two years.

a. Furnish names and addresses of each project within 100 miles of Project.

2. The Contractor that receives the award of this Project shall be the Installer of the roofing system. Installation of the roofing system shall not be subcontracted.

C. Installer's Field Supervision: Maintain a full-time supervisor/foreman on-site during times that the roofing installation is in progress, who is experienced in installing roofing systems similar to type and scope required for this Project, and who is certified by the manufacturer as an approved applicator of the roofing system.

D. Technical Field Monitor: Arrange with an independent roofing consultant to provide the services of an on-site, full-time technical field monitor to observe the total roofing system installation, and to provide the following:

1. Confirm that the Roofing Contractor's applicators have completed the membrane manufacturer's training program.

2. Monitor quality control over the total roofing operation, including but not limited to, roofing installation, metal work, flashing, and manufacturer supplied roofing system components and accessories required for the complete installation of the roofing system.

a. Confirm that all work is in compliance with the Contract Documents and installed as required to obtain warranty.

3. Inspect roof installation daily and prepare daily punchlist for corrective action by the Installer.

4. Provide a written daily report to the Architect and Installer.

E. Source Limitations: Obtain components for membrane roofing system from or approved by roofing membrane manufacturer.

F. Preinstallation Roofing Conference: Conduct conference at Project site.

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1. Meet with General Contractor, Owner, Owner's Representative, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
 1. Store membrane rolls horizontally on pallets, fully protected from the weather with canvas tarpaulins. Non-vented, polyethylene tarpaulins are not permitted.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT CONDITIONS

- A. Temporary Support Facilities: Furnish and install all temporary lifts, hoists, staging, scaffolding, rigging, labor and materials, and temporary support to perform all operations in connection with the installation of this Work. Remove all temporary support facilities when no longer required.
- B. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

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- C. Substrate Conditions: Proceed with roofing installation after substrates have been inspected and determined to be in satisfactory condition. Commencement of work indicates acceptance of substrates.

1.11 WARRANTY

- A. Existing Warranty: Not Applicable.
- B. Special Warranty: Manufacturer's customized form, without monetary limitation, edge-to-edge, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
 - 1. Special warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, cover boards, substrate board, vapor retarder, and other components of membrane roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- C. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, and vapor retarders, for the following warranty period:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 - 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7 and the Massachusetts State Building Code.
 - 1. Exposure Category: Exposure C.
 - 2. Risk Category: III.
 - 3. Basic Wind Speed: 125 mph.

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- a. Field, edge, and corner roof zones are defined in ASCE 7-05, Figure 6-10, as referenced in the Massachusetts State Building Code.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 EPDM MEMBRANE ROOFING

- A. EPDM: ASTM D 4637, Type II, reinforced, uniform, flexible EPDM sheet.
 - 1. Basis of Design Product: Subject to compliance with requirements, provide products by **Johns Manville** or one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. Or approved equal.
 - 2. Thickness: 60 mils nominal.
 - 3. Exposed Face Color: Black.

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Protection Sheet: Epichlorohydrin or neoprene non-reinforced flexible sheet, 55- to 60-mil-thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
- D. Bonding Adhesive: Manufacturer's standard.
- E. Seaming Material: Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- wide minimum, butyl splice tape with release film.
- F. Lap Sealant: Manufacturer's standard, single-component sealant.
- G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- H. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

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- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.4 VAPOR RETARDERS

- A. Vapor Retarder: Self-adhesive vapor barrier composed of SBS modified bitumen with a top surface of high-density polyethylene grid laminated between two layers of polyethylene film, and a silicone release plastic film that covers the self-adhesive back side.
 - 1. Product: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle; VapAir Seal 725TR.
 - b. Johns Manville; Vapor Barrier SA.
 - c. Sika Sarnafil; Sarnavap SA.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. To maintain system warranty, manufacturer's approved insulation must be installed.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.6 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.
- D. Cover Board: ASTM C 1289, Type II, Class 2, high density, fiberglass coated, closed-cell polyisocyanurate foam insulation.
 - 1. Compression Strength: ASTM D 1621, not less than 100 psi.

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2. Thickness: Manufacturer's standard, not less than 1/2- inch thick.
3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle SynTec Incorporated; SecurShield HD Plus.
 - b. Firestone Building Products; IsoGuard HD.
 - c. Johns Manville; Invinsa Roof Board.
 - d. Or approved equal.

2.7 PITCH POCKETS

- A. Pitch Pockets: Stainless steel, formed to provide not less than two inches clear between the penetrating item face and vertical edge of the pitch pan.
 1. Form side walls that project not less than 6 inches above the finished sheet membrane, with 1-1/2" inside hem at the top edge.
 2. Flange: Not less than 3-1/2- inches wide.
 3. Solder all seams to avoid open joints and to form a water tight seal.
 4. Prime the interior and exterior surfaces with metal primer.

2.8 JOINT SEALANTS

- A. Exterior Joint Sealants:
 1. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) BASF Corporation-Construction Systems; MasterSeal NP 1 (formerly Sonolastic NP1).
 - 3) Pecora Corporation; Dynatrol I-XL.
 - 4) Sika Corporation, Construction Products Division; Sikaflex - 1a.
 - 5) Tremco; Dymonic.
 - 6) Or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 1. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Commencement of the work indicates acceptance of substrates.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging gutters, downspouts, and conductors and from spilling or migrating onto surfaces of other construction.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 FASTENER PULL-OUT TESTING

- A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to Architect and roofing membrane manufacturer before installing new membrane roofing system.
 - 1. Obtain roofing membrane manufacturer's approval to proceed with specified fastening pattern. Roofing membrane manufacturer may furnish revised fastening pattern commensurate with pull-out test results.

3.4 TEMPORARY CUT-OFF

- A. All flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses. All temporary waterstops shall be constructed to provide a 100 percent watertight seal. The stagger of the insulation joints shall be made even by installing partial panels of insulation. The new membrane shall be carried into the waterstop. Waterstop shall be sealed to the deck or substrate so that water will not be allowed to travel under the new or existing roofing. The edge of the membrane shall be sealed in a continuous heavy application of sealant as specified. When work resumes, the contaminated membrane shall be cut out. All sealant, contaminated membrane, insulation fillers, etc. shall be removed from the work area and properly disposed of offsite. None of these materials shall be used in the new work.
- B. If inclement weather occurs while a temporary waterstop is in place, the Contractor shall provide the labor necessary to monitor the situation to maintain a watertight condition.
- C. If any water is allowed to enter under the newly-completed roofing, the affected area shall be removed and replaced at the Contractor's expense.

3.5 VAPOR-RETARDER INSTALLATION

- A. Substrate must be clean, dry and free of dust, grease or other contaminants; smooth and free of voids. Apply primer to clean and dry surfaces with a brush, roller or sprayer at application rate recommended by manufacturer and as required for substrate. Allow primer to dry completely prior to installation of vapor barrier. Install vapor barrier on the same day as primer.
- B. Self-Adhering Vapor Retarder for Concrete Deck:

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1. Substrate must be clean, dry and free of dust, grease or other contaminants; smooth and free of voids. Apply primer to clean and dry surfaces with a brush, roller or sprayer at application rate recommended by manufacturer and as required for substrate. Allow primer to dry completely prior to installation of vapor barrier. Install vapor barrier on the same day as primer.
2. Laminate Sheet: Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 3 inches and 6 inches, respectively. Stagger end laps a minimum of 12 inches. Bond vapor retarder to substrate as follows:
 - a. Unroll sheet onto substrate without adhering for alignment. Do not immediately remove the silicone release sheet.
 - b. Once aligned, peel back a portion of the silicone release sheet and press membrane onto the substrate for initial adherence. Hold sheet tight and peel back release sheet by pulling diagonally.
 - c. Use a 75 lb. roller to press sheet down onto the substrate including the laps. Finish by aligning the edge of the roller with the lower end of the side laps and rolling up the membrane. Do not cut membrane to remove air bubbles trapped under laps. Squeeze air bubbles by pushing the roller to the edge of the laps.
3. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system. Avoid tenting or wrinkles in the vapor retarder. If tenting or wrinkles occur, cut out imperfection and apply patch over area in accordance with manufacturer's instructions.

3.6 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation and/or crickets under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
 1. Where installing composite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- E. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

- F. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
 - 3. Mechanically fasten all base layers to deck.
 - 4. Adhere tapered layers in low-rise insulation adhesive.
- G. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together.
 - 1. Adhere cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Adhere cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.7 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll membrane roofing and allow to relax before installing.
- B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
- E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeters.
- F. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of membrane roofing terminations.
 - 1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
- H. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
- I. Install membrane roofing and auxiliary materials to tie in to existing membrane roofing to maintain weather-tightness of transition.

- J. Adhere protection sheet over membrane roofing at locations indicated.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 PITCH POCKET INSTALLATION

- A. Install pitch pockets at all pipe and conduit penetrations, including equipment supports.
- B. Attach pitch pockets directly to roofing sheet membrane in accordance with roofing manufacturer's written instructions.
- C. Provide wood blocking at all pitch pockets greater than 6 inches in any direction.
- D. Fill any holes in bottom of pitch pocket with roofing insulation and fill with sand or mortar to within 2 inches of the top of the pan.
- E. Fill to top of pitch pocket with two-component, cold-applied elastomeric flashing cement.

3.10 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect and Owner's Representative.
 - 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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3.11 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 WASTE DISPOSAL

- A. Disposal: At completion of roofing work, transport demolished materials and waste off Owner's property.
 - 1. Separate, salvage, recycle, and legally dispose of materials in accordance with the Commonwealth of Massachusetts Waste Ban, 310 CMR 19.017.

3.13 PROJECT COMPLETION

- A. Prior to demobilization from the site, the work shall be reviewed by the Owner's Representative and the Applicator. All defects noted and non-compliances with the Specifications or the recommendations of the manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Applicator to the satisfaction of the Owner's Representative and the manufacturer prior to demobilization.
- B. All Warranties referenced in this Section shall have been submitted and have been accepted at time of contract award.

END OF SECTION 07 53 23

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 070001 ROOFING AND FLASHING FILED SUB BID

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. BIDDING AND CONTRACT REQUIREMENTS, DIVISION 00, and the GENERAL REQUIREMENTS, DIVISION 01, are hereby made a part of this Section.
- B. Examine all Drawings and all Sections of the Specifications and requirements and provisions affecting the work of this Section.

1.3 SUMMARY

A. Section Includes:

1. Formed Products:

- a. Counterflashing
- b. Drip edges.
- c. Roof penetration flashing.
- d. Roof drainage sheet metal fabrications.
- e. All other sheet metal work associated with Roofing.

2. All hoisting and scaffolding necessary for the completion of the work.

3. Waste disposal.

B. Related Sections:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
- 2. Section 075323 "EPDM Membrane Roofing".

1.4 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

- B. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1-1998.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
 - 3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 4. Details of termination points and assemblies, including fixed points.
 - 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 - 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 - 7. Details of special conditions.
 - 8. Details of connections to adjoining work.
 - 9. Detail formed flashing and trim at a scale of not less than 1-1/2 inches per 12 inches.
- C. Fabrication Samples: For copings and roof edge flashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.
- D. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
 - 3. Accessories and Miscellaneous Materials: Full-size sample.
- F. Qualification Data: For qualified fabricator.

- G. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.
- H. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

- A. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- B. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- C. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof eave, including gutter and fascia trim, approximately 10 feet long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with General Contractor, Owner, Architect, Construction Manager, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, and roof-mounted equipment.
 - 2. Review methods and procedures related to sheet metal flashing and trim.
 - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 4. Review special roof details, roof drainage, roof penetrations, and condition of other construction that will affect sheet metal flashing.
 - 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.8 COORDINATION

- A. Coordinate installation of manufactured roof specialties with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
 - 1. Surface: Smooth, flat.
 - 2. Exposed Coil-Coated Finish:
 - a. 2-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

C. Stainless Steel Sheet: ASTM A 240 / A 240M, Type 304, with No. 2D, cold rolled finish; thickness as specified in this Section.

2.2 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.

b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

3. Fasteners for Aluminum Sheet: Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry,

metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- H. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.
- I. Do not use graphite pencils to mark metal surfaces.

2.4 ROOF SHEET METAL FABRICATIONS

- A. Counter-Flashing, Step Flashing, and Base Flashing: Fabricate from the following materials:
1. Aluminum sheet, 20 gauge thick min.
- B. Drip Edges: Fabricate from the following materials:
1. Extruded aluminum, 0.050 inch thick min.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 - 5. Install sealant tape where indicated or recommended by the roofing system manufacturer.
 - 6. Torch cutting of sheet metal flashing and trim is not permitted.
 - 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.

- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Seal joints as shown and as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 - 2. Prepare joints and apply sealants.
- F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.
 - 1. Do not solder aluminum sheet.
 - 2. Pre-tinning is not required for zinc-tin alloy-coated copper.
 - 3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in SMACNA's "Architectural Sheet Metal Manual" and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with sealant. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant.
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.4 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.7 WASTE DISPOSAL

- A. Unless otherwise indicated, excess materials are Contractor's property. At completion of roofing work, remove from Project site.

END OF SECTION 07 62 00

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 070001 ROOFING AND FLASHING FILED SUB BID

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections apply to the work of this Section.

1.3 SUMMARY

- A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Acoustical joint sealants.

- B. Related Sections include the following:

1. Section 09 30 00 "Tiling" for sealing tile joints.
2. Section 09 51 13 "Acoustical Panel Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

1.4 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

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5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.6 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- B. Qualification Data: For Installer.
- C. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- D. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.
- E. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

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1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:

1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.
2. Each type of sealant and joint substrate indicated.

E. Preinstallation Conference: Conduct conference at Project site.

1.9 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

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1. Warranty Period for Urethane: Five years from date of Substantial Completion.
 2. Warranty Period for Silicone: 20 years from date of Substantial Completion.
- B. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Two years from date of Substantial Completion.
- C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Mildew Resistant, Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
1. Products: Subject to compliance with requirements, provide one of the following, or equal:
 - a. Dow Corning Corporation; 786 Mildew Resistant.
 - b. GE Silicones; Sanitary SCS1700.
 - c. Tremco; Tremsil 200 Sanitary.

2.3 URETHANE JOINT SEALANTS

- A. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type M, Grade P, Class 25, for Use T and I.
1. Products: Subject to compliance with requirements, provide one of the following, or equal:
 - a. BASF Corporation-Construction Systems; MasterSeal SL 2.
 - b. Pecora Corporation; Dynatrol II-SG.
 - c. Sherwin Williams; Loxon 2K SL.
 - d. Tremco; THC-900.

2.4 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. Products: Subject to compliance with requirements, provide one of the following, or equal:
 - a. American Sealants, Inc.; ASI 174.
 - b. Pecora Corporation; AC-20+.
 - c. Sherwin Williams; 950A.
 - d. Tremco; Tremflex 834.

2.5 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
1. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 2. Products: Subject to compliance with requirements, provide one of the following, or equal:

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- a. Green Glue; Green Glue Noiseproofing Sealant.
- b. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
- c. Sherwin Williams; 950A.
- d. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

2.6 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

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1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

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- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

- G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Penetrations in cast-in-place concrete slabs on grade.
 - b. Other joints as indicated.
 - 2. Urethane Joint Sealant: Multicomponent, pourable, traffic grade, Class 25.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors, for each material.

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- B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Tile control and expansion joints.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors.
 - c. Other joints as indicated.
 - 2. Joint Sealant: Latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Other joints as indicated.
 - 2. Joint Sealant: Single component, nonsag, mildew resistant, acid curing silicone.
 - 3. Joint-Sealant Color: White.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces at counters and backsplashes.
 - 1. Joint Sealant Location:
 - a. Joints between counters and walls.
 - b. Joints between backsplashes and walls.
 - c. Joints between counters and backsplashes.
 - 2. Joint Sealant: Single component, nonsag, mildew resistant, acid curing silicone.
 - 3. Joint-Sealant Color: Clear.
- E. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Location:
 - a. Acoustical joints where indicated.
 - b. Wall penetrations in non-rated partitions, including but not limited to pipes and conduits.
 - c. Other joints as indicated.
 - 2. Joint Sealant: Acoustical.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 07 92 00

SECTION 088713

GLAZING FILMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. Section includes:
 - 1. Solar control glazing film for application to existing skylight glazing.
- B. Related Sections:
 - 1. Division 08 Section "Glazing" for standard glass products.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire Performance: Surface burning characteristics with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

1.5 SUBMITTALS

- A. Product Data: Submit product data for each product indicated.
- B. Qualification Data: For qualified Installer.
- C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of film overlay to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer acceptable to the glazing film manufacturer.

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- B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup in the location as directed by Architect.
 - 2. Apply glazing film to determine before and after values of visible light transmittance.
 - 3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials according to manufacturer's written instructions and as needed to prevent damage to surfaces and edges.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install materials until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of openings and construction contiguous with glazing films by field measurements before fabrication.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace glazing films that deteriorate within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOLAR CONTROL GLAZING FILM

- A. Solar Control Window Film:
 - 1. Basis of Design Product: Subject to compliance with requirements, provide the following, or equal:
 - a. **3M Window Film; Sun Control Window Film Exterior Prestige Series (PR40X).**
 - 2. Uniformity: No noticeable pin holes, streaks, thin spots, scratches, banding or other optical defects.
 - 3. Identification: Labeled as to Manufacturer as listed in this Section.
 - 4. Solar Performance Properties: Film applied to 1/4 inch thick clear glass.
 - a. Visible Light Transmission (ASTM E 903): 42 percent.
 - b. Solar Heat Gain Coefficient (ASTM E 903): 0.39.
 - c. Total Solar Energy Rejected: 61 percent.

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5. Adhesive System: The film shall be supplied with a high mass pressure sensitive weatherable acrylate adhesive applied uniformly over the surface opposite the abrasion resistant coated surface. The adhesive shall be essentially optically flat and shall meet the following criteria:
 - a. Viewing the film from a distance of ten feet at angles up to 45 degrees from either side of the glass, the film itself shall not appear distorted.
 - b. It shall not be necessary to seal around the edges of the applied film system with a lacquer or other substance in order to prevent moisture or free water from penetrating under the film system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate conditions for substrates are acceptable for product installation in accordance with manufacturer's instructions.
- B. Film Examination:
 1. Inspect packaging for any damage and, if the packaging is damaged, open and inspect for any film damage.
 2. It is recommended that the film to be laid flat for a period of 24 hours in a space within the range of the manufacturer's specified installation temperature (67° to 82°F). Failure to lay flat will make it more difficult to install and could possibly result in permanent unsightly creasing of the film.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Refer to Manufacturer's installation instructions for methods of preparation for solar control film attachment systems.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Cut film edges neatly and square at a uniform distance of 1/8 inch to 1/16 inch of window sealant.
- C. Edge seal the film where water will puddle.

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- D. Upon completion of film application, allow 30 days for moisture from film installation to dry thoroughly, and to allow film to dry flat with no moisture dimples when viewed under normal viewing conditions.

3.4 CLEANING AND PROTECTION

- A. Remove left over material and debris from Work area. Use necessary means to protect film before, during, and after installation.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. After application of film, wash film using common window cleaning solutions, including ammonia solutions, 30 days after application. Do not use abrasive type cleaning agents and bristle brushes to avoid scratching film. Use synthetic sponges or soft cloths.

END OF SECTION 08 87 13

SECTION 090120.91

PLASTER REPAIR

PART 1 - GENERAL

- 1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 090002 LATHING AND PLASTERING FILED SUB BID
- 1.2 Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.
- 1.3 RELATED DOCUMENTS
- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, entitled “Related Documents.”
- 1.4 SUMMARY
- A. This Section includes the following:
1. Patching and repair of existing plaster.
- B. Related Section:
1. Section 099100 “Painting” for painting plaster surfaces.
- 1.5 SUBMITTALS
- A. Product Data: For each type of product indicated.
- 1.6 QUALITY ASSURANCE
- A. Fire-Test-Response Characteristics: For portland cement plaster assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Mockups: Before plaster repair, install mockups of repairs in area of at least 100 sq. ft. to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

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- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.8 PROJECT CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Interior Plasterwork: Maintain room temperatures at greater than 40 deg F for at least 48 hours before plaster application, and continuously during and after application.
 - 1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.
 - 2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

PART 2 - PRODUCTS

2.1 METAL LATH

- A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Alabama Metal Industries Corporation (AMICO).
 - b. California Expanded Metal Products Company (CEMCO).
 - c. Clark Western Building Systems, a division of ClarkDietrich Building Systems.
 - 2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
 - 3. Diamond-Mesh Lath: Flat and Self-furring, 3.4 lb/sq. yd.

2.2 ACCESSORIES

- A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Zinc-Coated (Galvanized) Accessories:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- a. Alabama Metal Industries Corporation (AMICO).
 - b. California Expanded Metal Products Company (CEMCO).
 - c. Clark Western Building Systems, a division of ClarkDietrich Building Systems.
2. Cornerbeads: Fabricated from zinc-coated (galvanized) steel.
 3. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 4. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of unperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.
 5. Expansion Joints: Fabricated from zinc-coated (galvanized) steel; folded pair of unperforated screeds in M-shaped configuration; with expanded flanges.

2.3 MISCELLANEOUS MATERIALS

- A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Bonding Compound: ASTM C 932.
- C. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of not fewer than three exposed threads.
- D. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.

2.4 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
 1. Color for Finish Coats: White.
- B. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- C. Sand Aggregate: ASTM C 897.
 1. Color for Job-Mixed Finish Coats: White.

2.5 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

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- b. Brown Coat: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material (sum of separate volumes of each component material).
- C. Base-Coat Mixes: Single base coats for two-coat plasterwork as follows (over existing masonry):
 - 1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material.
- D. Job-Mixed Finish-Coat Mixes:
 - 1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 1-1/2 to 2 parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.3 INSTALLING METAL LATH

- A. Expanded-Metal Lath: Install according to ASTM C 1063.
 - 1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
 - 2. On Solid Surfaces, Not Otherwise Furred: Install self-furring, diamond-mesh lath.

3.4 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Reinforcement for External Corners:
 - 1. Install cornerbead at interior locations.

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- C. Control Joints: Install control joints at locations indicated on Drawings, and as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft.
 - b. Horizontal and other Nonvertical Surfaces: 100 sq. ft.
 - 2. At distances between control joints of not greater than 18 feet o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.

3.5 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
 - 1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.
 - 2. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Bonding Compound: Apply on existing unit masonry plaster bases.
- C. Walls; Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork; 3/4-inch thickness.
 - 1. Portland cement mixes.
- D. Plaster Finish Coats: Apply to provide float finish, to match existing adjacent surfaces.

3.6 CUTTING AND PATCHING

- A. Cut, patch, replace, and repair plaster as necessary to accommodate other work and to restore cracks, dents, and imperfections. Repair or replace work to eliminate blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.7 PATCHING AND REPAIR OF EXISTING PLASTER

- A. Preparation: Scrape and sand existing plaster surfaces to be repaired. Remove all loose and peeling paint.
- B. Removal: Remove all existing plaster in area of repair that is loose, bubbled, crumbling or deteriorated. Make clean, sharp edges to bond new plaster.
- C. Install metal lath and accessories as required in areas of repair and patching.
- D. Apply new plaster and restore existing adjacent surfaces to a smooth finish.

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3.8 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of other work. Promptly remove plaster from doorframes, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION 090120.91

SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Non-load-bearing steel framing members for the following applications:
 - a. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
 - 2. Interior gypsum board.
- B. Related Sections include the following:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood blocking built into gypsum board assemblies.
 - 2. Division 09 Section "Painting" for primers applied to gypsum board surfaces.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Access doors and frames, furnished by Fire Protection, Plumbing, Mechanical, and Electrical Subcontractors in accordance with Division 08 Section "Access Doors and Frames."

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
- C. Delegated-Design Submittal: For cold-formed steel framing.

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1. For non-load-bearing metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer licensed in the Commonwealth of Massachusetts responsible for their preparation.
2. Include calculations for span capabilities of cold-formed metal framing for deflection criteria specified.

D. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Qualification Data: For professional engineer.

C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.

D. Research/Evaluation Reports: For cold-formed metal framing.

1.06 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the Commonwealth of Massachusetts and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

D. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

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- F. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."
- G. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- H. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- I. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 - 3. Simulate finished lighting conditions for review of mockups.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.
- C. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide interior non-load-bearing metal framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: In accordance with the Massachusetts State Building Code.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Interior Framing Systems:
 - 1) Maximum Deflection: $L/240$ at 5 psf, stud spacing at 16 inches o.c.
 - 3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 - 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of $3/4$ inch.
- C. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."
 - 1. Provide interior framing systems sized to accommodate maximum deflection using limiting heights of metal studs without contribution of gypsum wallboard (non-composite).

2.02 INTERIOR NON-LOAD-BEARING STEEL FRAMING

- A. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:
 - 1. ClarkDietrich Building Systems; ProSTUD Series.
 - 2. MarinoWare; a division of Ware Industries.
 - 3. SCAFCO Steel Stud Company.
- B. Interior Framing Members, General: Comply with ASTM C 645 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal.
 - 2. Protective Coating: Comply with ASTM C 645; roll-formed from hot-dipped galvanized steel; complying with ASTM A 1003/A 1003M and ASTM A 653/A 653M G40 or having a coating that provides equivalent corrosion resistance. A40 galvanized products are not acceptable.

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- a. Coatings shall demonstrate equivalent corrosion resistance with an evaluation report acceptable to the authority having jurisdiction.
- C. Steel Studs and Runners: ASTM C 645.
1. Non-Structural Studs: Cold-formed galvanized steel C-studs as per ASTM C 645 for conditions indicated below:
 - a. Flange Size: 1-1/4-inch.
 - b. Web Depth: As indicated on Drawings.
 - 1) Minimum Thickness: 0.033 inch.
 - 2) Minimum Design Thickness: 0.0346 inch.
- D. Slip-Type Head Joints: Where indicated, provide the following:
1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
- E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ClarkDietrich Building Systems; BlazeFrame.
 - b. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Posi Clips.
 - c. Metal-Lite, Inc.; The System.
 - d. Sliptrack Systems; SLP-TRK.

2.03 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
1. Fabricate framing assemblies using jigs or templates.
 2. Cut framing members by sawing or shearing; do not torch cut.
 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

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- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

2.04 GYPSUM PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.05 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36 or ASTM C 1396, as applicable to type of gypsum board indicated and whichever is more stringent.
- B. Moisture- and Mold-Resistant Gypsum Board, ASTM C 1396/C 1396M. With moisture- and mold-resistant core and coated surfaces.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10.
 - 4. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed; M2Tech.
 - b. Continental Building Products; Mold Defense.
 - c. G-P Gypsum; ToughRock Moisture-Guard Gypsum Board.
 - d. National Gypsum Company; Gold Bond XP Gypsum Board.
 - e. USG Corporation; Mold Tough Panels.

2.06 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - d. Expansion (control) joint.
 - e. Curved-Edge Cornerbead: With notched or flexible flanges.

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2.07 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.08 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."
- C. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

2.09 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Commencement of work indicates acceptance of areas and substrates.

3.02 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.03 INSTALLATION, COLD FORMED METAL FRAMING

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

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- a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 07 21 00 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
- 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.04 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
- 1. Space studs for all applications at 16 inches o.c., unless otherwise indicated.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
- 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, unless otherwise indicated.

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- b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.05 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

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- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.06 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Mold-Resistant Type: Ceilings, as indicated on Drawings.
 - 2. Tile Backing Board: At all locations indicated to receive ceramic tile, furnished and installed by Division 09 Section "Tiling."
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels either vertically (parallel to framing) or horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying face layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.07 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

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- B. Control Joints: Install control joints at locations indicated on Drawings, or if not indicated, according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.

3.08 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.

3.09 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports for cold formed metal framing.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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END OF SECTION 09 21 16

SECTION 099100

PAINTING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS – FILED SUB-BID REQUIRED AS PART OF 090001 PAINTING
FILED SUB BID

- A. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law Chapter 149, Sections 44A to 44J inclusive; and applicable Section of the MGL, Public Contract Law Chapter 30 as amended.

1.2 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.1A, entitled “Related Documents.”

1.3 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following substrates:
 - 1. Plaster.
 - 2. Gypsum Wall Board
- B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts, hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
- D. Related Sections include the following:
 - 1. Section 081113 "Hollow Metal Door Frames" for factory priming steel door frames.
 - 2. Section 090120.91 "Plaster Repair" for repaired plaster surfaces to be painted.

1.4 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

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1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
 3. Certification by the manufacturer that products supplied comply with the Commonwealth of Massachusetts Ozone Transportation Commission (OTC) regulations controlling use of volatile organic compounds (VOCs).
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches square.
 2. Step coats on Samples to show each coat required for system.
 3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
 5. Submit 2 Samples on the following substrates for Architect's review of color and texture only:
 - a. Stained Wood: 4-by-8-inch. Samples of natural- or stained-wood finish on representative wood surfaces.
- C. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
- D. Product List: For each product indicated, include the following:
1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 2. VOC content.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For coatings to include in maintenance manuals. Include the following:
1. Area summary with Finish Schedule and area detail designating where each product, color, and finish is used.

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2. Product data pages.
3. Material safety data sheets.
4. Care and cleaning instructions.
5. Touch-up procedures.
6. Color samples of each color and finish (gloss level) used.

- B. Manual: Provide Sherwin Williams; "Custodian Project Color and Product Information" manual, or equal.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 1 gallon of each material and color applied.

1.8 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

- B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
 - a. Wall Surfaces: Provide samples of at least 100 sq. ft.
2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
3. Final approval of color selections will be based on benchmark samples.
 - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.

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2. Remove rags and waste from storage areas daily.

1.10 PROJECT CONDITIONS

- A. Temporary Support Facilities: Furnish and install all temporary lifts, hoists, staging, scaffolding, rigging, labor and materials, and temporary support to perform all operations in connection with the installation of this Work. Remove all temporary support facilities when no longer required.
- B. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- C. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Benjamin Moore & Co., including affiliate the following affiliate brands:
 - a. Lenmar Wood Finishes.
 2. PPG Industries Inc. (PPG).
 3. Sherwin-Williams Company.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. VOC Content for Interior Paints and Coatings:
 1. All interior paints and coatings shall comply with the VOC content regulations of the Ozone Transportation Commission (OTC) effective in the Commonwealth of Massachusetts. For interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - a. Flat Coatings: 100 g/L.
 - b. Nonflat Coatings: 150 g/L.
 - c. Nonflat-High Gloss Coatings: 250 g/L.
 - d. Primers, sealers and undercoaters: 200 g/L.

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- e. Anti-corrosive and Anti-rust Paints Applied to Ferrous Metals: 250 g/L.
- f. Clear Wood Finish: Lacquer: 550 g/L
- g. Clear Wood Finish: Sanding Sealer: 350g/L.
- h. Clear Wood Finish: Varnish: 350 g/L.
- i. Stain: 250 g/L.

- C. Colors: As required to match existing, or as selected by Architect from manufacturer's full range.

2.3 EXTERIOR PRIMERS

- A. Exterior Wood Primer: Factory-formulated alkyd primer for exterior application.
 - 1. Benjamin Moore; Super Spec Alkyd Exterior Primer No. 176: Applied at a dry film thickness of not less than 1.3 mils.
 - 2. PPG; SpeedHide Exterior Wood Primer Alkyd: Applied at a dry film thickness of not less than 1.8 mils.
 - 3. Sherwin-Williams; Exterior Oil-Based Wood Primer Y24W8020: Applied at a dry film thickness of not less than 1.4 mils.
- B. Exterior Galvanized Metal Primer: Factory-formulated galvanized metal primer for exterior application.
 - 1. Benjamin Moore; Super Spec HP Acrylic Metal Primer No. P04: Applied at a dry film thickness of not less than 2.0 mils.
 - 2. PPG; 90-912 Pitt-Tech Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
 - 3. Sherwin-Williams; Pro Industrial Pro-Cryl Universal Acrylic Primer: Applied at a dry film thickness of not less than 2.0 mils.
- C. Exterior Cellular PVC and Urethane Primer: Factory-formulated primer for exterior application.
 - 1. Benjamin Moore; Fresh Start All-Purpose Alkyd Primer 024: Applied at a dry film thickness of not less than 1.5 mils.
 - 2. PPG; Seal Grip Interior/Exterior Acrylic Universal Primer 17-921 Series: Applied at a dry film thickness of not less than 1.6 mils.
 - 3. Sherwin-Williams; Extreme Bond Primer B51W00150: Applied at a dry film thickness of not less than 0.9 mils.

2.4 INTERIOR PRIMERS

- A. General: Provide tinted primers as required for dark colors.
- B. Interior Wood Primer for Acrylic-Enamel Finishes: Factory-formulated acrylic-latex-based interior wood primer (**150 g/L**).
 - 1. Benjamin Moore; Fresh Start Multi-Purpose Latex Primer N023: Applied at a dry film thickness of not less than 1.2 mils.
 - 2. PPG; 6-855 Interior Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.2 mils.
 - 3. Sherwin-Williams; Premium Wall and Wood Primer B28W08111 Series: Applied at a dry film thickness of not less than 1.8 mils.

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- C. Interior Plaster Primer for Acrylic-Enamel Finishes: Factory-formulated acrylic-latex-based interior plaster primer (**150 g/L**).
1. Benjamin Moore; Fresh Start Multi-Purpose Latex Primer N023: Applied at a dry film thickness of not less than 1.2 mils.
 2. PPG; 6-855 Interior Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.2 mils.
 3. Sherwin-Williams; Premium Wall and Wood Primer B28W8111 Series: Applied at a dry film thickness of not less than 1.8 mils.
- D. Interior Metal Primer: Factory-formulated metal primer (**250 g/L**).
1. Benjamin Moore; Super Spec Acrylic Metal Primer No. P04: Applied at a dry film thickness of not less than 1.7 mils.
 2. PPG; 90-912 Series Pitt-Tech Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 2.0 mils.
 3. Sherwin-Williams; Pro Industrial Pro-Cryl Universal Acrylic Primer B66 Series: Applied at a dry film thickness of not less than 2.0 mils.

2.5 EXTERIOR PAINTS

- A. Exterior Satin Acrylic Paint: Factory-formulated satin acrylic-emulsion latex paint for exterior wood, cellular PVC, and urethane application.
1. Benjamin Moore, Ultra Spec EXT Satin Finish N448: Applied at a dry film thickness of not less than 1.5 mils.
 2. PPG; 6-2045 Series SpeedHide Exterior Satin 100% Acrylic Latex: Applied at a dry film thickness of not less than 1.2 mils.
 3. Sherwin-Williams; Emerald Exterior Latex Satin K48 Series: Applied at a dry film thickness of not less than 2.1 mils.
- B. Exterior Full-Gloss Acrylic Enamel: Factory-formulated full-gloss waterborne acrylic-latex enamel for exterior metal application.
1. Benjamin Moore; Ultra Spec HP DTM Acrylic Gloss Enamel, HP28: Applied at a dry film thickness of not less than 2.3 mils.
 2. PPG; 90-374 Series Pitt-Tech Interior/Exterior High Gloss DTM Industrial Enamels: Applied at a dry film thickness of not less than 3.0 mils.
 3. Sherwin-Williams; Acrylic Coating Gloss (Waterborne) B66 Series: Applied at a dry film thickness of not less than 2.4 mils.

2.6 INTERIOR PAINTS

- A. Interior Acrylic Enamel for Wood Surfaces: Factory-formulated semi-gloss acrylic latex enamel (**150 g/L**).
1. Benjamin Moore; Advance Waterborne Interior Alkyd Semi-Gloss 793: Applied at a dry film thickness of not less than 1.3 mils.
 2. PPG; 6-500 Series SpeedHide Interior Semi-Gloss Acrylic Latex: Applied at a dry film thickness of not less than 1.4 mils.
 3. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Semi-Gloss B31-2600 Series: Applied at a dry film thickness of not less than 1.7 mils.

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- B. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application ceilings and soffits (**50 g/L**).
 - 1. Benjamin Moore, Ultra Spec 500 Interior Flat N536: Applied at a dry film thickness of not less than 1.8 mils.
 - 2. PPG; 6-70 Series Speedhide Interior Latex Flat: Applied at a dry film thickness of not less than 1.3 mils.
 - 3. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Flat Wall Paint B30-2600 Series: Applied at a dry film thickness of not less than 1.6 mils.

- C. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel for walls (**100 g/L**).
 - 1. Benjamin Moore, Ultra Spec 500 Interior Eggshell N538: Applied at a dry film thickness of not less than 1.8 mils.
 - 2. PPG; 6-411 Series Speedhide Interior Enamel Latex Eggshell: Applied at a dry film thickness of not less than 1.5 mils.
 - 3. Sherwin-Williams; ProMar 200 Zero VOC Interior Latex Egg-Shell Enamel B20-2600 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.7 INTERIOR WOOD STAINS AND VARNISHES

- A. Interior Wood Stain: Factory-formulated water-based penetrating wood stain for interior application applied at spreading rate recommended by manufacturer (**250 g/L**).
 - 1. Lenmar; Waterborne Interior Wood Stain 1WB1300.
 - 2. PPG; Olympic Premium Interior Oil Based Wood Stain, Tint Base 44500.
 - 3. Sherwin-Williams; Minwax Wood Finish 250 VOC Stains.

- B. Clear Sanding Sealer: Factory-formulated fast-drying acrylic polyurethane clear wood sealer applied at spreading rate recommended by manufacturer. (**350 g/L**).
 - 1. Benjamin Moore; Benwood Stays Clear Acrylic Polyurethane Gloss N422.
 - 2. PPG; Olympic Premium Interior Water Based Sanding Sealer 41061.
 - 3. Sherwin-Williams; Wood Classics Waterborne Polyurethane A68 Series.

- C. Interior Polyurethane-Based Clear Varnish: Factory- formulated polyurethane-based clear varnish (**350 g/L**).
 - 1. Benjamin Moore; Benwood Stays Clear Acrylic Polyurethane Low Lustre N423.
 - 2. PPG; Olympic Premium Interior Water Based Polyurethane Clear Satin 42786.
 - 3. Sherwin-Williams; Wood Classics Waterborne Polyurethane A68 Series

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

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1. Wood: 15 percent.
 2. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.
- E. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.
- F. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- D. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- F. Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 2. Sand surfaces that will be exposed to view, and dust off.
 3. Prime edges, ends, faces, undersides, and backsides of wood.

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4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.

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- g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINT SCHEDULE

- A. Wood: Provide the following finish systems over exterior wood surfaces:
- 1. Satin Latex Finish: Two finish coats over a wood primer.
 - a. Primer: Exterior alkyd primer.
 - b. Finish Coats: Exterior satin acrylic latex.
- B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated metal surfaces:
- 1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over galvanized metal.
 - a. Primer: Metal primer, including surfaces with factory prime coat.
 - b. Finish Coats: Exterior full-gloss acrylic enamel for metal surfaces.
- C. Cellular PVC and Urethane Trim: Provide the following finish systems over exterior cellular PVC and urethane trim:

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1. Satin Latex Finish: Two finish coats over a wood primer.
 - a. Primer: Exterior acrylic primer.
 - b. Finish Coats: Exterior satin acrylic latex.

3.7 INTERIOR PAINTING SCHEDULE

- A. Wood: Provide the following paint finish systems over new interior wood surfaces:
 1. Gloss Acrylic-Enamel Finish: Two finish coats over a wood primer.
 - a. Primer: Interior wood primer for acrylic-enamel finishes.
 - b. Finish Coats: Interior acrylic enamel for wood surfaces.
- B. Plaster: Provide the following finish systems over interior plaster surfaces:
 1. Flat Acrylic Finish (ceilings): Two finish coats over a primer.
 - a. Primer: Interior plaster primer.
 - b. Finish Coats: Interior flat acrylic paint.
 2. Low-Luster Acrylic-Enamel Finish (Walls): Two finish coats over a primer.
 - a. Primer: Interior plaster primer.
 - b. Finish Coats: Interior low-luster acrylic enamel.
- C. Ferrous and Zinc-Coated Metal: Provide the following finish systems over ferrous metal:
 1. Full-Gloss Acrylic-Enamel Finish: Two finish coats over a metal primer.
 - a. Primer: Metal primer, including surfaces with factory prime coat.
 - b. Finish Coats: Interior full-gloss acrylic enamel for metal surfaces.

3.8 INTERIOR STAIN AND NATURAL-FINISH WOODWORK SCHEDULE

- A. Stained Woodwork: Provide the following stained finishes over new interior woodwork:
 1. Stain Satin-Varnish Finish: Two finish coats of alkyd-based clear satin varnish over a sealer coat and interior wood stain. Wipe wood filler before applying stain.
 - a. Filler Coat: Open-grain wood filler.
 - b. Stain Coat: Interior wood stain.
 - c. Sealer Coat: Clear sanding sealer.
 - d. Finish Coats: Interior polyurethane-based clear satin varnish.

END OF SECTION 09 91 00

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SECTION 23 00 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 MECHANICAL PRIME

- A. The mechanical contractor shall serve as the prime contractor on this project and shall be responsible for all work accordingly.
- B. Bidding procedures shall be in accordance with latest edition of Massachusetts General Laws, Chapter 149, Section 44, including provisions for pre-qualification; and Chapter 30, Section 39M. Time and place for submission of bids is given in Advertisement for Bids.

1.2 GENERAL PROVISIONS

- A. The General Requirements, Division 01, and Bidding And Contract Requirements, and Division 00 are hereby made a part of this Specification Section.
- B. Examine all drawings and all sections of the specifications and requirements and provisions affecting the work of this section.

1.3 SCOPE OF WORK

- A. This project includes the partial renovation of 40,000 SF of existing office space into 1st Class offices. Selective demolition of existing systems shall be required. This work includes the installation of new fan powered VAV boxes, insulated ductwork, diffusers and controls. The existing air handling system shall remain active during construction. The entire existing system shall be balanced.
- B. Refer to the commissioning section of the specifications. Include all associated testing and certifications necessary for compliance and any required remedial actions and retesting due to failure.
- C. The building is a LEED design and Contractor shall provide materials, equipment and required documentation to attain the points for this section of the specifications.
- D. The building is to be commissioned and Contractor shall provide all labor required to fully test and demonstrate that all systems operate as designed.
- E. The work under this section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:
 - 1. Piping and Fittings (all systems and types) including submitting sizing where called for on the drawings or in these specifications
 - 2. Pipe Hangers and Supports
 - 3. Identification
 - 4. Sleeves, Fire stopping

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5. Pipe Expansion Joints, Guides and Anchors
6. Valves and Accessories (all types)
7. Flash Tanks
8. Expansion Tanks
9. Air Separators
10. Steam Traps
11. Heat Exchangers
12. Freeze Protection Systems / Glycol Feed Units
13. Pressure Gauges, Thermometers, Accessories
14. Electric Motors and Starters
15. Pumps (Water systems)
16. Baseboard Radiation
17. Boiler/Burner Units
18. Water Treatment Systems
19. Chillers
20. Air Cooled Condensing Units
21. Equipment Nameplates
22. Cooling Towers
23. Factory Tests
24. Ductless Split AC Systems
25. Computer Room Air Conditioning Units
26. Vibration Isolation
27. Ductwork
28. Sound Attenuation Equipment
29. Diffusers, Registers and Grilles
30. Louvers
31. Fans
32. Coils
33. Air Filters
34. Air Handling Units
35. Fan Coil Units
36. Coil Induction Units
37. Variable Air Volume Terminal Units
38. Fan Powered Terminal Units
39. Unit Heaters (all types)
40. Cabinet Unit Heaters (all types)
41. Energy Recovery Units
42. Factory Painting
43. Insulation
44. Chimneys, Stacks, and Flues
45. Roof Curbs
46. Relocation of existing HVAC components that interfere with new construction and removal and disposal of obsolete components.
47. Operating and maintenance instructions and manuals
48. Coordination drawings
49. Shop drawings
50. Cleaning, Testing, Adjusting, & Balancing of all Ducted and Piped Systems and Equipment
51. Record (as-built) Drawings
52. HVAC Control Systems
53. Seismic Restraints
54. Training of Owners Personnel on Equipment, Systems, and Controls
55. Documentation Required for LEED Points

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- F. The work to be done under this section is generally shown on the Mechanical HVAC Drawings.

1.4 RELATED WORK

- A. Principal classes of Work related to the Work of this section are listed below, and are specified to be performed under the indicated sections of these specifications. Refer to the indicated sections for description of the extent and nature of the indicated Work, and for coordination with related trades. This listing may not include all related Work items. It is the responsibility of the Contractor to coordinate the Work of this section with that of all other trades.
- B. The following work is not included in this section and will be provided under other sections, except as specified herein:
 - 1. Electrical power wiring for all HVAC equipment and to junction box(es) in mechanical areas. Power wiring from these box(es) to all control equipment (control panels, etc.) and all controls/interlock wiring shall be provided by the controls Contractor. Control wiring shall be from standby power source (if available).
 - 2. Starters and variable speed drives that are not integral to equipment, unless specified otherwise.
 - 3. Structural supports necessary to distribute loading from equipment to roof or floor.
 - 4. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing. Refer to Division 01, General Conditions.
 - 5. Gypsum drywall enclosures of supply, return and exhaust ductwork on all rooftop/penthouse air handlers, supply and return air shafts, as shown on drawings.
 - 6. Outdoor air intake and exhaust louvers (if under the Architectural scope of work).
 - 7. Excavation and backfill.
 - 8. Concrete work including concrete housekeeping pads and blocks for vibrating and rotating equipment, and cast-in-place manholes.
 - 9. Flashing of roof and wall penetrations.
 - 10. Painting.

1.5 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish pipe sleeves for placement into formwork by the General Contractor.
- B. Furnish access panels and doors for installation by the General Contractor.
 - 1. Furnish access panels for installation in walls, ceiling and floors at locations to permit access for adjustment, removal, replacement and servicing of all concealed equipment, valves and materials installed under this section of the specifications.
 - 2. Access panels will be installed under the section of the related trades of the finished surfaces in which they are located.
 - 3. Access panels shall be located in closets, storage rooms and/or other non-public areas if possible, positioned so that the equipment can be easily reached, and the size shall be sufficient for this purpose (min. 16" x 16"). When access panels are required in corridors, lobby or other habitable areas, they will be located as directed by the Owner's Representative.

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4. Access panels shall be prime painted, keyed alike and provided with cylinder lock and two (2) keys for each panel. Units shall be manufactured by Milcor, Inland Steel, Miami Carey or approved equal. Required fire resistance of walls and ceilings shall be maintained.
- C. Furnish roof curbs for installation by the Roofing Subcontractor.
- D. Furnish line voltage fan speed control switches for installation by the Electrical Subcontractor.
- E. Furnish and mount line voltage aquastats for wiring by the Electrical Subcontractor.

1.6 PRODUCTS INSTALLED, BUT NOT FURNISHED UNDER THIS SECTION

- A. Install duct-mounted smoke detectors which will be furnished by the Electrical Subcontractor. The HVAC Subcontractor shall wire the appropriate fan to shut down upon detection of smoke. The Electrical Subcontractor shall power wire and wire the smoke detector to the fire alarm panel.
- B. Emergency generator exhaust silencers and flexible connection(s) furnished under Section 26 00 00.

1.7 DEFINITIONS

- A. As used in this section, the following terms shall be understood to have the following meaning:
 1. "*Contractor*," or "*Subcontractor*," unless otherwise qualified, shall mean the installer of the work specified under this section, and shall be responsible for coordination of this work with the work of the ATC Contractor.
 2. "*Furnish*" shall mean purchase and deliver to the project site, complete with every necessary appurtenance and product support.
 3. "*Install*" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.
 4. "*Provide*" shall mean furnish and install.
 5. "*Work*" shall mean all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.
 6. "*Concealed*" shall mean hidden from sight in chases, furred in spaces, shafts, embedded in construction, in a crawl space, and above hung ceilings.
 7. "*Exposed*" shall mean not installed underground or concealed as defined above.
 8. "*Furnished by others*" shall mean materials or equipment purchased under other sections of the general contract and installed by this section of the specifications by this trade Contractor.
 9. "*Owner's Representative*" shall be the party responsible to make decisions regarding all contractual obligations in reference to the Scope of Work for the Owner.
 10. "*Date of Substantial Completion*" shall indicate the date where the work has been formally accepted as evidenced by completed final punchlist or where the work has reached the stage that the Owner obtains beneficial use and commences utilization of the installed systems for business or occupancy purposes. The General Requirements, Division 01, shall supersede this definition where specifically defined.

11. "Piping" shall mean, in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.
12. "ATC" shall mean Automatic Temperature Controls, and shall be interchangeable with "BAS" (Building Automation System).

1.8 CODES, REFERENCES AND PERMITS

- A. Materials, installation of systems and equipment provided under this section shall be done in strict accordance with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, and any other Codes and Regulations having jurisdiction including but not limited to:
 1. All Applicable NFPA Standards
 2. State and Local Building Mechanical, Electrical, and Energy Codes
 3. American Society of Mechanical Engineers (ASME)
 4. American Society of Testing and Materials (ASTM)
 5. American National Standards Institute (ANSI)
 6. Underwriters' Laboratories, Inc. (UL)
 7. Occupational Safety and Health Administration (OSHA)
 8. Any other local codes or authorities having jurisdiction.
- B. Heating, pumping, process piping and refrigeration systems shall be installed by Contractors and personnel appropriately licensed in the State (Installing Contractor).
- C. All pressure vessels shall conform to ASME and State codes and regulations.
- D. All equipment shall meet the more efficient requirement:
 1. As shown on bid documents,
 2. Minimum efficiencies state in ASHRAE 90.1-2013, or
 3. Minimum efficiencies stated in the governing Energy Code.
- E. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, except when more rigid requirements are specified or are required by applicable codes but not limited to:
 1. Air Conditioning and Refrigeration Institute (ARI)
 2. Air Diffusion Council (ADC)
 3. Air Movement and Control Association (AMCA)
 4. American Boiler Manufacturers Association (ABMA)
 5. American National Standards Institute (ANSI)
 6. American Petroleum Institute (API)
 7. American Society of Heating, Refrigeration and Air Conditioning (ASHRAE)
 8. American Society of Mechanical Engineers (ASME)
 9. American Society of Testing and Materials (ASTM)
 10. American Welding Society, Inc. (AWS)
 11. Associated Air Balance Council (AABC)
 12. Certified Ballast Manufacturers (CME)
 13. Copper Development Association (CDA)
 14. Cooling Tower Institute (CTI)
 15. Expansion Joint Manufacturers Association, Inc. (EJMA)
 16. Factory Mutual System (FM)
 17. Illuminating Engineering Society (IES)
 18. Institute of Electrical and Electronics Engineers (IEEE)

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19. Insulated Cable Engineers Association (ICEA)
 20. Manufacturer's Standardization Society of the Valve & Fitting Industry (MSS)
 21. National Electrical Contractors Association (NECA)
 22. National Electric Manufacturers Association (NEMA)
 23. National Environmental Balancing Bureau (NEBB)
 24. North American Insulation Manufacturer's Association (NAIMA)
 25. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)
 26. The Hydronics Institute (HI)
 27. Thermal Insulation Manufacturer's Association (TIMA)
- F. Codes, laws and standards provide a basis for the minimum installation criteria acceptable. The drawings and specifications illustrate the scope required for this project, which may exceed minimum codes, laws and standards.
- G. The date of the code or standard is that in effect at the Bid date.
- H. Give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from authorities having jurisdiction. Deliver all certificates of inspection to the authorities having jurisdiction. No work shall be covered before examination and approval by the Owner's Representative, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work to conform to requirements, satisfactory to Owner's Representative, and without extra cost to the Owner. If work is covered before inspection and approval, this Contractor shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.9 GENERAL REQUIREMENTS

- A. Nameplates
1. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, type or style, model number, catalog number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.
- B. Maintenance Information
1. Systems and equipment which require periodic maintenance to maintain efficient operation shall be furnished with complete necessary maintenance information. Required routine maintenance actions, as specified by the manufacturer, shall be stated clearly and incorporated on a readily accessible label on the equipment. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.
- C. Equipment Guards
1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.10 MATERIAL AND EQUIPMENT STANDARDS

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- A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Owner's Representative.
- B. Substitutions (approved equals) may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. In order for Requests for substitution to be considered, all must be submitted for pre-approval of manufacturer within thirty (30) days of award of contract. All requests must be accompanied by a list of minimum five (5)-year-old successful installations of similar scope (with Owner contact and phone number), complete specifications together with drawings or samples to properly appraise the materials, equipment or process. Allow thirty (30) days for Owner's Representative's review.
- C. If a substitution of materials or equipment in whole or in part is made, this Contractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.
- D. All materials, equipment and accessories provided under this section shall be new and unused products of recognized manufacturers as approved.

1.11 SUBMITTALS

- A. Conform to the requirements of Division 01, General Conditions, for schedule and form of all submittals unless specifically noted otherwise in this section. Coordinate this submittal with submittals for all other finishes. Shop drawings and design layouts shall be prepared by licensed installing Contractors and shall note the name(s), license number(s) and license expiration date(s) of the Contractor(s) installing the **[edit list]** heating, pumping, process piping and refrigeration systems.
- B. Definitions:
 - 1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than indicated in the Contract Documents.
 - 2. Acceptable Manufacturers: The mechanical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. In addition, the MATERIAL AND EQUIPMENT STANDARDS paragraph potentially allows for substitutions as being acceptable. These are acceptable only if, as a minimum, they:
 - a. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure (with the allowed pressure drop of dirty filters) using equal or less horsepower as the air handler listed in the schedules.
 - b. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings, and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean the Engineer has determined that the manufacturer's products will fit within the available space – this determination is solely the responsibility of the Contractor.

- c. For rooftop mounted equipment and equipment mounted in areas where structural matters are a concern, the products must have a weight no greater than the product listed in the schedules or specifications.
- d. Products must adhere to all architectural considerations including, but not limited to: being of the same color as the product scheduled or specified, fitting within the architectural enclosures and details.

C. Submittal Procedures, Format and Requirements

1. Review submittal packages for compliance with Contract Documents and then submit to Owner's Representative for review. Submit enough sets of shop drawings such that, after review, two (2) sets will be kept by the reviewer, with only the remaining sets returned with reviewer's marks and comments.
2. Each Shop Drawing shall indicate in title block, and each Product Data package shall indicate on cover sheet, the following information:
 - a. Title.
 - b. Equipment number.
 - c. Name and location of project.
 - d. Names of Owner, Engineer and Seller.
 - e. Names of manufacturers, suppliers, vendors, etc.
 - f. Date of submittal.
 - g. Whether original submittal or resubmitted.
3. Shop drawings showing manufacturer's product data shall contain detailed dimensional drawings (minimum ¼ inch = one (1) foot scale) including plans and sections (where physical clearance could be an issue). Provide larger scale details as necessary. Sheet metal drawings shall show elements of Architect's reflected ceiling plan, exposed ductwork, walls and partitions (highlighting fire walls and smoke partitions), diffusers, registers, grilles, all dampers (fire, smoke, balancing, backdraft, and control dampers), sleeves and other aspects of construction as necessary for coordination.
4. Submit accurate and complete description of materials of construction, manufacturer's published performance characteristics, sizes, weights, capacity ratings (performance data, alone, is not acceptable), electrical requirements, starting characteristics, wiring diagrams, and acoustical performance for complete assemblies. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
5. Provide shop drawings showing details of piping connections to all equipment. If connection details are not submitted and connections are found to be installed incorrectly, this Contractor shall reinstall them within the original contract price.
 - a. Alternate pipe joining methods such as grooved and permanent push-to-connect systems shall be shown on drawings and product submittals, and be specifically identified with the applicable manufacturer's style or series number. Installation shall include any additional hangers required for the alternate system.
6. Provide complete data for all auxiliary services and utilities required by submitted equipment. This shall include power, cooling water and compressed air requirements and points of connection.
7. Provide a complete description of all controls and instrumentation required including electrical power connection drawing for all components and interconnection wiring to starters, detailed information on starters, control

diagrams, termination diagrams, and all control interfaces with a central control system.

8. Provide installation and erection information including; lifting requirements, and any special rigging or installation requirements for all equipment.
9. The Owner's Representative shall approve all materials before commitment for materials is made.

D. Specifications, Schedule, and Control Sequence Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph for those submittals listed in **Paragraph E**: Product Data that are noted with an asterisk (*).
2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in Part 2 and applicable Part 3 of the specification and that the unit controls will provide all manufacturer's portions of the control sequences shown on the drawings for which the submitted product in the opinion of the manufacturer complies, deviates, or does not meet.
3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.
4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
5. Verify each field of the associated schedule where associated technical data is presented and sequences are shown on the drawings. Where the submitted material does not "comply" provide the value the submitted equipment will achieve based upon the specified conditions.
6. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and the product will be rejected.
7. Submissions which do not include a point by point statement of compliance as specified shall be disapproved.

E. Product Data: Submit complete manufacturer's product description and technical information including:

1. Piping and Fittings (all services, types, and joining methods)
2. Pipe Hangers and Supports
3. Identification
4. Sleeves, Fire stopping
5. Pipe Expansion Joints, Guides and Anchors
6. Valves and Accessories (all types)
7. Expansion Tanks
8. Air Separators
9. Steam Traps
10. Heat Exchangers
11. Freeze Protection Systems/Glycol Feed Units
12. Pressure Gauges, Thermometers, Accessories
13. Electric Motors and Starters
14. Pumps (Water systems)
15. Baseboard Radiation
16. Boiler/Burner Units (*)
17. Water Treatment Systems
18. Chillers (*)
19. Air Cooled Condensing Units
20. Cooling Towers (*)

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21. Factory Tests
 22. Ductless Split AC System
 23. Computer Room Air Conditioning Units (*)
 24. Vibration Isolation
 25. Complete ductwork, equipment layout, and piping shop drawings, construction details and construction standards
 26. Sound Attenuation Equipment
 27. Diffusers, Registers and Grilles
 28. Louvers
 29. Fans
 30. Coils
 31. Air Filters
 32. Air Handling Units (*)
 33. Rooftop Units (*)
 34. Fan Coil Units
 35. Coil Induction Units
 36. Variable Air Volume Terminal Units
 37. Fan Powered Terminal Units
 38. Unit Heaters (all types)
 39. Cabinet Unit Heaters (all types)
 40. Energy Recovery Units (*)
 41. Factory Painting
 42. Insulation
 43. Chimneys, Stacks, and Flues
 44. Roof Curbs
 45. Coordination Drawing
 46. Operating and maintenance instructions and manuals
 47. HVAC Control Systems (*)
 48. Seismic Restraints
 49. Color selection charts and samples for equipment and systems in finished areas
 50. Testing, Adjusting, & Balancing Qualifications, Plan, and Reports
 51. Identification, labels and tags
 52. All information required for documenting LEED points
 53. O&M manual table of contents
 54. O&M manual
- F. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in an individual (combined) submittal.
1. Access panel shop drawings shall be submitted to the Construction Supervisor for approval.
 2. Do not submit multiple product information in a single bound manual.
 3. Three-ring binders shall not be accepted.
- G. Deviations
1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Owner's Representative.
 2. Without letters flagging the deviation to the Owner's Representative, it is possible that the Engineer may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Owner's Representative, the Seller shall hold the Engineers, his consultants and the

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- Owner harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Engineer has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
3. Approval of proposed deviations, if any, will be made at discretion of Engineer.
- H. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. This Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule: Allow at least ten (10) working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that twenty (20) working days, exclusive of transmittal time are required for the following:
1. HVAC temperature control submittals
 2. Coordination Drawings
 3. TAB Plan
 4. TAB draft and final balancing reports.
 5. O&M manuals
 6. As built drawings
 7. If more than five (5) shop drawings of a single trade are received in one (1) calendar week.
- I. Responsibility
1. Intent of Submittal review is to check for capacity, rating, and certain construction features. HVAC Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other sections. Work shall comply with approved submittals to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor the shop drawing errors or deviations from requirements of Contract Documents. The Engineer's noting of some errors while overlooking others will not excuse the HVAC Contractor from proceeding in error and will not absolve the Contractor from meeting the full design intent of the associated system(s). Contract Documents requirements are not limited, waived nor superseded in any way by review.
 2. Inform Contractors, manufacturers, suppliers, etc. of scope and limited nature of review process and enforce compliance with contract documents.
- J. In the event that the HVAC Subcontractor fails to provide Shop Drawings for any of the products specified herein:
1. The HVAC Subcontractor shall furnish and install all materials and equipment herein specified in complete accordance with these specifications.
 2. If the HVAC Subcontractor furnishes and installs material and/or equipment that is not in complete accordance with these specifications, he shall be responsible for the removal of this material and/or equipment. He shall also be responsible for the replacement of this material and/or equipment with material and/or equipment that is in complete accordance with these specifications, at the direction of the Owner's Representative.
 3. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall be done at no extra cost to the Owner.

4. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall not be allowed as a basis for a claim of delay of completion of the Work.
- K. Mark dimensions and values in units to match those specified.
- L. Submit Material Safety Data Sheets (MSD) on each applicable product with submittal.

1.12 OPERATION AND MAINTENANCE DATA

- A. Commence preparation of the Operating and Maintenance (O&M) Manuals immediately upon receipt of "Approved" or "Approved as Noted" shop drawings and submit each section within one (1) month. The final submission shall be no later than two (2) months prior to the projected date of Substantial Completion of the Project.
- B. Each O&M document shall include the manufacturer's web address for equipment - specific O&M information for Internet access by the Owner.
- C. The manual shall consist of (3) sets of manuals and include (3) sets of CDs, which shall contain the scanned content of the entire manual. The manual shall highlight the actual equipment used and not be a master catalog of all similar products of the manufacturer. The manual shall be submitted for review prior to creation of the CDs.
- D. The Manual shall contain the following:
 1. Operations Manual
 - a. Systems description including all relevant information needed for day-to-day operations and management including:
 - 1) Start-up requirements and procedures, including Water Treatment systems.
 - 2) Shut-down requirements and procedures, including Water Treatment systems.
 - 3) Trouble-shooting checklist (i.e., common alarms with possible cause & effect, etc.).
 - b. Wiring diagrams, schematics, logic diagrams and sequence of operations that accurately depict the controls system.
 - c. Depiction of each interface screen where programmable logic and visual displays are provided. Descriptors shall be provided to define displayed data, alarms, etc.
 - d. A single sheet (for ease of removal) of all access codes and passwords necessary to access all levels of control and programming.
 2. Maintenance Manual
 - a. Define all maintenance activities required to ensure system operation within manufacturers specified parameters. Maintenance documentation shall include:
 - 1) Data retrieval sheet
 - 2) Special instructions (i.e., lockout/tag-out, etc.)
 - 3) Special tools (i.e., key, allen wrench, etc.)
 - 4) Tasks
 - 5) Frequency
 - 6) Required materials, lubricants, etc.

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- b. Provide table of all required activities plotted vs. interval with adequate fill-in-space for "activity completion date" and "comments". Where multiple instrument readings are required, provide data sheet formatted to accommodate activity.
 - c. Provide as part of each package, lubricating charts indicating equipment tag number, location, equipment service, greasing and lubricating requirements, lubricants, and intervals.
 - d. Provide as part of each package, a valve and system chart that corresponds to the valve tags. Provide directions for normal positions and positions for equipment failure modes.
 - e. The HVAC Subcontractor shall furnish spare-parts data for each different item of equipment furnished. The data shall include a complete list of: parts and supplies, with current unit prices, lead time, and source of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract; and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 360 days at the particular installation. The foregoing shall not relieve the HVAC Subcontractor of any responsibilities under the guarantees specified herein.
 - f. Provide copy of all warranty information including extended warranties where specified with associated date of substantial completion (commencement of warranty) and end date of coverage. Define all components/subsystems specifically included and excluded.
- E. Provide O&M manuals for each of the following as a minimum:
1. Pipe Expansion Joints
 2. Valves and Accessories (all types, including charts for all balancing valves)
 3. Steam Traps
 4. Heat Exchangers
 5. Freeze Protection Systems / Glycol Feed Units
 6. Electric Motors and Starters
 7. Pumps (Water systems)
 8. Boiler/Burner Units
 9. Water Treatment Systems
 10. Chillers
 11. Air Cooled Condensing Units
 12. Cooling Towers
 13. Ductless Split AC Systems
 14. Computer Room Air Conditioning Units
 15. Vibration Isolation
 16. Fans
 17. Coils
 18. Air Filters
 19. Air Handling Units
 20. Fan Coil Units
 21. Coil Induction Units
 22. Variable and Constant Air Volume Terminal Units
 23. Fan Powered Terminal Units
 24. Unit Heaters (all types)
 25. Cabinet Unit Heaters (all types)
 26. Energy Recovery Units
 27. HVAC Control Systems

1.13 BIM MODEL

- A. Provide BIM model of the systems included in this specification section in accordance with Section XXXXX BIM Coordination.
- B. All relevant models will be incorporated into one (1) review file for use during coordination meetings. The Coordination Team shall utilize the most current version of Navisworks Manage clash detection software to expedite the drawing review process and resolution. Contractor Models must be submitted in a model format that is compatible with the most current version of Navisworks.
- C. Coordination Model, or Federated Model: The coordination model will be reconciled by each Contractor to find the best collective solution to the coordination of all items.
 - 1. Each Contractor will supply a 3D Contractor Model for their own scope of work separated by areas as directed by General Contractor.
 - 2. Each Contractor will be responsible for working in harmony with the other Contractors to resolve coordination issues.
 - 3. Contractor models will be color coded to provide delineation between systems as directed by the General Contractor.
 - 4. 2D coordination drawings will still be required as directed by General Contractor and required for shop drawing approvals.
- D. Electronic Copies of Models: Submit to the Owner's Project Manager progress and final models when requested, including, at the end of the project, a model(s) appropriate for facilities management and maintenance purposes to be used in association with the Owner's Management System. Electronic copies of tabular data for equipment, spaces, building systems and other items specified by the Owner's Project Manager shall be submitted in a format specified by Owner.
- E. Time is of the essence on this project. Contractor is responsible for all efforts, methods, procedures and costs required to meet or better the scheduled dates. If, at any time, it is determined by the General Contractor or the Owner's Project Manager that this Contractor is not on schedule for any reason within the control or responsibility of the Contractor, the Contractor shall increase its manpower or work such overtime as is required to bring the work back within the Project Schedule. Such additional efforts shall be performed at no additional cost to the General Contractor or the Owner.
- F. The proposed schedule includes "estimated" start dates for the construction activities. In the interest of the Project, the General Contractor reserves the right to alter the sequencing of activities in order to accommodate the project conditions or Authority requirements. It is understood that the Contractor shall be obligated to complete its activities within the specified durations regardless of the actual start date. Contractor agrees to meet or better each duration. The Contractor shall advise the Owner's project manager of any and all automated scheduling software being used on the project.
- G. 3D Contractor Model – computer generated 3D drawings used for coordination, conflict resolution, fabrication, and as-built documentation.
 - 1. Each Contractor will be responsible for producing a model/models to represent the work of the Contractor in accordance with the work breakdown structure to be provided by the General Contractor.
 - 2. If the Contractor does not have the in-house capability to produce the required model/models, the Contractor may utilize the service of an outside entity to provide this service. The Contractor shall, within seven (7) business days of

being identified as the approved low bidder, provide to the General Contractor and Owner's project manager the name, qualifications and experience history of the proposed BIM Production Modeler. The BIM Production Modeler shall have experience on projects of similar size, scope and complexity. The Owner's project manager has the right to approve any proposed BIM Production Modeler.

If the BIM Production Modeler proposed is not approved by the Owner's project manager, then the Contractor shall identify another firm acceptable to the Owner's project manager without any change in cost.

3. All elements must be drawn to scale and shall be a true representation of what is to be installed in the field in all three dimensions.
4. File origin or project insertion point (x,y,z) shall be agreed upon by the project team. Any conflicts that arise due to non-adherence with the insertion point shall be the responsibility of the non-compliant Contractor.
5. File layering convention shall follow the Owner layering standards if applicable.
6. The file naming convention shall be broken down as follows: trade_level_date:
7. Model coordination files will be saved to the project intranet site for access by all trades, General Contractor and the Owner's project manager. The folder structure will contain a "Current Model" file folder and an "Old Model" file folder. It will be the Contractor's responsibility to maintain the appropriate models in the correct file at all times.
8. When an update to a model has been posted each Contractor shall issue a notification via email to each of the other coordination team members notifying them that new information is available. Email, however, shall not be the primary method of delivering model or drawing updates.
9. Working units, unless otherwise specified, shall be in inches.
10. All trades must use a separate color as agreed upon. Colors and/or textures per standards shall be provided by the General Contractor's Modeling Manager.
11. Each Contractor shall maintain their own model files as sole author. Contractors are responsible for providing the team with Navisworks compatible files for their scope of work which will be used for coordination. In some cases separate files will be requested for specific systems within a trade in order to provide the Owner's project manager with greater functionality in the record model. Each Subcontractor is also responsible for compiling and formatting tabular data associated with the equipment, spaces, building systems and other features as directed by the Owner's project manager, and for storing such data in the model and/or in a tabular data base format as directed by the Owner's project manager.
12. In the event the design changes are issued by bulletin which will result in changes in the model/models, and associated data bases, it is the responsibility of the Contractor to make any and all changes required for coordination and compliance with the design. The Contractor may include the cost of modeling and coordination if warranted into their request for change authorization.

H. Ownership:

1. The BIM Files, CADD files, AutoCAD Revit files, TIF files, shop drawings, RFI's, as-built drawings, data bases, etc. (collectively "Project Information"), provided to the Contractor are the Property of the Owner. The Contractor agrees it will keep all project information in strict confidence and will not use on any other project or for any other reason. The Contractor further agrees it will not disseminate the project information to anyone except with a need to know, and will return all project information to Owner when services requiring the project information are complete.
2. In addition to the record documents required by the specifications, the master building information model, data bases, and the subsidiary models provided for design and construction of the project will, upon completion of the project, be

property of Owner and the parties agree to provide Owner, as deliverables prior to Final Completion, the most recent version of all files. Upon Owner request the parties will provide the most updated BIM models.

I. Coordination Meetings

1. Each Contractor is required to take part in regular coordination review meetings. The time and place for these meetings will be established by General Contractor. "Big Room" technology, products like Autodesk 360, and/or other products appropriate for remote meeting for engineering and construction projects may be used for these meetings.
2. The purpose of the coordination meeting is to identify and resolve probable interferences between building systems.
3. Contractors shall supply a Modeling Manager or person authorized to act and make decisions on behalf of their organization.
4. If conflicts are identified and a resolution is agreed upon it is the Contractor's responsibility to have the necessary changes made in their model and republish said model to the project intranet site in time for the next meeting unless another timeframe is agreed upon.

J. Coordination Process

1. Step 1: Contractors to identify conflicts between their system model and the base model and resolve with the General Contractor and design team prior to MEP coordination meeting.
2. Step 2: Contractors to identify any required penetrations in architectural and structural elements for their work prior to MEP coordination meeting.
3. Step 3: Contractors to provide system model to the General Contractor. General Contractor will integrate system model with base model in Navisworks to create a "coordination model".
4. Step 4: Contractors and the General Contractor to meet, review, and resolve clashes/conflicts within the coordination model.
5. Step 5: Contractors make changes to their system model per resolutions from MEP coordination meeting.
6. Step 6: Repeat steps 3 through 5 until all clashes/conflicts have been resolved in the coordination model.

K. Equipment Models: All equipment specified and intended to be used for installation shall be represented in the coordination model as a fully functional 3D component with the following characteristics:

1. Create models in a software application capable of embedding all information specific to that equipment which would typically be available in the required shop drawings and submittals.
2. Construct the models to accurately identify all of the physical components including:
 - a. Length, width and height of equipment.
 - b. Weight of equipment.
 - c. Accurate location of all facility connection points.
 - d. Proper identification of required supports whether provided by the Contractor or others.
 - e. Access for maintenance and/or filter changes locations.
 - f. Clearances required for proper ventilation and/or maintenance.
 - g. OSHA clearances.

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3. Include all clearance requirements for the equipment as outlined by the equipment manufacturer and all applicable building codes. Identify clearances on a specific layer that can be turned off for coordination purposes. Identify clearances as solid planes (“no fly zones”) which will register as clashes during the coordination effort.
4. Provide equipment model information to the General Contractor in its native (*.dwg) format as well as IFC format (IFC format describes the behavior, relationship, and identity of a component object within a model).
5. Provide all tabular data associated with the equipment as specified by Owner, and maintain those data in the model and/or an associated tabular data base formatted to Owner specifications.

L. Record Information

1. Upon completion of coordination activities for a floor area as deemed appropriate by General Contractor, a 2D drawing or series of drawings representing the floor or area will be printed for review by the General Contractor and all members participating in the coordination. This will become the record coordination document.
2. Contractors shall maintain their models during construction to match the ‘as-built’ condition of their installed work.
3. The General Contractor will deliver to the Owner’s project manager, at the completion of the project, a record construction model in Navisworks that incorporates all of the models, fabrication models and updated design models. The native files from each trade shall also be provided. In addition the General Contractor will deliver to the Owner’s project manager, an updated Navisworks model.

M. Change Conditions

1. In that design changes are issued by bulletin, CCD or other method the applicable Contractors will make the changes required in their model/models to support the coordination process without delay.

N. Stratification:

1. Each Contractor will be assigned specific work zone elevations (top and bottom) to run racks and mains. The assigned trades will take precedence in these areas, when traveling outside of these areas the following order of importance rules apply. Additional rules may be instituted at the first coordination meeting.
 - a. Immovable objects (equipment pads, hoods, shafts).
 - b. Graded piping routed throughout floors (waste, storm drainage, high purity).
 - c. Item coordinated with structure (duct penetrations shown on structural).
 - d. Items located in their designated area (piping zone, pipe rack, cable tray).
 - e. Items that require access (VAV’s, shut off valves, fire/smoke dampers, and similar items).
 - f. Electrical Clearances of electrical devices.

O. System Models and Level of Detail:

1. The level of detail defined in each section below (Modeling Standards) is the minimum level of detail required in the model. Greater detail than the minimum should be incorporated in the model whenever inclusion of such detail will improve spatial or sequencing coordination of the work.

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2. To the extent that location can be determined from the construction documents, the model will reflect that location. The intent of this model is to show the ductwork and piping, and similar items in as true representation of the actual condition at construction completion.
3. Pre-purchased equipment shall be the responsibility of the Contractor assigned to receive, install and coordinate the equipment, and they shall be fully responsible for layout, 3D drawings and coordination of the pre-purchased equipment.
4. Each Contractor is responsible for modeling protected access zones. Access zones should be drawn at 60% shading as not to obscure the main fixture or element being protected, or shall have another similar identifying characteristic.
5. Individual model elements (such as VAV boxes, pumps, and similar items) described in further detail below shall each contain the specific and individual name assigned to it as per the design documents, as well as such other information that the Owner's project manager may require, following the approved naming conventions established by the Designer in concert with the General Contractor.

P. Modeling Standards:

1. In addition to the physical characteristics described in each of the following sections, descriptive data regarding each item shall be captured and included in the model(s) and/or an associated tabular data base. Owner will provide a template delineating the descriptive data to be captured for each designated item of equipment. Depending upon the nature of the project, the template may be revised to accommodate additional equipment and/or descriptive fields.
2. General for all trades
 - a. All sleeves shall be shown and include sizes, waterproofing data, fire stopping data and details
 - b. All concrete bases shall be shown
 - c. All miscellaneous metal supports shall be shown and include sizes, material of construction and attachment details.
 - d. All equipment, fixtures, devices, etc. provided shall have a data base associated with each piece that includes, as a minimum, actual capacity of the equipment installed matching the design scheduled categories, materials of construction, serial numbers, parts lists, Installation manuals, maintenance schedules, Operation and Maintenance data, etc.
 - e. All equipment clearances shall be shown in the model.
3. HVAC Sheet Metal Standards
 - a. All ducts, related accessories (including but not limited to standard dampers, fire dampers, VAV boxes, diffusers, turning vanes, etc.) and HVAC equipment will be modeled.
 - b. Ducts will be modeled to the outside face dimension of duct or duct insulation. Hangers must be modeled where necessary to coordinate with the work of other trades.
 - c. Access zones shall be modeled for all elements requiring access including but not limited to equipment, fixtures, standard dampers, fire dampers, VAV boxes, diffusers, turning vanes, and similar items.
 - d. All equipment shall be modeled to its overall height, width and depth.
 - e. All access panels shall be modeled, including access zones above and below.
 - f. In the event that seismic bracing for suspended elements is required by code, such bracing shall be included in the model.

- g. Descriptive data regarding individual ducts and related accessories to be included in the model and/or model data base(s) will be specified in the equipment template provided by Owner. The responsibility for the capture and incorporation of these data into the model and/or the model data base(s) will be specified in the BIM Execution Plan.
 - h. The sequence of installation of individual ducts, and related accessories will be specified by the MEP Coordination Engineer and approved by the Owner's project manager.
4. HVAC Piping Standards
- a. All piping, related accessories (valves, air vents, drain valves, flow meters, etc.) and HVAC equipment will be modeled.
 - b. Pipes will be modeled to the outside diameter of the pipe or pipe insulation. Hangers must be modeled where necessary to coordinate with the work of other trades.
 - c. Equipment will be modeled to its overall height, width and depth.
 - d. Access zones shall be modeled for all elements requiring access including but not limited to equipment, fixtures and valves.
 - e. All access panels shall be modeled, including access zones above and below.
 - f. In the event that seismic bracing for suspended elements is required by code, such bracing shall be included in the model.
 - g. Descriptive data regarding individual pipes and related accessories to be included in the model and/or model data base(s) will be specified in the equipment template provided by Owner. The responsibility for the capture and incorporation of these data into the model and/or the model data base(s) will be specified in the BIM Execution Plan.
 - h. The sequence of piping installation and related accessories will be specified by the General Contractor's MEP Coordination Engineer and approved by the Owner's project manager.
5. Structural Steel
- a. All structural steel shall be included in the model, including but not limited to columns, beams, braces, gusset plates, connections, reinforcing plates and angles, pour stops, metal grating, seismic or secondary supports and beam penetrations.
 - b. The model elements shall contain non-graphic information that associates each element with its erection sequence as appropriate, and identifies the size of the structural element.

1.14 RECORD DRAWINGS

- A. Refer to Division 01, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.
- B. Record Drawings (red-line drawings) will be updated by this Contractor daily for review with the monthly requisition. The record drawing shall be an accurate depiction of the systems as completed, including dimensions (vertical/horizontal) of concealed components off fixed building elements.
- C. The HVAC Foreman shall maintain complete and separate set of prints of Contract Drawings at job site at all times and shall record work completed and all changes from

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original Contract Drawings clearly and accurately including work installed as a modification or addition to the original design.

- D. At completion of work the HVAC Contractor shall prepare a complete set of record drawings on AutoCAD showing all systems as actually installed. The Architectural background AutoCAD files will be made available for the Contractor's copying, at his expense, to serve as backgrounds for the drawings. The HVAC Contractor shall transfer changes from field drawings onto AutoCAD drawings and submit copy of files and three (3) sets of prints to Owner's Representative for comments as to compliance with this section. CADD layering as established by the A & E design team shall be maintained with any and all changes done by the Contractor.
- E. The Architect and Engineer are not granting to the Contractor any Ownership or property interest in the CADD Drawings by the delivery of the CADD Disks to the Contractor. The Contractor's rights to use the CADD disks and the CADD Drawings are limited to use for the sole purpose of assisting in the Contractor's performance of its contractual obligations under its contract with respect to the Project. The Architect and Engineer are granting no further rights. Any reuse or other use by the Contractor will be at the Contractor's sole risk and without liability to the Architect and Engineer. The Contractor hereby waives and releases any losses, claims, damages, liabilities of any nature whatsoever, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor. The Contractor, to the maximum extent permitted by law, hereby agrees to indemnify, defend and hold the Architect and Engineer harmless from all loses, claims, damages, liabilities, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor.
- F. Record Drawings, shall show "as-built" condition of all plans, mechanical room part plans, details, sections, piping diagrams, control diagram and sequence changes and corrections to schedules. Schedules shall show actual manufacturer model numbers and capacities of final installed equipment.
- G. Record drawings shall include the specific locations of the following life safety and control points/sensors:
 - 1. All smoke, fire and combination smoke/fire dampers.
 - 2. All duct smoke detectors.
 - 3. All differential pressure sensors for fan and pump speed control.
 - 4. All outdoor air temperature and humidity sensors.
 - 5. All duct mounted and room sensors, including temperature, humidity, CO2, and occupancy sensors.
- H. The HVAC Contractor shall submit the record set for approval a minimum of three (3) weeks prior to seeking the permanent certificate of occupancy.

1.15 WARRANTIES

- A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this section. Such warranties shall be in addition to and not in lieu of all liabilities which the manufacturer and the HVAC Subcontractor may have by law or by provisions of the Contract Documents.
- B. All materials, equipment and work furnished under this section shall be guaranteed against all defects in materials and workmanship for a minimum period of one (1) year

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commencing with the Date of Substantial Completion. Where individual equipment sections specify longer warranties, provide the longer warranty. Any failure due to defective material, equipment or workmanship which may develop, shall be corrected at no expense to the Owner including all damage to areas, materials and other systems resulting from such failures.

- C. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the drawings.
- D. Upon receipt of notice from the Owner of the failure of any part of the systems during the guarantee period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.16 COORDINATION

- A. Refer to Division 01, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.
- B. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.
- C. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other sections. Any conflicts shall be referred immediately to the Owner's Representative for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Owner's Representative's satisfaction at no expense to the Owner.
- D. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section may interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8 inch scale or larger working drawings and sections, clearly showing how the work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.
- E. Keep fully informed as to the shape, size and position of all openings required for all apparatus, piping, ductwork, etc., and give information in advance to build openings into the work. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the Owner's Representative for the proper setting of same.
- F. All distribution systems which require pitch or slope such as condensate drains and water piping shall have the right of way over those which do not.
- G. Make reasonable modifications in the work as required by structural interferences, interference with work of other trades, or for proper execution of the work without extra charge.
- H. Keep fully informed as to the size, shape and location of all openings required for the work of this section and give full information to all Subcontractors and the Owner's Representative.

1.17 COORDINATION DRAWINGS

- A. Provide a set of HVAC coordination drawings for use in verifying required code clearances (as well as clearances for operation, repair, removal, and testing) of all equipment and for use in coordinating installation of equipment with other trades. Where practical, the CADD layering as established by the A&E team for the construction documents shall be utilized in the preparation of all coordination drawings. Where CADD layering deviates from the A&E team's layering convention, submit the proposed layering system for approval. The CADD layering used shall provide, as a minimum, the flexibility of illustrating trade specific items similar to the established A&E team layering standard.
- B. The intent of the coordination drawings is to identify and resolve installation conflicts prior to fabrication and installation of any MEP trade.
- C. The HVAC Contractor's floor plans shall be the basis for floor plan coordination. The Electrical Contractor's reflected ceiling plans shall be the basis for reflected ceiling plan coordination.
- D. The CADD Drawings prepared by the Architect and Engineer contain representations of certain elements of the Project, and are not necessarily complete, nor are the CADD Drawings comparable or identical to final construction drawings. The Architect and Engineer make no representations or warranties with respect to the accuracy or completeness of the CADD Drawings. The Architect and Engineer do not recommend that the Contractor use the CADD Drawings in connection with the preparation of shop drawings. Should the Contractor choose to do so, however, the Contractor shall carefully review and compare the CADD Drawings with the corresponding final construction drawings to verify their accuracy and identify all discrepancies, differences, and inconsistencies in design, locations, dimensions, scope, and all other respects between the CADD Drawings and the corresponding final construction drawings. The Contractor, shall base the preparation and submission of shop drawings, and in general, shall base the performance of all its obligations with respect to the Project upon the information contained in the final construction drawings and not the CADD drawings. Nothing shall be construed as to relieve the Contractor of any of its obligations (such as, by way of illustration, the obligation to make field measurements or to coordinate drawings) under its contract with respect to the Project.
- E. HVAC Coordination Drawings shall be prepared as outlined below.
 - 1. Prepare HVAC Coordination Drawings showing all HVAC work to be installed as part of Section 23 00 00. The Coordination Drawings shall be created using AutoCAD and shall have a scale of not less than 3/8 inch for mechanical/electrical rooms and 1/4 inch for all other areas.
 - 2. The HVAC Coordination Drawings shall show all equipment, pipes, sleeves, inserts, ducts, registers, diffusers and supports. Drawings shall include dimensions and elevation tags for all equipment, devices and material. Under no conditions shall any pipe or conduit pass through any ductwork system
 - 3. After incorporating all trades, resolve any areas of conflicts between trades under the direction of the General Contractor/Construction Manager and submit fully coordinated drawings to the Owner's Representative.
 - 4. Do not install any of this work prior to the preparation and Engineer's review of the final Coordination Drawings. If HVAC work proceeds prior to the final Coordination Drawings, any changes to the HVAC work to correct the

interferences and conflicts which result will be made by this Contractor at no additional cost to the Owner.

5. Coordination Drawings are for this Contractor's and Owner's Representative's use during construction and shall not be construed as replacing any shop, "as-built", or Record Drawings required elsewhere in these Contract Documents.
6. Owner's Representative's review of Coordination Drawings shall not relieve this Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.18 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. It is the intention of the specifications and drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the drawings, but mentioned in the specifications or vice versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the HVAC Subcontractor or his/her Sub Subcontractors, without additional expense to the Owner.
- B. The drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the site and shall have the approval of the Architect before being installed. The HVAC Subcontractor shall follow drawings, including shop drawings, in laying out work and shall check the drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Architect before proceeding with the installation. The HVAC Subcontractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. Any requests for information (RFI) for resolving an apparent conflict or unclarity, or a request for additional detail, shall include a sketch or equivalent description of Contractors proposed solution.
- D. Sizes of ducts and pipes and routing are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the intent and purpose of the drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge.

1.19 INSPECTION OF SITE CONDITIONS

- A. Prior to submission of bid, visit the site and review the related construction documents to determine the conditions under which the Work has to be performed. Send a report, in writing, to the Owner's Representative, noting any conditions which might adversely affect the Work of this section of the specifications.

1.20 SURVEY AND MEASUREMENTS

- A. Base all required measurements, horizontal and vertical, from referenced points established with the Owner's Representative and be responsible for correctly laying out the Work required under this section of the specification.

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- B. In the event of discrepancy between actual measurements and those indicated, notify the Owner's Representative in writing and do not proceed with the related work until instructions have been issued.

1.21 DELIVERY, STORAGE AND HANDLING

- A. No materials shall be delivered or stored on site until Shop Drawings have been approved.
- B. All manufactured materials shall delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
- C. Protect materials against dampness. Store off floors, under cover, and adequately protected from damage.
- D. Inspect all equipment and materials, upon receipt at the job site, for damage and conformance to approved shop drawings.

1.22 PROTECTION OF WORK AND PROPERTY

- A. This Contractor shall be responsible for the care and protection of all work included under this section until the completion and final acceptance of this Contract.
- B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.
- C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this section and make good damage thus caused.
- D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.23 SUPERVISION

- A. Provide a competent Supervisor with a minimum of 5 years of experience in HVAC Construction Supervision who shall be in charge of the HVAC work at the site.

1.24 SAFETY PRECAUTIONS

- A. Life safety and accident prevention shall be a primary consideration. Comply with all of the safety requirements of the Owner and OSHA throughout the entire construction period of the project.
- B. Furnish, place and maintain proper guards and any other necessary construction required to secure safety of life and property.

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1.25 SCHEDULE

- A. Construct work in sequence under provisions of Division 01 and as coordinated with the Owner's Representative.

1.26 HOISTING, SCAFFOLDING AND PLANKING

- A. The work to be done under this section of the specifications shall include the furnishing, set-up and maintenance of all derricks, hoisting machinery, cranes, helicopters, scaffolds, staging and planking as required for the work.

1.27 CUTTING AND PATCHING

- A. Include all coring, cutting, patching, and fireproofing necessary for the execution of the work of this section. Structural elements shall not be cut without written approval of the Architect. This Contractor shall be responsible for taking all precautions required to identify hidden piping, conduits, etc. before any core drilling and/or cutting of slabs commences, including X-raying the affected slabs. Provide fire stopping to maintain the fire rating of the fire resistance-rated assembly. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details and be listed by UL or FM.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. Form all chases or openings for the installation of the work of this section of the specifications, or cut the same in existing work and see that all sleeves or forms are in the work and properly set in ample time to prevent delays. Be responsible that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and consult with the Owner's Representative and all trades concerned in reference to this work. Confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Owner's Representative.
- D. Fit around, close up, repair, patch, and point around the work specified herein to match the existing adjacent surfaces and to the satisfaction of the Owner's Representative.
- E. Fill and patch all openings or holes left in the existing structures by the removal of existing equipment that is part of this section of the specifications.
- F. All of this work shall be carefully done by workmen qualified to do such work and with the proper and smallest tools applicable.
- G. Any cost caused by defective or ill-timed work required by this section of the specifications shall be borne by the Subcontractor.
- H. When, in order to accommodate the work required under this section of the specifications, finished materials of other trades must be cut or fitted, furnish the necessary drawings and information to the trades whose materials must be cut or fitted.

1.28 SLEEVES, INSERTS AND ANCHOR BOLTS

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- A. Coordinate with other trades the location of and maintaining in proper positions, sleeves, inserts and anchor bolts to be supplied and/or set in place under this section of the specifications. In the event of incorrectly located preset sleeves, inserts and anchor bolts, etc., all required cutting and patching of finished work shall be done under this section of the specifications.
- B. All pipes passing through floors, walls, ceilings or partitions shall be provided with fire stopping to maintain the fire rating of the structure. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details. Provide sleeves for all penetrations where required by the listed detail, for the penetration of all mechanical room floors and where specifically required on the drawings.
- C. Field drilling (core drilling), when required, shall be performed under this section of the specifications, after receipt of approval by the Owner's Representative.
 - 1. When coring cannot be avoided, provide ¼ inch pilot hole prior to coring. When coring through floor or slab, verify location of core on floor below and protect and piping, ductwork, wiring, furniture, personnel, etc., below the location of the core.

1.29 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

- A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all equipment and systems provided under this section of the specification.
- B. Supplementary steel and factory fabricated channels shall be firmly connected to building construction in a manner approved by the Owner's Representative, as shown on the drawings, or hereinafter specified.
- C. The type and size of the supporting channels and supplementary steel provided under this section of the specifications shall be determined by the Subcontractor and shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.
- E. All supplementary steel including factory fabricated channels, supports and fittings shall be galvanized steel, aluminum, or stainless steel where exposed or subject to rust producing atmosphere and shall be manufactured by Unistrut, H-strut, Powerstrut, ERICO or approved equal.

1.30 HAZARDOUS MATERIALS

- A. Dispose of all hazardous materials in accordance with Federal and State laws. All handling shall conform to EPA requirements. A uniform hazardous waste manifest shall be prepared for all disposals and returned with all applicable signoffs prior to application for final payment. Provide breakout cost for this scope.

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- B. Recovered refrigerant shall be recycled by a licensed facility approved by the Owner's Representative.
- C. Removed equipment or fluids containing any hazardous materials such as ethylene glycol, oil, mercury or chromate shall be recycled by a licensed facility approved by the Owner's Representative.
- D. Where it has been identified that asbestos-containing material exists within the scope limits, refer to the Asbestos Abatement specification section for requirements. Where insulation is removed, provide new insulation (types and thicknesses as specified in this section). Where scope is not defined, provide unit prices with bid for all pipe and duct sizes involved.

1.31 ACCESSIBILITY

- A. All work provided under this section of the specification shall be installed so that parts requiring periodic inspection, maintenance and repair are readily accessible. Work of this trade shall not infringe upon clearances required by equipment of other trades, especially code required clearances to electrical gear. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the Owner's Representative.

1.32 SEISMIC RESTRAINT REQUIREMENTS

- A. Submit working plans and calculations reviewed, signed and stamped by a professional engineer who is registered in the State where the project is located and has specific experience in seismic calculations, certifying that the plans meet all seismic requirements established by authorities having jurisdiction over the project, including bracing for any hazardous exhaust systems.

1.33 WELDING QUALIFICATIONS

- A. Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9 (or B31.1 for steam boiler piping over 15 PSIG and all steam and condensate piping over 150 PSIG). The Owner's Representative shall be notified twenty-four (24) hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Division 01.
- B. A fire watchman with an approved fire extinguisher shall be posted at the site of the welding work, during that work, and for a minimum of thirty (30) minutes after the work is completed, to see that sparks or drops of hot metal do not start fires.

1.34 ELECTRICAL WORK

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- A. All electrical apparatus and controls furnished, and the installation thereof, as a part of the HVAC work, equipment, and controls shall conform to applicable requirements under Division 26 - Electrical.

1.35 COMMISSIONING

- A. The HVAC systems shall be provided with system commissioning by the contractor in accordance with section C408 of the 2015 International Energy Conservation Code. The contractor shall provide commissioning and commissioning plans including preliminary commissioning reports developed by a registered design professional or an approved agency in accordance with section C408.2 of the 2015 International Energy Conservation Code. The same registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion to the professional engineer stamping the HVAC drawings in accordance with the provisions of the code sections.

1.36 PROJECT CLOSEOUT

A. Certificates Of Approval

- 1. Upon completion of all work, provide certificates of inspections from the following equipment manufacturers stating that the authorized factory representatives have inspected and tested the operation of their respective equipment and found the equipment to be in satisfactory operating condition and installed per the manufacturers installation instructions and requirements.
 - a. Rooftop HVAC Units
 - b. Air Handling Units
 - c. Make-Up Air Units
 - d. Automatic Temperature Controls
 - e. Boilers
 - f. Water Treatment Systems
 - g. Chillers
 - h. Cooling Towers
 - i. Radiant Heating System

B. Construction Observations By The Engineer

- 1. The engineer shall make progress site visits during construction and one (1) substantial completion (punch list) site visit for determining substantial completion.
- 2. The Trade Contractors and the General Contractor are required to inspect their own work and make any corrections to the work to comply with the specifications and the contract documents. It is not the responsibility of the engineer to develop lists of incomplete work items.
- 3. Progress Site Visits
 - a. The purpose of the progress site visit by the engineer is to observe if the work is proceeding in accordance with the contract documents.
 - b. The engineer will prepare a field report which will note in general the work completed since the last observation visit, work found not to be in accordance with the contract documents and work not corrected since the previous observation visit.

C. Substantial Completion

1. When the Contractor considers the Work under this section is substantially complete, the Contractor shall submit written notice, through the General Contractor, with a detailed list of items remaining to be completed or corrected and a schedule of when each remaining work item will be completed. Should the engineer determine the list of remaining work does not constitute substantial completion the engineer will notify the Architect and/or Owner and he will not make a substantial completion site visit.
2. The following items shall be completed prior to the written request for substantial completion site visit:
 - a. Certification of successful operation of all systems.
 - b. Training of the Owner's personnel in the operation of the systems.
 - c. Record Drawings in accordance with the contract specifications.
 - d. Operation and Maintenance manuals.
 - e. Testing reports.
 - f. Balancing reports.
 - g. Manufacturers certificates of approvals.
 - h. Emergency contact list for reporting of malfunctioning equipment during the warranty period.
 - i. Contractors Project Completion certificate in accordance with the building code requirements.
3. Should the Engineer, during the substantial completion visit, observe that the Work is substantially complete, s/he will provide a written listing of the observed deficiencies referred herein as the Punch List. The Punchlist will provide for a place for the Contractor and General Contractor to sign off and date each item individually indicating that the observed deficiency item has been corrected.
4. Should the Engineer, during the substantial completion site visit, observe that the Work is not substantially complete, s/he will provide, a written list of the major deficiencies and a reason for the work not being considered substantially complete.
5. If the work is found not to be substantially complete then the engineer shall be reimbursed for his time to reobserve the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any further observations by the engineer.
6. The Contractor shall remedy all deficiencies listed in the punchlist within the time frame required by the contract.

D. Engineer's Construction Completion Certification

1. Where required by the applicable code, the Engineer's Construction Completion Certification will be issued by NV5 when all life safety and health related issues are complete, all required functional tests are complete and all reports are complete. The following is a minimum listing of the required systems to be tested with reports generated indicating they are complete and ready for use:
 - a. Air and Water Balancing
 - b. Boiler Plant Start Up
 - c. Water Treatment Systems
 - d. Chiller Plant Start Up
 - e. Duct Pressure/Leakage Tests
 - f. Pipe Pressure Tests
 - g. Smoke Control Systems
 - h. Commissioning of Systems

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2. There shall be NO outstanding items identified on the punchlist for scope within any of these categories.
- E. Final Completion
1. The following items shall be submitted prior to the written request for Final completion:
 - a. Revised Substantial Completion items to be resubmitted in accordance with the review process comments.
 - b. Warranties commencing the date of Substantial completion
 - c. Individual Signed and dated Punchlist acknowledging completion of all punchlist items
 2. When the Contractor considers all of the punchlist work items complete, the Contractor shall submit written notice through the General Contractor that all Punchlist items are complete and resolved and the work is ready for final observation site visit. The signature lines for completion of each punchlist item shall be signed by the Contractor indicating the work is complete and signed by the General Contractor indicating s/he has inspected the work and found it to be complete. Should the Engineer find the work to be finally complete and all Punchlist items are complete the Engineer will make a recommendation to the Architect or Owner. If the Engineer has found the punchlist work to be incomplete during final inspection a written listing of the observed deficiencies will be prepared by the Engineer.
 3. If the work is not fully complete then the engineer shall be reimbursed for his time to reobserve the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any re-observations by the Engineer.
- F. Re-observation Fees
1. The re-observation fee shall be **\$1200.00** per visit.
- G. Contractor's Project Completion Certificate
1. Upon completion of work and prior to request for Certificate of Occupancy, each Trade Contractor and the General Contractor shall issue a certificate stating that work has been installed generally consistent with construction documents and all applicable codes. NV5 can furnish a blank Contractor's certificate form upon request. The certificate shall certify:
 - a. Execution of all work has been installed in accordance with the approved construction documents.
 - b. Execution and control of all methods of construction was in a safe and satisfactory manner in accordance with all applicable local, state and federal statutes and regulations.
 2. The certificate shall include the following information:
 - a. Project.
 - b. Permit Number.
 - c. Location.
 - d. Construction Documents.
 - e. Date on Plans and specifications submitted for approval and issuance of the Building Permit.
 - f. Addendum(a) and Revision Dates.
 3. The certificate shall be signed by the Contractor and include the following:

- a. Signature.
- b. Date.
- c. Company.
- d. License Number.
- e. License Expiration Date.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. General Requirements for Pipe

1. Pipe material shall be indicated in the Schedule of Pipe and Fittings for each type of service.
2. Steel pipe shall conform to ASTM A53 Grade B or ASTM A106 Grade B (A106 is required for systems with temperatures that could go over 750°F) black steel. Pipe thickness (schedule) shall be as specified for the service.
3. Stainless steel pipe shall be grade 304, 304L, 316 or 316L and shall conform to ASTM A312, seamless. Pipe thickness (schedule) shall be as specified for the service.
4. Copper tubing shall conform to ASTM B75 or ASTM B88, seamless. Thickness (type) shall be as required for the service with a minimum safety factor of 4:1. Tubing for compressed air tubing shall conform to ASTM B251.
5. Polyethylene tubing shall be fire-resistant (FR), low-density virgin polyethylene conforming to ASTM D 1248, Type I, Category 5, Class B or C.

B. General Requirements for Fittings

1. Pipe fittings shall be indicated in the Schedule of Pipe and Fittings for each type of service. Fittings shall be rated to match the larger of the pipe pressure rating in the Schedule or the valve rating listed in the valve tables in the Part 2 Valve and Strainer section of this specification.
2. All fittings shall be installed per code requirements and the manufacturer's best recommendations.
3. Malleable iron pipe fittings shall conform to ASME B16.3, type required to match adjacent piping.
4. Cast iron (CI) pipe fittings shall conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.
5. Steel pipe fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer. For 90° elbows, provide long radius fitting unless they will not physically fit, in which case short radius may be used. Flanges shall be flat faced weld neck up to Class 125 and raised face weld neck type for Class 150 and above.
6. The steel pipe joining methods below are only allowed when they are specifically listed in the Schedule of Pipe and Fittings:
 - a. Type S1: Welded fittings shall conform to ASTM A234 with WPA marking. Butt-welded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11. Make fusion welded joints as required by ANSI/ASME B31.1.
 - b. Type S2: Steel flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 for the class required (Class 150 minimum). Flange material shall conform to ASTM A53 Grade B. Blind flange material shall conform to ASTM A516 for cold service and ASTM A515 for hot service. Bolts shall be high strength or

- intermediate (Class 150 only) strength with material conforming to ASTM A193.
- c. Type S3: Cast Iron (CI) flanged fittings shall be of malleable cast iron conforming to ASTM A47, Grade 32510. Bolts shall be high strength or intermediate (Class 125 only) strength with material conforming to ASTM A193. Class 125 iron flanges shall be limited to 175 PSIG / 230oF (up to twelve (12) inches) and 125 PSIG / 230oF (14 inches – 24 inches). Class 250 iron flanges shall be limited to 400 PSIG / 250oF (up to 12 inches) and 250 PSIG / 250oF (14 inches – 24 inches).
 - d. Type S4: Ductile iron (DI) flanged fittings shall conform to ASTM A536, Grade 65-45-12. Bolts shall be high strength or intermediate (Class 150 only) strength with material conforming to ASTM A193. Class 150 ductile iron flanges shall be limited to 225 PSIG / 230oF. Class 300 ductile iron flanges shall be limited to 425 PSIG / 450oF.
 - e. Type S5: Threaded joints: For use up to two (2) inch pipe size. Pipe threads shall conform to ASME B1.20.1. Nipples shall conform to ASTM A733 or ASTM B687. Class 125 iron threaded fittings shall be limited to 150 PSIG / 250oF or 125 PSI at 350oF. Class 250 iron threaded fittings shall be limited to 340 PSIG / 250oF. Class 150 ductile iron threaded fittings shall be limited to 185 PSIG / 250oF or 150 PSIG / 300oF (maximum temperature). Class 300 ductile iron threaded fittings shall be limited to 1200 PSIG / 250oF or 600 PSIG / 450oF (maximum temperature).
 - f. Type S6: Malleable iron pipe press fittings equal to IMS Fastlock may be used (in exposed, accessible areas only) and shall be NSF-61-4 certified, approved by the state where it will be installed, and be IAPMO approved. Sealing elements for press fittings shall be EPDM gasket and 316L stainless steel ring. System shall be suitable for, and limited to, water systems up to two (2) inch pipe size with operating temperatures up to 210°F and maximum pressure rating up to 200 PSIG. Press ends shall have a design feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection with a 10 PSIG air pressure test. 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.
 - 1) Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Press fitting joints may be used on hot water systems below 210° generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum three (3) foot thermal traps at the heat exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.
 - g. Type S7: For use over two (2) inch pipe size. Standard grooved mechanical pipe joints shall conform to ANSI/AWWA C606. Use is limited to low temperature water systems below 210°F and 250 PSIG in easily accessible locations. Couplings shall be designed for not less than 250 PSI service and shall provide a water-tight joint.
 - 1) Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Grooved joints may be used on hot water systems below 210° generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum three (3) foot thermal traps at

- the heat exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.
- 2) Grooved mechanical joint fittings shall be full flow factory manufactured forged or fabricated steel fittings or cast ductile iron fittings. Mechanical pipe couplings shall be of the bolted type and shall consist of a housing fabricated in two (2) parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings shall be of ductile iron conforming to ASTM A536, Grade 65-45-12. Coupling nuts and bolts shall be of heat treated carbon steel, zinc electroplated to ASTM B-633 and conform to ASTM A-183 and A-449, minimum 110,000 PSI tensile strength. Gaskets shall be of molded synthetic rubber, Type EPDM (for water service) with central cavity, pressure responsive configuration, rated for a temperature range of -30°F to +230°F, and shall conform to ASTM D-2000 (Gaskets shall be verified as suitable for the intended service prior to installation).
 - 3) Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact of housings upon installation to insure positive rigid clamping of the pipe. Rigid grooved pipe couplings shall be used with grooved end pipes, fittings, valves and strainers. Rigid segmentally welded elbows shall not be used. Standard rigid coupling (2 inch-12 inch) housings shall be Victaulic Style 107, 07, or Grinnell Style 772, (over 12 inches shall be 2 piece housings equal to Victaulic AGS) and shall provide system rigidity equal to welded steel with supports and hanging requirements corresponding to ANSI B-31.1 Power Piping and ANSI B-31.9 Building Services Codes (same spacing as steel pipe).
 - 4) Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment other than pumps.
 - 5) Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Owner's Representative shall be notified twenty-four (24) hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.
7. Fittings for copper tubing shall be wrought copper and bronze fittings conforming to ASME B16.22 and ASTM B75 or cast copper alloy fittings conforming to ASME B16.18. Copper may be used up to two (2) inch tubing size. Adapters may be used for connecting tubing to flanges and threaded ends of valves and equipment. The copper tubing/pipe joining methods below are only allowed when they are specifically listed in the Schedule of Pipe and Fittings:
- a. Type C1: Soldered copper fittings shall use either 95/5 (Tin/Antimony), silver solder (for systems up to 250°F and 175 PSI), or shall be brazed (for higher temperature/pressure systems – Contractor shall submit brazing material and pressure/temperature rating of joint). Solder shall conform to ASTM B32. Solder and flux shall be lead free. Silver solder

- shall conform to FS QQ-B-654. Brazing alloys shall be B-Ag alloy (or equivalent strength alloy) having a melting point above 1,000°F.
- b. Type C2: Copper and copper alloy press fittings equal to Viega ProPress may be used (in exposed, accessible areas only) and shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer and shall be suitable for, and limited to, water systems with operating temperatures up to 210°F and maximum pressure rating up to 200 PSIG. Press ends shall have a design feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. 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.
 - c. Type C3: Grooved joints (copper tube sized) fittings (rated and limited for systems up to +210°F and maximum pressure rating of 300 PSI) equal to Victaulic Style 607 may be used for water systems (in exposed, accessible areas only).
8. Type SC1: Vic-Press 304™ fittings and couplings or ProPress® Stainless joints with Schedule 5 stainless steel pipe may be used for up to two (2) inch water piping (in exposed, accessible areas only) in lieu of other copper or steel joining methods to a maximum operating temperature of +210°F and maximum pressure rating of 200 PSI. Pipe shall be ASTM A312 Schedule 5, stainless steel. Fittings shall be stainless steel with EPDM O-ring seals.
 - a. Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Press fitting joints may be used on hot water systems below 210° generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum three (3) foot thermal traps at the heat exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.
 9. Composition gaskets for flanges shall conform to ASME B16.21. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.
 10. Unions shall conform to FS WW-U-531 or FS WW-U-516, type to match adjacent piping.
 11. Adapters for copper tubing shall be brass or bronze for soldered and brazed fittings.
 12. Dielectric Waterway fittings equal to PPP Clearflow shall be used where dissimilar pipe materials (such as steel and copper) in any water or glycol system are joined. Fittings shall conform to the tensile strength and dimensional requirements specified in FS WW-U-531. Waterways shall have metal connections on both ends to match adjacent piping. Metal parts of dielectric Waterways shall be fully separated by NSF/FDA listed thermoplastic lining so that the electrical current is well below 1% of the galvanic current that would exist upon metal-to-metal contact. Fittings shall be rated for 300 PSIG and 225°F. Galvanized pipe, dielectric unions, or insulated couplings shall not be used.
 13. Flexible pipe connectors shall be as specified in Vibration Isolation paragraph.

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C. Schedules of Pipe and Fittings

1. As used in the pipe and fitting schedule tables, closed loop systems have expansion tanks and are not open to the atmosphere, examples are chilled, hot, dual temperature and closed heat pump condenser water systems. Open loop systems are open to the atmosphere with open condenser water system being the most common.
2. Relief valve piping shall have the same pressure/temperature ratings as the fluid being relieved. Exposed outdoor piping shall be stainless steel.

WATER AND GLYCOL SERVICES: UP TO 230 PSIG AT 250°F, OR 275 PSIG AT 100°F (relieve valve setting) (Some joint types or materials may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.)				
Service	Pipe Material & Schedule or Type	Joint Types Allowed	Fitting Material	Min. Pressure Class (PSIG) & / or Schedule
Closed loop piping up to 2"	Copper / Type L	C1, C2, C3, or SC1	Copper, Bronze	150
Closed loop piping up to 2"	Steel / Schedule 40	S5, S6, or SC1	CI, DI	250 / Standard Weight
Closed loop piping 2.5"-24"	Steel / Standard Weight	S1, S2, S3, S4, or S7	Steel, CI, DI	150 / Standard Weight
Open loop piping up to 2"	Copper / Type L	C1, C2, C3, or SC1	Copper, Bronze	150
Open loop piping up to 2"	Steel / Schedule 40 (80 if threaded)	S5, S6, or SC1	CI, DI	250 / Schedule 40 (80 if threaded)
Open loop piping 2.5"-24"	Steel / Standard Weight	S1, S2, S3, S4, or S7	Steel, CI, DI	150 / Standard Weight
Condensate gravity drain	Copper / Type M or DWV	C1, C2, C3, or SC1	Copper, Bronze	125
Cold water make-up	Copper / Type L	C1 (silver soldered or brazed only), C2, C3, or SC1	Copper, Bronze	150

STEAM AND CONDENSATE SERVICES: UP TO 125 PSIG (353°F SATURATED), OR ANY PUMPED CONDENSATE TO 175 PSIG (relieve valve setting): (Some joint types or materials may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.)				
Service	Pipe Material & Schedule or Type	Joint Types Allowed	Fitting Material	Min. Pressure Class (PSIG) & / or Schedule
Steam up to 2"	Steel / Schedule 40 (80 if threaded)	S1 or S5	Steel, CI, DI	125 / Schedule 40 (80 if threaded)
Condensate up to 2"	Steel / Schedule 80 Seamless	S1 or S5	Steel, CI, DI	125 / Schedule 80
Steam 2.5"-12"	Steel / Standard Weight	S1, S2, S3, or S4	Steel, CI, DI	125 / Standard Weight

STEAM AND CONDENSATE SERVICES: UP TO 125 PSIG (353°F SATURATED), OR ANY PUMPED CONDENSATE TO 175 PSIG (relieve valve setting): (Some joint types or materials may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.)				
Service	Pipe Material & Schedule or Type	Joint Types Allowed	Fitting Material	Min. Pressure Class (PSIG) & / or Schedule
Steam 14"-24"	Steel / Standard Weight	S1, S2, S3, or S4	Steel, CI, DI	250 / Standard Weight
Condensate 2.5"- 12"	Steel / Extra Strong Seamless	S1, S2, or S4	Steel, DI	125 / Extra Strong
Condensate 14"- 24"	Steel / Extra Strong Seamless	S1, S2, or S4	Steel, DI	250 / Extra Strong
Boiler Feed Water up to 2"	Steel / Schedule 80 Seamless	S5	CI, DI	125 / Schedule 80
Boiler Feed Water 2.5"-12"	Steel / Extra Strong Seamless	S1, S2, S3, or S4	Steel, CI, DI	125 / Extra Strong

D. Refrigerant Piping:

1. Refrigerant gas relief piping shall be ASTM A53 Schedule 40, black steel. Fittings for pipe sizes two (2) inches and below shall be threaded 300 pound malleable iron or 2000 pound forged steel. Joints shall be welded for pipe sizes 2-1/2 inches and above, threaded for pipe sizes two (2) inches and below. Unions for use with steel piping shall be 300 pound malleable iron, ground joint, or 2000 pound forged steel. Cast iron fittings must not be used on refrigerant systems.
2. Dimensions and material requirements for refrigerant (and other fluids/gasses that can be below 35°F) pipe, pipe fittings and components shall conform to ASHRAE 15 and ASME/ANSI B31.5 and shall be compatible with fluids used and capable of withstanding the pressures and temperatures of the service. Pipe, tubing, and components used for refrigerant service shall be cleaned, sealed, capped, or plugged prior to shipment from the manufacturer's plant.
 - a. Copper pipe and fittings shall be seamless copper tubing, soft drawn, Type K for underground use (all underground piping shall be pre-insulated with no joints), Type ACR for all other uses (unless otherwise noted), ASTM B 280. Fittings for copper tubing shall be wrought copper, brazed joint type (type C1), ASME/ANSI B16.22. Brazing alloys shall be B-Ag alloy (or equivalent strength alloy) having a melting point above 1,000°F. Flared-tube joint fittings conforming to ASME B16.26 and ASTM B62 (where operating pressures allow) may be used with soft copper tubing (annealed ASTM B280) only in nominal sizes smaller than one (1) inch for connection to equipment and no larger than 1 3/8 inches outside diameter for other connections. Flanges shall be bronze, ANSI B16.24.
 - b. Where copper pipe size or pressure rating is too small, refrigerant piping shall be ASTM A53 Schedule 40, black steel. All joints shall be welded. Unions for use with steel piping shall be 300 pound malleable iron, ground joint, or 2000 pound forged steel.

2.2 PIPE HANGERS AND SUPPORTS

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- A. Hangers shall be as manufactured by Carpenter & Patterson, Inc., Grinnell Corporation, B-Line Systems, ERICO, or equal. Hangers shall transmit the load exclusively to the structure of the building. All hangers and supports to conform to MSS standards SP-58 and SP-69 and ANSI B 31.1.
- B. Hangers for all piping four (4) inches and above shall be adjustable roll type. Hangers for piping below four (4) inches shall be clevis type. Hangers for piping in tunnels on strut support frames shall be roller type, similar to Fig. B379 by B-Line Systems. Additionally, the first five (5) pipe hangers on both sides of all pump piping (suction and discharge) to be precompressed spring and double-deflection neoprene style, with 30° hanging rod swing capability, similar and equal in all respects to Mason Industries Model PC 30N, selected by manufacturer for anticipated loading and deflection.
- C. Provide all additional structural steel required for proper installation of hangers, anchors, guides and supports; hangers shall be arranged to maintain the required grading and pitch of piping, to prevent vibration and to provide for expansion and contraction.
- D. Maximum spacing of hangers and supports for steel pipe:
- | <u>Pipe Size (inches)</u> | <u>Horizontal</u> | <u>Vertical</u> |
|---------------------------|-------------------|-----------------|
| Up to 1 | 6 feet | 10 feet |
| 1¼-2½ | 9 feet | 15 feet |
| 3-and up | 12 feet | 15 feet |
- E. Reduce Steel pipe spacing to a maximum of ten (10) feet, regardless of pipe, as necessary for fittings, valves, and other concentrated loads.
- F. Horizontal copper tubing shall have maximum hanger spacing of five (5) feet for tubing up to 1-¼ inch and eight (8) feet for 1½ inch and larger. Vertical copper tubing shall have maximum hanger and support spacing of ten (10) feet. Maximum spacing for PVC pipe hangers and supports shall be four (4) feet (horizontal), and ten (10) feet (vertical) with mid-story guides.
- G. Steel or stainless steel tubing shall have maximum hanger and support spacing of eight (8) feet (horizontal) or ten (10) feet (vertical).
- H. If any other piping material is used, the maximum hanger and support spacing shall be the lesser of manufacturer's recommendation or the listed spacing in the mechanical code (adopted edition of IMC Table 305.4).
- I. Branch piping and runouts of over 5 feet shall have at least one (1) hanger or support.
- J. At all copper piping, provide pipe supports with copper finish to eliminate the possibility of galvanic action.
- K. Furnish additional hangers or supports at vertical or horizontal changes of direction and at locations of concentrated loads due to valves, fittings, strainers, and accessories.
- L. Hangers and supports shall provide for two (2) inches of vertical adjustments.
- M. Hanger rods shall be steel, threaded and furnished with two (2) removable nuts at each end of positioning rod and hanger and locking each in place.

- N. Except as otherwise noted, hanger rods shall be of the following sizes:

SCHEDULE OF PIPE HANGER ROD SIZES		
Pipe Sizes (inches)	Single Rod Diameter (inches)	Double Rod Diameter (inches)
½-2	3/8	3/8
2½-3	½	3/8
4 & 5	5/8	½
6	¾	5/8
8 – 12	N/A	7/8
14 – 18	N/A	1
20	N/A	1¼
24	N/A	1-½

- O. Pipe covering protection saddles shall not be loaded to more than 80% of maximum loading as rated by the manufacturer.
- P. Insulated piping insulation shields:
1. Up to three (3) inch pipe size: 18 gauge galvanized steel, located outside the vapor barrier, minimum 180° arc, twelve (12) inches long, or pipe covering protection saddles.
 2. 4" pipe size and larger: pipe covering protection saddles.
- Q. Vertical support shall be by means of riser clamps (anchors with split ring type allowable up to two (2) inch size only) and adjustable pipe support with flange anchored to floor or supplementary steel.
- R. Rods, clamps and hangers shall be electro-galvanized coated.
- S. All clamps, hangers and rods located outdoors or other high moisture environment **[list these, such as spa or swimming pool area]** shall be stainless steel or PVC coated.
- T. Valve and piping supports, from the floor, shall be equal to Carpenter & Paterson, Inc. Figure 101, adjustable pipe support and complete with pipe standard and flange, anchored to floor.
1. Supports shall be installed at each control valve, riser, tee or elbow and where any unsupported section exceeds four (4) feet-zero (0) inches in length measured along piping centerline.
- U. Upper Attachments to Building Structure:
1. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles that are expansion-bolted to the concrete. Expansion bolting shall be located so that piping loads place bolts in shear. Submit details for approval.
 2. Structural Steel Framing: Upper attachments welded or clamped to structural steel members. Additional steel members may be necessary in some support

- locations where piping locations differ from that known on contract drawings. Submit details for approval.
3. Structural Wood Framing: Submit details for approval.
 4. Expansion Fasteners and Power Set Fasteners: In existing concrete slab construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- V. All hangers and shields exposed to the exterior shall be galvanized steel and PVC coated to manufacturer's standard thickness.
- W. In grooved piping systems, rigid type grooved joint mechanical couplings may be used on IPS steel piping systems, which meet the support and hanging requirements of these specifications and ASME B31.1 and B31.9. Adequate numbers of flexible type couplings may also be used to compensate for thermal expansion and contraction, settling of the pipe, vibration, noise or other piping system movement. Maximum hanger spacing for flexible couplings shall be in accordance with either manufacturer's published guidelines or the requirements of Item D of this section; whichever is more stringent.

2.3 SLEEVES

- A. Size sleeves to provide a minimum of one (1) inch clearance around piping and ductwork, and to allow continuous runs of insulation where specified. Ensure that insulated piping and ductwork do not touch sleeves.
- B. Pack clearance spaces with Thermafibre Fire stopping. Caulk with fire-resistant, resilient waterproof compound, RectorSeal Biostop 500+ or equal. Ensure that fire ratings of floors and walls are maintained.
- C. Piping sleeves shall be according to the following:
 1. Through interior non-masonry walls, use 18 gauge rolled and tack welded galvanized steel sleeves, set flush with finished surfaces on both sides.
 2. Through interior masonry walls, exterior walls above grade and roofs, use machine cut and reamed standard weight steel piping, set flush with finished surfaces on inside and to suit flashing on outside.
 3. For floors in mechanical equipment rooms, and similar areas where a water dam is required, use machine cut and reamed standard weight steel piping set flush to underside of structure and extending six (6) inches above finished floor.
 4. For other floors, use 18 gauge rolled and tack welded galvanized steel, or machine cut and reamed plastic pipe or standard weight steel piping set flush to both finished surfaces. Refer to Room Finish Schedule.
 5. Cover pipe sleeves in walls and ceilings of finished areas other than equipment rooms with satin finish stainless steel, or satin finish chrome or nickel plated brass escutcheons, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks may be used.
 6. In non-rated walls, escutcheon plates shall be of adequate size to allow for piping with full insulation to pass through the wall uninterrupted. The interior diameter of the plate shall fit snugly around the outside diameter of the insulation.
- D. Duct sleeves shall be minimum 18 gauge galvanized steel. Provide adequate bracing for support of sleeves during concrete and masonry work. For fire rated floors and walls,

build fire dampers into structure to attain fire rated construction, in a manner acceptable to the local and state authorities.

- E. Cover exposed duct sleeves in finished areas with 18 gauge galvanized steel plates in the form of duct collars. Fix in position with non-ferrous metal screws.

2.4 FIRE STOPPING

- A. Provide asbestos-free fire stopping material capable of maintaining an effective barrier against flame, gases, and temperature. Provide noncombustible fire stopping that is nontoxic to human beings during installation or during fire conditions. Devices and equipment for fire stopping service shall be UL FRD listed or FM P7825 approved for use with applicable construction, and penetrating items.
 - 1. Fire Hazard Classification: Material shall have a flame spread of 25 or less, a smoke developed rating of 50 or less when tested in accordance with UL 723 or UL listed and accepted.
 - 2. Fire stopping Rating: Fire stopping materials shall be UL FRD listed or FM P7825 approved for "F" and "T" ratings at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected, except that "F" and "T" ratings may be three (3) hours for fire stopping in through-penetrations of 4-hour fire rated wall or floor.

2.5 PIPE EXPANSION JOINTS, GUIDES AND ANCHORS

- A. Furnish and install where shown on the drawings, a system of expansion compensation, main anchors and pipe guides to control the expansion of the new distribution piping. Unless otherwise stated, temperature fluctuation shall be between 40°F minimum and 10°F above the maximum operative temperature of the fluid. Wherever possible, expansion shall be absorbed by the use of elbows, "Z" bends, or pipe loops; otherwise expansion joints shall be used.
- B. Pipe anchors shall be designed to limit movement in all planes to zero. Submit details on assembly with all locations and forces (for structural review). Assembly to be fabricated of carbon steel and finished with one (1) coat of rust inhibitive paint.
- C. Pipe guides shall be 4-finger spider-and-sleeve type to insure multiple guiding and to allow for complete insulation of piping. Spider and sleeve shall be formed of two halves to facilitate installation of spider on pipe and mounting of guide to structure. Guides shall be provided in accordance with "Standards of the Expansion Joint Manufacturer's Association", latest edition. Guides shall provide a minimum of axial pipe movement equal to the sum of the full movement of the expansion device plus two (2) inches. Assembly to be fabricated of carbon steel and finished with one (1) coat of rust inhibitive paint.
- D. Expansion joints shall be in compliance with all applicable requirements of EJMA-01 and ASME B31.1.
 - 1. Multi-ply bellows expansion joints shall be manufactured from a laminated tube consisting of multiple thin gauge 316 or 321 stainless steel plies. The tube shall then be formed into corrugations. Plies between inner and outer liner shall be spiral-wound to act as a labyrinth seal. Joint shall be designed for a minimum of 7000 full-load thermal cycles without failure. Joints shall have flanged ends rated

for the full pressure rating of the bellows (minimum of 150 PSI). Joints shall be tested for 150% of the rated pressure and rated for 600°F. Provide 304 stainless steel internal liner. Install joint in piping to allow for draining of water from liner. Joints shall provide the minimum axial, lateral and/or angular movements required or scheduled on the drawings. Pipe alignment guides shall be installed as recommended by joint manufacturer, but in any case shall not be more than 5 pipe diameters from expansion joint. Joints shall be as manufactured by American BOA, Metraflex, Proco Products, or approved equal.

2. Expansion Joints for Grooved Piping Systems:
 - a. Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with rigid couplings, providing up to three (3) inch axial end movement (no angular deflection provided), suitable for water services up to 210° F and operating pressures up to 350 PSIG, or
 - b. Combination of a series of grooved end short nipples joined in tandem with flexible couplings to provide increased expansion (axial and angular deflection allowed for). Joint movement and expansion capabilities determined by number of couplings/nipples used in the joint. Pressure rating determined by style and size of flexible couplings used.

2.6 VALVES AND STRAINERS

A. General:

1. Valves and strainers shall be constructed of the materials shown in the tables for each system and be rated by the manufacturer for the appropriate pressure class required for the listed pressure and temperature limits and for the fluid used and per the valve tables.
2. The manufacturers and model numbers indicated below are to be used as a means of identifying the type, quality, materials and workmanship required. Note that some of the manufacturers listed for a type of valve do not make valves for all pressure/temperature limits and/or all sizes. All valves of each type (400 PSIG ball, 150 PSIG globe, etc.) for the project shall be by the same manufacturer.
3. All valves shall be located and oriented as to valve stem direction to permit proper and easy operation, and access to valve for maintenance of packing, seat and disc. Valve stems shall not be tilted down unless approved by the manufacturer. Where valves are more than seven (7) feet above the floor, stems shall be horizontal and all valves 2-1/2 inch and above shall have chain wheel and "endless link" style chain for operation from floor; where impact wheel is required, it shall be provided. Packing and gaskets shall not contain asbestos. Provide unions adjacent to equipment end of all threaded and soldered or permanent push-to-connect end valves. Provide grooved joint couplings adjacent to equipment end of all grooved end valves.

B. Service:

1. Shutoff or Isolation Valves shall be provided in all branch connections to mains and where shown on piping diagrams.
 - a. In general, for 2½ inch and larger piping use flanged valves or grooved-ended valves in grooved water systems; butterfly valves for water and glycol systems or gate valves for steam and condensate systems.
 - b. In general, for piping smaller than 2½ inch use threaded, sweat, permanent push-to-connect or press/cripped water system connections;

full port ball valves for water, fuel oil, and glycol systems or gate valves for steam and condensate systems.

2. Balancing Valves
 - a. No balancing valves are required where Pressure Independent Automatic Control Valves (PIACV) are used for a single coil. Where multiple coils are served by a single PIACV, each coil shall have a combination balancing and shut-off valve to provide proportional balancing. When non-PIACVs are used, provide automatic flow limiting valves or combination balancing and shut-off valves as shown on drawings and details for water and glycol systems and globe valves for steam and condensate. Triple duty valves (balancing with flow measurement, shut-off, and check valve) or equivalent tri-service assemblies (in grooved piping systems) can be used where shown on the drawings and allowed in the tables on pump discharges.
 3. Check Valves
 - a. For pump discharge use silent check valves (where allowed in the tables and where triple duty valves are not used). All others shall be swing-check type.
 4. Drain Valves and Manual Vent Valves
 - a. Globe with plug-type disc or ball valves (as shown on drawings).
 5. Vacuum Breakers
 - a. Vacuum breakers shall be of stainless steel and brass construction rated for a minimum of 200 PSIG saturated steam and be equal to Spriax Sarco Model VB-14. Provide at least one (1) vacuum breaker for each steam coil and heat exchanger.
- C. Swing Check Valves: Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, Victaulic (grooved), Grinnell (grooved), or Hammond.
- D. Silent Check Valves: Silent check valves for use on pump discharge shall be of the materials and pressure/temperature ratings shown in the tables. Minimum open area through valve shall be at least 100% of the pipe area. Valves shall be as manufactured by Mueller, Nibco, Metraflex, APCO, Victaulic (grooved), Grinnell (grooved), or SF Equipment.
- E. Globe Valves (including angle valves): Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-85, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Maximum seat leakage for manual valves shall be no more than 10 cc/hr per inch of diameter. Control valves leakage shall be no more than that allowed by ANSI seat leakage Class IV (0.01% of full open valve capacity). Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, or Hammond. For areas where clearances are

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restricted, non-rising stems may be used – Contractor shall indicate locations on submittal.

- F. Gate Valves: Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-70, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Maximum seat leakage shall be no more than 10 cc/hr per inch of diameter. Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, or Hammond. For areas where clearances are restricted, non-rising stems may be used – Contractor shall indicate locations on submittal.
- G. Ball Valves: Valves shall meet FS WW-V-35C, Type II, and have the appropriate trim to meet the required pressure/temperature ratings listed in the tables. Valves shall have locking handles to allow servicing and removal of piping or equipment. Valves on insulated piping shall have stem extension assemblies equal to the insulation thickness. Valves shall have 100% tight shut-off (no seat leakage). Valves used for isolation (all 2-position applications) shall be full port. Valves shall be as manufactured by Conbraco Industries (Apollo), Watts, Stockham, Nibco, Hammond, or Milwaukee. Ball valves for modulating control service may be reduced port and shall have characterized disc where available to provide equal percentage flow characteristics and extended rangeability. Modulating ball valves shall be Bray VCB series or Belimo B series.
- H. Butterfly Valves: Provide butterfly valves of the type and materials listed in the tables. Valve necks shall allow a minimum of two (2) inch insulation. Valves shall have the trim required to meet the listed pressures and temperatures listed in the tables. Valves shall have visual position indication. Valve seats shall have zero or near zero (bubble-tight) bi-directional seat leakage. Valves six (6) inches and larger and all steam valves shall be gear operated. Non-steam valves under six (6) inches shall be lever operated with balance stops.
1. General Service: Standard lug or grooved (in grooved systems) type with ductile or cast iron body, resilient EPDM seats, bronze, nickel, PPS (Polyphenylene Sulfide), Nylon 11 coated ductile iron disc and 416 stainless steel stem. Valves shall comply with MSS SP-25, MSS SP-67, and API-609. Valves shall be as manufactured by Mueller, Centerline, DeZurik, Milwaukee, Nibco, Hammond, Keystone, Bray Model 31H, Victaulic Masterseal (grooved), Grinnell Model B302 (grooved), or SF Equipment.
 2. High Performance: Valves shall have lug-style carbon steel body, 316 stainless steel eccentric disc, offset 17-4 PH stainless steel shaft, and filled PTFE soft seat. Valves shall comply with ANSI B16.5, ANSI B16.34, MSS SP-25, MSS SP-61 (zero leakage), MSS SP-58, and API-609. Valves shall be as manufactured by Flowseal (Crane), Neles-Jamesbury, DeZurik, Posi-Seal, Milwaukee, Hammond or Bray/McCannalok.
- I. Combination Balancing and Shutoff Valves
1. Furnish and install circuit balancing valves as shown on plans and in accordance to manufacturer's installation instructions. Valve size shall match pipe size (except ½ inch shall be used where flow rate is 1 GPM or less). Valves shall provide three (3) functions: precise flow measurement, precision flow balancing, and positive drip tight shut off. Valves shall be as manufactured by Bell & Gossett, Mepco, Flowset, Tour Anderson, Taco, Nexus, Macon or Armstrong.

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2. Each valve shall have two (2) ¼ inch NPT brass metering ports with Nordel or EPDM check valves and gasketed caps located on both sides of valve seat. Two (2) additional ¼ inch NPT connections with brass plugs are to be provided on the opposite side of the metering ports for use as drain connections. Drain connections and metering ports are to be interchangeable to allow for measurement flexibility when valves are installed in tight locations.
3. An integral pointer shall register degree of valve opening. Valves shall be calibrated so that flow in GPM can be determined when valve opening in degrees or turns and pressure differential across valve is known. Valve hand-wheel shall have memory lock feature that will provide a means for locking the valve position after the system is balanced.
4. Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables.
5. All valves on insulated piping shall be supplied with removable preformed insulation equal in R-value to the adjacent pipe insulation and a removable PVC jacket.
6. Provide one (1) portable differential meter suitable for the operating and differential pressures specified and required, complete with hoses, vent, and carrying case.

J. Triple Duty Pump Discharge Valves

1. Furnish and install multi-purpose valves as shown on plans and in accordance to manufacturer's installation instructions. Valve size shall match pipe size. Valves shall provide four (4) functions: precise flow measurement, precision flow balancing, non-slam check valve, and positive drip tight shut off. Valves shall be as manufactured by Bell & Gossett, Flowset, Taco, or Armstrong.
2. Each valve shall have two (2) ¼ inch NPT brass metering ports with Nordel or EPDM check valves and gasketed caps located on both sides of valve seat. Two (2) additional ¼ inch NPT connections with brass plugs are to be provided on the opposite side of the metering ports for use as drain connections. Drain connections and metering ports are to be interchangeable to allow for measurement flexibility when valves are installed in tight locations.
3. An integral pointer shall register degree of valve opening. Valves shall be calibrated so that flow in GPM can be determined when valve opening in degrees and pressure differential across valve is known. Valve type shall be one of the types listed for the service in the table. Valve hand-wheel shall have memory lock feature that will provide a means for locking the valve position after the system is balanced.
4. Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables.
5. All valves on insulated piping shall be supplied with removable preformed insulation equal in R-value to the adjacent pipe insulation and a removable PVC jacket.
6. Provide one (1) portable differential meter suitable for the operating and differential pressures specified and required, complete with hoses, vent, and carrying case.
7. On grooved piping systems, equivalent tri-service valve assemblies may be used in lieu of Triple Duty pump discharge valves as shown on plans and in accordance with the manufacturer's installation instructions. Valve size shall match pipe size and be straight pattern consisting of a combination shut-off,

throttling, flow measurement, and non-slam check valve in one unit with a maximum pressure rating of 300 PSI and temperatures to 230 °F, memory stops standard.

- K. Automatic Flow Limiting Valves: Valves shall be pressure flow limiting independent type with spring loading to provide the required opening to maintain constant flow across the entire control pressure range. Valve flow selection shall be adjustable on the valve assembly with a minimum range of +50% above the design flow. Valves whose flow rate can't be field selected (fixed flow) shall be selected within in the range of -5% to +10% of the design flow and be provided with replacement flow cartridges as required by the balancing Contractor or engineer. The valves shall be provided with a permanent nameplate or tag carrying a record of the factory-determined flow rate, flow range and flow control pressure ranges. Valves shall be certified to control the flow within 5% of the flow set per the tag's listed flow and control pressure range. Unless shown otherwise, the minimum control pressure range shall be 2 to 32 psid. Valves shall be of materials suitable for the maximum operating pressure and temperature listed in the table for the intended service. Valves up to two (2) inches shall be threaded or solder-end. Valves over two (2) inches shall be flanged. Each valve shall have a pressure fitting with quick disconnect valve located on both sides of the valve. Provide deluxe meter kit in carrying case. Provide molded insulation kit. Valves shall be as manufactured by Griswold, Flow Design/Autoflow, Macon, Hays or Nexus.
- L. Pressure Independent Automatic Control Valves: The intent is for PIACVs to be used for all modulating 2-way control valves on all water systems (including glycol). Each pressure independent (PI) automatic control valve (ACV) is a two-section valve referred to herein as a PIACV. These valves shall be self-balancing (pressure independent) over a minimum operating range across both sections of the valve assembly of 6 to 45 psid (or up to 58 psid where the associated pump head is over 130 feet) with the mechanical PI section limiting the differential pressure over the ACV section to provide very stable and accurate control. Electronic PI sections are not allowed as they require the ACV section to absorb the entire pressure drop at the maximum psid. Control valves leakage shall be no more than that allowed by ANSI seat leakage Class IV (0.01% of full open valve capacity). See the Controls section of the specifications for further information and requirements for these valves.
- M. Strainers
1. Strainer-body connections shall be the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with a tapped blowdown opening. Provide full size nipple and appropriate type of valve for blowdown. The basket shall be of stainless steel with small perforations of sufficient number to provide a net free area through the basket of at least 5 times that of the entering pipe. The flow shall be into the basket and out through the perforations. Bronze strainers shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron strainers shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables. Steel strainers shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Y-type strainers are listed in the tables, provide basket type strainers of same construction where shown on drawings. Strainers shall be as manufactured by Mueller, Sarco, Watts, Armstrong, Keckley, or Yarway.

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2. Strainers for grooved end piping systems shall be of the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with a tapped blowdown opening:
 - a. Y-pattern, two (2) inch through twelve (12) inch sizes, 300 PSI maximum pressure rating. Suitable for services up to 210°F, ductile iron body, Type 304 stainless steel perforated metal removable baskets, blowdown port with pipe plug and grooved ends.
 - b. T-pattern, two (2) inch through twelve (12) inch sizes, 300 PSI maximum pressure rating. Suitable for services up to 210°F, ductile iron body, Type 304 stainless steel frame and mesh removable basket, removable access coupling/cap for strainer maintenance, and grooved ends.
 - c. T-pattern, fourteen (14) inch through twenty-four (24) inch sizes, 300 PSI maximum pressure rating. Suitable for services up to 210°F, carbon steel body, Type 304 stainless steel frame and mesh removable basket, carbon steel T-bolt hinged closure/cap for strainer maintenance, and grooved ends.

N. Suction Diffusers

1. Where shown furnish pump inlet suction diffusers as manufactured by Mueller, Bell & Gossett, Armstrong, Taco, or Paco. Units shall consist of an angle type body with inlet vanes and a combination diffuser/strainer and straightening vanes for use on pump inlet. The body or bottom opening shall be equipped with a tapped blowdown opening. Provide full size nipple and appropriate type of valve for blowdown. The basket shall be of stainless steel with small perforations of sufficient number to provide a net free area through the basket of at least 5 times that of the entering pipe. Unit shall be equipped with a disposable fine mesh start up strainer that shall be removed after system flushing. The body shall be full line size, non-reducing type. Provide reducer as required to fit the pump. Units shall be provided with adjustable support feet to relieve piping strains from the pump suction. Provide valved gauge connections with gauges at diffuser inlet and pump suction to indicate when cleaning is required. Iron strainers shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables. Steel strainers shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables.
2. Where shown furnish pump inlet suction diffusers as manufactured by Victaulic or Grinnell on grooved installations. Unit shall be full line size, non-reducing type with flanged outlet and grooved inlet connections, ductile iron body, angle-type, 304 stainless steel frame and perforated sheet diffuser. Removable 20 mesh stainless steel startup pre-filter, outlets for pressure/temperature drain connection and base support boss, 300 PSI maximum pressure rating and 210°F maximum operating temperature.

O. Water Pressure Reducing and Back-pressure Valves

1. Valves shall be as manufactured by Bell and Gossett, Armstrong, Taco, Spence, Sarco, Leslie, Kay & MacDonald, Cashco, or Watts.
2. Provide pressure reducing and back-pressure regulating valves where shown on the drawings. Valves shall be constructed for the applicable temperature and pressure limits in the table for the service intended.
3. Make-up water PRVs shall be provided with integral low inlet-pressure check valves (optionally an external check could be substituted) and inlet strainers.

The strainers shall be easily removable without system shutdown. The valve seat, strainer and stem shall be removable and of non-corrosive material. The body shall be brass. The valve shall be full line sized as shown on the drawings. Pressure setting to be minimum system operating pressure (static head plus approximately 4 PSI).

P. Pressure Relief Valves and Accessories

1. Pressure relief valves shall be provided where shown on the drawings in accordance with ASME BPV VIII Division 01. Relief valves shall be constructed for the maximum pressure the system can operate at. The aggregate relieving capacity of the relief valves shall be not less than that required by the above code. Provide at least one (1) relief valve for each closed loop piping system. Discharge from water relief valves shall be to indirect drain. Pipe chiller refrigerant relief and steam relief valves to a safe location outdoors. Valves shall be as manufactured by Watts, Kunkle, Lonergan, or Lunkenheimer.
2. For steam relief valves that are piped outdoors, provide steam exhaust heads where shown on drawings. Exhaust heads shall be low pressure drop cyclone design with drains as manufactured by Bryan Steam HEH Series (rated at 7,000 fpm) or equal by, Crane (Cochrane), Penn Separator, Watson McDaniel, Anderson or Hayward (Wright-Austin). Pipe drains as required. Exhaust heads shall remove at least 99% of liquids and solids larger than 10 microns and be fabricated of cast iron or carbon steel (with high heat and rust resistant aluminum paint) with stainless steel separating elements. Contractor shall verify that the exhaust head's steam capacity is equal to or greater than the associated relief valves capacity and provide any required pipe increases

Q. Air Vents: Provide air vents at all high points in the piping systems meeting the pressure and temperature limits shown on the table for each system.

1. Automatic: Normal Capacity – Float operated with bronze or steel body and stainless steel internals, ball-check valve type with materials as required for the pressure/temperature listed in the table for the system. Provide each vent with safe drainage piping for venting air/water to drain.
2. Manual: For low pressure/temperature water and glycol systems, provide 1/8-in. brass body, chrome plated with two-detachable keys. For higher pressure/temperature systems, provide globe valves with plug-type disc or ball valves with materials, as required and allowed in the table for the system.

R. Drain Valves: Drain valves shall be one of the type listed for isolation in the table for each piping system. Provide drain connections at all equipment and all low points in the piping systems to allow for complete drainage. Drain connections shall have full size threaded hose end connections with cap/plug. For piping up to four (4) inches, provide minimum 3/4 inch valves. For piping between four (4) inches and ten (10) inches, provide minimum 1 1/2 inch valves. For piping larger than ten (10) inches, provide minimum two (2) inch valves. Provide fifty (50) feet of premium grade hose for each size drain.

S. Valve Lubrication: Furnish a lubrication gun in the mechanical equipment room with extra lubricant sticks sufficient to repack each valve. Guns shall be extra heavy, lever type hydraulic hand type with automatic shutoff, 1500 PSI gauge and twelve (12) inches long connecting hose. Lubricant shall be as required by valve manufacturer for the service intended.

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WATER SERVICES: Maximum 150 PSIG at 250°F (Heating & Dual Temperature Systems), or 275 PSIG at 120°F (CHW & CW)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Minimum Pressure Rating/Class
Ball	To 2"	2 or 3 piece	Isolation or ATC Modulation (with characterized disc)	Brass or Bronze/RTFE	Sweat (3-piece only) or Threaded (2 or 3-piece)	400 PSIG CWP (Cold Working Pressure) or ANSI Class 150
PIACV	To 2"	Control & Balancing	ATC Modulation for Water & Glycol Systems	Brass or Bronze/RTFE	Threaded	400 PSIG CWP or ANSI Class 150
PIACV	2½" and up"	Control and Balancing	ATC Modulation for Water & Glycol Systems	Ductile Iron /EPDM	Flanged	ANSI Class 150 for 150 PSIG or Class 300 for 275 PSIG
Butterfly	2½" - 12"	General Service	Isolation or ATC 2-Position	Iron/EPDM	Flanged	200 PSIG CWP, Bi-directional, dead end service.
Butterfly	14" - 48"	General Service	Isolation or ATC 2-Position	Iron/EPDM	Flanged	150 PSIG CWP, Bi-directional, dead end service.
Butterfly	2½" - 24"	High Performance (Double offset)	ATC Modulation (C _v at 2/3 open)	Steel/Reinforced PTFE	Flanged	ANSI Class 150
Globe	To 2"	Control	ATC Modulation	Bronze/Brass	Threaded	ANSI Class 125 for 150 PSIG or Class 200 for 275 PSIG
Balancing /Shutoff	To 2"	Flow Indication	Isolation and balancing	Bronze or Brass/Brass	Threaded	ANSI Class 125 or 300 PSIG CWP
Balancing /Shutoff	2½" -12"	Flow Indication	Isolation and balancing	Iron or Steel/Brass	Flanged	ANSI Class 125 for 150 PSIG or 300 PSIG CWP for 275 PSIG
Triple Duty	To 2"	Flow Indication	Pump discharge isolation, check, and balancing	Bronze or Ductile or Cast Iron /Bronze	Threaded or Flanged	ANSI Class 125 for 150 PSIG or Class 200 for 275 PSIG
Triple Duty	2½" - 12"	Flow Indication	Pump discharge isolation, check, and balancing	Bronze or Ductile or Cast Iron /Bronze	Flanged	ANSI Class 125 for 150 PSIG or 300 CWP for 275 PSIG
Check	To 2"	Silent	Pump discharge	Bronze or Stainless Steel/Brass, Bronze or Stainless Steel	Threaded or Flanged	300 PSIG CWP
Check	2" - 24"	Silent Globe	Pump discharge	Ductile or Cast Iron or Steel /Bronze or Stainless Steel	Flanged	ANSI Class 125 for 150 PSIG or Class 250 or 150 Steel for 275 PSIG

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WATER SERVICES: Maximum 150 PSIG at 250°F (Heating & Dual Temperature Systems), or 275 PSIG at 120°F (CHW & CW)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Minimum Pressure Rating/Class
Check	To 2"	Swing	Piping	Bronze/Bronze	Threaded	ANSI Class 125 for 150 PSIG or Class 200 for 275 PSIG
Check	2½" - 12"	Swing	Piping	Iron or Steel /Bronze or 13 Cr steel	Flanged	ANSI Class 125 for 150 PSIG or Class 250 or 150 Steel for 275 PSIG
Check	12" - 24"	Swing	Piping	Iron or Steel /Bronze or 13 Cr Steel	Flanged	ANSI Class 125 for 150 PSIG or Class 250 or 150 Steel for 275 PSIG
Strainer	To 2"	Y-type	ACVs, P&F HXs	Bronze/Stainless 1/16 inch screen	Threaded	ANSI Class 125 for 150 PSIG or Class 200 for 275 PSIG
Strainer	2½" - 4"	Y-type	ACVs, P&F HXs	Iron or Steel /Stainless 1/16 inch screen	Flanged	ANSI Class 125 for 150 PSIG or Class 250 or 150 Stl for 275 PSIG
Strainer	5" - 12"	Y-type	ACVs, P&F HXs	Iron or Steel/Stainless 1/8 inch screen	Flanged	ANSI Class 125 for 150 PSIG or Class 250 or 150 Steel for 275 PSIG
Strainer	14" - 24"	Y-type	ACVs, P&F HXs	Iron or Steel /Stainless 1/8 inch screen	Flanged	ANSI Class 250 or 150 Steel
Strainer	To 16"	Suction Diffuser	Pump Inlet (non- reducing)	Cast or Ductile Iron /Stainless 5/32 inch screen	Threaded (to 2 inches) or Flanged	300 PSIG CWP or ANSI Class 125

ALTERNATE PIPING METHOD (GROOVED JOINT) FOR WATER SERVICES: Maximum Service Rating of 230F; with pressure as required for the systems (see standard valve tables)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Pressure Rating/Maximu m System Rating
Ball	1½"- 6	2-piece	Isolation or ATC 2-Position	DI (ASTM A- 536)/Cr.-plated stem, ball TFE seats	Grooved	800 PSI/600 PSI

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ALTERNATE PIPING METHOD (GROOVED JOINT) FOR WATER SERVICES: Maximum Service Rating of 230F; with pressure as required for the systems (see standard valve tables)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Pressure Rating/Maximum System Rating
Ball	2"	1-piece	Diverting (3-port) or ATC 2-Position	DI (ASTM A-395)/SS TFE	Grooved	600 PSI/450 PSI
Butterfly	2"-12"	General Service	Isolation or ATC 2-Position	DI (ASTM A-536 or 395) DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Butterfly, 3-way	2"-12"	General Service	Diverting	DI (ASTM A-536 or 395)/ DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Butterfly	14"-24"	General Service	Isolation	DI (ASTM A-395) SS/EPDM	Grooved	175 PSI (dead-end to full rating of valve)/150 PSI
Butterfly	14"-24"	General Service	Isolation	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Balancing /Shutoff	To 2"	Flow Indication	Isolation and balancing	Ametal® Brass-Copper Alloy/EPDM	Sweat or Threaded	300 PSI/230 PSI
Balancing /Shutoff	2½"-12"	Flow Indication	Isolation and balancing	DI (ASTM A-536)/EPDM	Flanged or Grooved	300 PSI/230 PSI
Tri-Service	2½"-12"	Flow Indication	Pump discharge isolation, check and balancing	DI (ASTM A-536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	2½"-12"	Silent	Pump Discharge	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	4"-12"	Silent	Pump Discharge	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	2"-4"	Swing	Piping (Horizontal)	DI (ASTM A-536) SS/EPDM	Grooved	300 PSI/230 PSI
Check	14"-24"	Spring Assist Dual Check	Pump Discharge	DI (ASTM A-395) SS/EPDM	Grooved	230 PSI/200 PSI
Strainer	2"-12"	Y-Type	ACV's, P&F HXs	DI (ASTM A-395 or 536) /EPDM SS 1/16 inch or 1/8 inch screen	Grooved	300 PSI/230 PSI
Strainer	1½"-12"	T-Type	ACV's, P&F HXs	DI (ASTM A-395 or 536) /EPDM SS 1/8 inch screen	Grooved	400 PSI/350 PSI
Strainer	14"-24"	T-Type	ACV's, P&F HXs	DI (ASTM A-395 or 536) /EPDM SS 1/8 inch screen	Grooved	300 PSI/230 PSI

ALTERNATE PIPING METHOD (GROOVED JOINT) FOR WATER SERVICES: Maximum Service Rating of 230F; with pressure as required for the systems (see standard valve tables)						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Pressure Rating/Maximum System Rating
Strainer	3"-12"	Suction Diffuser	Pump Inlet (non-reducing)	DI (ASTM A-395)/EPDM SS 3/16 inch screen with 20 mesh start-up sleeve	Grooved System x ANSI Class 150 Pump Flange	300 PSI/230 PSI
Strainer	14"-24"	Suction Diffuser	Pump Inlet (non-reducing)	DI (ASTM A-395)/EPDM SS 3/16 inch screen with 20 mesh start-up sleeve	Grooved System x ANSI Class 150 Pump Flange	300 PSI/230 PSI

STEAM AND STEAM CONDENSATE SERVICES: Maximum (relief valve setting) 125 PSIG Saturated Steam (353°F), or Any Pumped Condensate to 175 PSIG						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Minimum Pressure Rating/Class
Ball	To 2"	2 piece	Isolation or ATC open-close (non-modulated)	Steel/Stainless Steel/Reinforced PTFE	Threaded	125 PSIG steam
Butterfly	2½" - 24"	High Performance (Double offset)	Isolation or ATC, open-close or Modulation (with C _v selected at 2/3 open)	Steel/Stainless Steel/Reinforced PTFE	Flanged	ANSI Class 150 with zero leakage bi-directional Note: Modulation is limited to 50 PSIG steam systems.
Butterfly	2½" - 24"	High Performance (Triple offset)	Isolation or ATC Modulation (with C _v at 2/3 open)	Steel/Stainless Steel or laminated	Flanged	ANSI Class 150 with zero leakage bi-directional.
Gate	To 2"	Screwed Bonnet	Isolation	Iron or Bronze/Bronze	Threaded	ANSI Class 125
Gate	2½" - 12"	OS&Y, Rising stem	Isolation	Iron/Bronze	Flanged	ANSI Class 125
Gate	14" - 24"	OS&Y, Rising stem	Isolation	Iron/Bronze	Flanged	ANSI Class 250
Globe	To 2"	Union or Screwed Bonnet	Balancing or ATC Modulation	Iron or Bronze/Stainless Steel	Threaded	ANSI Class 125
Globe	2½" - 12"	Bolted Bonnet	Balancing	Iron/Stainless Steel	Flanged	ANSI Class 125

STEAM AND STEAM CONDENSATE SERVICES: Maximum (relief valve setting) 125 PSIG Saturated Steam (353°F), or Any Pumped Condensate to 175 PSIG						
Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Minimum Pressure Rating/Class
Globe	14" - 24"	Bolted Bonnet	Balancing	Iron/Stainless Steel	Flanged	ANSI Class 250
Check	To 2"	Swing	Piping	Bronze/Bronze	Threaded	ANSI Class 125
Check	2½" - 12"	Swing	Piping	Iron/Bronze	Flanged	ANSI Class 125
Check	14" - 24"	Swing	Piping	Iron/Bronze	Flanged	ANSI Class 250
Strainer	To 2"	Y-type	Piping	Bronze or Iron/Stainless 3/64 inch screen	Threaded	ANSI Class 125
Strainer	½" - 2"	Y-type	Piping	Steel/Stainless 3/64 inch screen	Threaded	ANSI Class 125
Strainer	2½" - 12"	Y-type	Piping	Iron/Stainless 3/64 inch screen	Flanged	ANSI Class 125
Strainer	14" - 24"	Y-type	Piping	Iron/Stainless 1/16 inch screen	Flanged	ANSI Class 250

2.7 STEAM TRAPS

- A. Balanced pressure thermostatic traps/airvents shall be designed for steam working pressures up to 125 PSIG. Traps shall have brass bodies and caps with natural brass finish. Bellows, valve head and renewable valve seat shall be stainless steel
- B. Float-and-Thermostatic traps shall be designed for a steam working pressure of 30 PSIG, but shall operate with a supply pressure of between ¼ and 15 PSIG. The capacity of the traps shall be sized for two (2) times the equipment capacity. Where modulating control valves are used, trap capacity shall be based on a pressure differential of 1/4 PSI. Each float-and-thermostatic trap shall be provided with a hard bronze, monel, or stainless steel valve seat and mechanism and brass float, all of which can be removed easily for inspection or replacement without disturbing the piping connections. Inlet to each trap shall have a cast iron strainer, either an integral part of the trap or a separate item of equipment.
- C. Thermodynamic traps shall be disc type with integral or separate strainer and be of stainless steel or cast steel construction. Traps shall be designed for easy replacement of operating section without removal from pipe line, and for steam working pressures of between 4 to 450 PSIG, and shall operate with up to 80% back-pressure. Provide positive means of air venting without air binding, if not available internally, provide external thermostatic air vent. Provide insulated jacket for the pressure chamber to save steam and reduce wear.
- D. Traps shall be by TLV, Gestra, Spirax-Sarco, Hoffman, Illinois, Barnes & Jones, or approved equal.

2.8 PIPING, EQUIPMENT, PANEL AND VALVE IDENTIFICATION

- A. All piping, equipment, panels and valves furnished and/or installed under this section of the specifications including automatic temperature controls shall be identified with pipe markers, valve tags, and equipment name plates. Refer to Part 3 – Identification for materials and methods of installation.

2.9 EXPANSION TANKS

- A. Expansion Tanks shall be bladder type as manufactured by Taco, Bell & Gossett, Armstrong, Amtrol or approved equal.
- B. The only air in the system shall be the permanent sealed-in air cushion contained in the bladder-type tank. Sizes shall be as indicated. Expansion tank shall be welded steel, precharged to the minimum operating pressure. Tank air chamber shall be fitted with an air charging valve. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.
 - 1. Shell shall be of fabricated steel designed and constructed per ASME Section VIII, Division 01 and include ASME label.
 - 2. Bladder shall be of heavy duty butyl, replaceable.
 - 3. Tank shall be designed for a minimum suitable for a working pressure of 125 PSIG with an operating temperature of 250°F.

2.10 PRESSURE GAUGES, THERMOMETERS AND ACCESSORIES

- A. Pressure Gauges
 - 1. Gauges shall be provided for equipment and piping as indicated. A thermometer and pressure gauge shall be provided on the supply and return mains of each water and glycol system, and on the supply mains of each pressure steam system, and on the supply piping of each pressure steam system.
 - 2. Up to seven (7) feet above finished floor, provide 4½ inch diameter gauges; over seven (7) feet above finished floors, provide six (6) inch diameter gauges, oriented for ease of reading.
 - 3. Provide gauges having 1% of scale range accuracy, brass pipe and fittings, phosphor bronze bourdon tubes, beryllium copper bellows, 1/4-in. NPT male connection, stainless steel rack and pinion movement, micro adjustment for calibration, white dial and black figures, plastic lens, and threaded ring case. Provide minimum two (2) inch long brass nipples, ball valves (gate for steam), snubbers, and siphons (steam systems only) for each gauge.
 - 4. Gauge ranges to be selected so that normal operating range for a particular gauge will occur at approximately the midpoint of the total range, and so that under minimum and maximum conditions, damage to gauge will not occur. Provide compound gauges at suction side of condenser water pumps and at the steam inlet of each heat exchanger.
 - 5. Gauge Schedule: Provide at locations indicated on drawings. Shop drawing submittal package to include location, size of gauge and range.
 - 6. Manufacturers: Ashcroft Inc., Ametek/U.S. Gauge Division, Marsh Instruments, Weiss, Weksler, Trerice, or approved equal.
 - 7. Gauges on piping in all mechanical rooms shall be so placed as to be easily read from the floor without parallax.

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- B. Compound Gauges (based on Terrice No. 600C Series, 4-1/2 inch size)
1. Provide compound pressure gauges where the pressure readings could be below 0 PSIG. Gauge shall have cast aluminum case, black finish.
 2. Ring shall be friction type, stainless steel, clear glass window, with white dial with black figures and gradations.
 3. Pointer shall be adjustable, red tipped.
 4. Bourdon tube shall be phosphor bronze soldered to socket and tip, socket shall be brass, ¼ inch NPT.
 5. Accuracy shall be ANSI B.40.1, Grade A, 1% of full scale over middle half of range, 2% of full scale over first and last quarter of range.

C. Thermometers and Wells

1. Separable well type, industrial thermometers of the type specified below. Provide stainless steel separable wells with extended neck to suit insulation thickness. Provide stems and wells to extend approximately to center of the pipe or maximum length of twelve (12) inch for large pipe.
2. Provide thermometers having brass, cast aluminum-bronze or cast aluminum case with blue reading non-mercury and glass windows. Provide minimum nine (9) inch scales with black numbers and adjustable angle stem. Provide 1% accuracy at mid-range. Thermometers shall be as manufactured by Taylor Instrument Co., Ametek/U.S. Gauge Division, Ashcroft Inc., Marsh Instrument, Weiss, Weksler, Terrice, or approved equal.

<u>Service</u>	<u>Scale Range</u>	<u>Divisions</u>
Heating Hot Water and Dual Temperature	[30] to [240] °F.	2°F
Chilled Water	[0] to [120] °F.	1°F
Condenser Water	[0] to [120] °F.	1°F

D. P/T Test Plugs

1. Pressure/Temperature Test Plugs shall be nickel-plated brass body, with ½-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 PSIG.
2. Core Material: Conform to the following for fluid and temperature range:
 - a. Water, minus 30° to 275 °F (minus 35 to 136 °C): EPDM.
3. Test Kit: Provide test kit consisting of 2 pressure gauges, gauge adapters with probes, 2 bimetal dial thermometers, and carrying case.
4. Ranges of pressure gauges and thermometers shall be approximately two (2) times systems operating conditions.
5. Manufacturers: Peterson Equipment (Pete's Plug), Sisco (A Spedco Co.), Terrice, Watts Regulator, or approved equal.

2.11 MOTORS, DRIVES AND STARTERS

- A. All equipment shall be provided complete with motors and drives, unless otherwise indicated.

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- B. Motors shall be Premium Efficiency (as available by size/speed/horsepower) and shall conform to NEMA Standards and shall be suitable for load, duty service and location. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, efficiency, speed and current characteristics. Motors shall be Century "E+3", General Electric "Energy Saver Premium", Reliance "Premium Energy Efficient" Series, Baldor "Super Premium Efficiency", or approved equal.
- C. Motors shall be tested in accordance with the standards of ANSI C50 and conform therewith for insulation resistance and electric strength. Minimum efficiency levels shall be as listed in latest edition of ANSI/ASHRAE Standard 90.1 or the state's energy code, whichever is higher. All motors shall be tested in accordance with IEEE Standard 112, Test Method B. Provide on nameplate the type of bearing grease to use.
- D. Motors for use with variable frequency drives (VFD) shall be inverter duty rated and labeled, meet NEMA MG-1 Part 31, and have a minimum Class F or H insulation. All VFD motors shall have AEGIS™ or approved equal Shaft Ground Rings to prevent electrical bearing damage from capacitively coupled shaft voltages. For motors up to 100 HP, ring shall be installed on either the drive end or non-drive end. Motors over 100 HP shall have ring installed on the drive end of the motor with an insulated bearing on the non-drive end to prevent circulating currents. If rings are not factory installed, Contractor shall install them in the field following manufacturer's requirements and, to start factory warranty, shall register them with AEGIS™ in the Owner's name. Failure to install or register the rings will require Contractor to take on the responsibility of providing a 15 year warranty and to replace any failed motor bearings during the 15 year period.
- E. Motors 1/2 HP and larger shall have ball or roller bearings with pressure grease lubrication, specifically wound for the scheduled voltages. All bearings shall be suitable for radial and thrust loading.
- F. Single-Phase Motors
 - 1. Motors 1/20 HP and Smaller: Shaded-pole type.
 - 2. Motors over 1/20 HP and less than 1/12 HP shall be one (1) of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 - 3. Motors not less than 1/12 HP and less than 1 HP shall have a minimum efficiency of 70% (rated in accordance with DOE 10 CFR 431), a means to adjust motor speed for balancing or modulation or remote speed control (based on the application requirements), and be one (1) of the following, to suit starting torque and requirements of specific motor application:
 - a. Electronically commutated (ECM).
 - b. Permanent-split capacitor.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
 - 4. Bearings: Prelubricated, antifriction ball bearings for motors 1/12 HP and larger or, for motors under 1/12 HP, ball or sleeve bearings. All bearings shall be suitable for radial and thrust loading.
 - 5. Fractional horsepower motors, integral to equipment intended for installation in finished public spaces, shall be provided with an overload device responsive to

motor current. The device shall be integral to the motor and include a wired, concealed, NEMA rated disconnect switch.

- G. Electronically Commutated Motors (ECM): Motors shall be equal to General Electric ECM, variable-speed, DC, brushless motors specifically designed for use with single phase, 277 V (or 120 V), 60 Hz electrical input. For motors 1 HP and larger efficiency shall meet or exceed the minimum efficiencies listed in the governing energy code, or the efficiencies listed above, whichever is higher. Motors shall be complete with and operated by a single-phase integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and soft speed change ramps. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motors shall maintain a minimum of 70% efficiency over their entire operating range. Provide motor speed control, either integral to the motor or by remote input by the control system (0-10 VDC signal), as indicated on the drawings and by the control sequences) for field adjustment between 20% and 100% of motor speed. Inductors shall be provided to minimize harmonic distortion and line noise. Motors shall be designed to overcome reverse rotation and not affect life expectancy.
- H. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- I. All motors over 5 HP for variable flow air and water systems shall be variable speed. In addition, the drawings may require variable speed motors for smaller motors or for motors with constant flow systems. Coordinate motors with VFD or starter type used.
- J. Motors shall be furnished complete with conduit terminal box of size adequate to accommodate conduits and wires as sized on the Electrical Drawings or specified under this section.
- K. Motor capacity shall be sufficient to operate associated driven devices under conditions of operation and load and with overload and at least the horsepower indicated or specified. All motors shall be of the premium efficiency, high power factor, low energy consuming type most suitable for the application and installed environment. Any motor replacement necessary for compliance to the application shall be at no additional cost to the Owner.
- L. Motors shall be suitable for continuous duty at rated horsepower with temperature rise not to exceed 40°C for drip proof motors, 50°C for splash proof motors, 55°C for totally enclosed or explosion proof motors. All non-VFD motors shall be capable of 15% overload without overheating and suitable for operation for the ambient conditions of its specific location.
- M. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except fractional HP motors, which shall have slotted mounting holes.
- N. Drives for belted motors shall be as manufactured by Dodge Manufacturing Company, Browning Manufacturing Company, T.B. Woods Company or equal with adjustable motor sheaves and adjustable slide bases. The drive belts shall be as short as practicable. All fans and fan units shall be furnished with cogged-type triple V-belt drives, each sized for

150% of the design drive capacity. All multiple belt drives shall have matched sets of belts.

- O. Where starters or variable speed drives are not integral with packaged equipment specified in this section, the Electrical Subcontractor shall furnish all starters and drives in accordance with Division 26 drawings and specifications.
- P. For packaged equipment, motor controllers shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required. Controller operating coils shall be generally designed for 120 V operation, and 3 phase motors shall be provided with thermal overload protection in all phases.
- Q. All electrical apparatus furnished under this section shall be approved by UL (or other agencies approved by the authority having jurisdiction) and shall be labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.

2.12 PUMPS (WATER SYSTEMS)

- A. In-Line Mounted Centrifugal Pump (Up to 20 HP): Provide pumps with capacities as shown on the drawings. Pumps shall be in-line type, close-coupled, single stage design, for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing piping connections.
 - 1. Pumps shall be as manufactured by Bell & Gossett, Grundfos/PACO, Taco, Armstrong, Weinman or approved equal.
 - 2. Pump volute shall be cast iron, bronze or S.S. and impeller shall be synthetic (up to two (2) inch flanges), bronze/brass S.S. or cadmium plated steel, enclosed type dynamically balanced, keyed to the shaft and secured by locking capscrew or nut.
 - 3. Pumps shall be rated 125 PSI minimum (up to four (4) inch flanges) and a minimum of 175 PSI working pressure (for larger pumps), with gauge ports at nozzles, and with vent and drain ports.
 - 4. Pump shall be suitable for continuous operation between 35 and 225°F.
 - 5. Bearings shall be non-lubricated bronze type with S.S. shafts. Seal shall be mechanical type.
 - 6. Motors shall meet the requirements of separate specification "Motors, Drives and Starters" paragraph, be non-overloading throughout pump curve, premium efficiency, VFD duty rated and labeled (where shown on drawings as using VFD's), meet NEMA specifications, and shall be size, voltage and enclosure called for on the drawings. It shall have heavy-duty grease lubricated ball bearings.
 - 7. Each pump over 2 HP shall be fitted with a factory installed flush line. Supply, for field installation in the flush line to the mechanical seal, a 50 micron cartridge filter and floating ball type sight flow indicator suitable for the working pressure encountered. The HVAC Subcontractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the Owner.
 - 8. Each pump shall be factory tested and painted with at least one (1) coat of high-grade machinery enamel prior to shipment.

2.13 WATER TREATMENT SYSTEMS AND EQUIPMENT

A. General

1. Provide the necessary apparatus to provide pipe cleaning chemicals and water treatment, and complete water treatment services for all HVAC water, steam, and glycol systems in the building. Coordinate equipment sizes and sensor locations with the HVAC contractor. The water quality of the make-up water shall be tested and used as a basis for installing a first class water treatment system designed for the water quality available at the site.
2. A contract agreement satisfactory in form and substance to the Owner shall be executed between the HVAC contractor and the Water Treatment Subcontractor through its authorized agents binding the Water Treatment Subcontractor to provide supervisory service to assure the use of proper chemical treatment to and for the various systems involved for a period of one (1) year from the date of the initial system start and treatment thereof, as hereinafter described in these specifications. The contract shall be assigned to the Owner on the Date of Substantial Completion so that water treatment will continue uninterrupted during the one (1) year life of the contract. The Water Treatment Subcontractor shall perform the following consulting analysis services.
3. Supervise the cleaning and flushing out of all systems.
 - a. After completing the installation or modification of each system, it shall be properly flushed out prior to start up. Flush out chemicals and procedures shall be furnished by the Water Treatment Subcontractor. Passivation shall be done as recommended by water treatment Subcontractor for the piping and equipment or as required by equipment manufacturers (such as galvanized cooling tower basins).
 - b. All side loops and low points shall be drained and flushed.
 - c. Systems shall then be refilled as specified and treated chemically in accordance with recommendation of the Water Treatment Subcontractor. HVAC contractor shall notify the Water Treatment Subcontractor at least forty-eight (48) hours in advance of initial system fill.
 - d. Tests shall be made following the flush out and refilling procedure and a written report submitted to the Architect, Owner and General Contractor stating that the flushing out has been completed satisfactorily.
4. Provide one (1) year service and reporting of the chemical treatment: At no additional costs to the Owner, perform quarterly service and monitoring visits for each closed loop system and monthly service and monitoring visits for each open loop system. A written Service Report shall be provided to the Owner/operator. Each visit by the manufacturer's service representative shall include the following (as applicable for each system):
 - a. Inspection of the control system for functionality.
 - b. Inspection of the blowdown system for functionality.
 - c. Calibration and cleaning of conductivity probes or other instrumentation related to blow down.
 - d. Visual inspection of overall system condition as accessible. Service visits may be timed to coincide with the opening of certain system components such as a closed vessel or chiller.
 - e. At each service visit, unless otherwise listed below as quarterly or annually, provide a field analysis of the following water parameters shall be performed using field test kits: all controlled water quality items listed below for closed and open loop systems, as well as Specific Conductivity and Cycles of Concentration for open loop systems. Report shall

- highlight any items out of their control range and what was done to correct it.
- f. Make adjustments to the conductivity controller and blow-down system as required to maintain water quality after each visit.
5. The water quality of all closed loop hydronic systems shall be monitored, controlled and maintained within the following water quality ranges:
- a. pH: Maintain a value within 9.0 to 10.
 - b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - c. Boron: Maintain a value within 100 to 200 ppm.
 - d. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - e. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - f. TSS: Maintain a maximum value of 10 ppm.
 - g. Ammonia: Maintain a maximum value of 20 ppm.
 - h. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - i. Glycol systems shall be set for the specified percent by weight of propylene glycol. Inhibitor level shall be checked and replenished as required by manufacturer.
 - j. Corrosion Limits (annually tested by coupons in coupon rack and quarter by use of a Corratrater):
 - 1) Uniform mild steel corrosion of not more than 0.75 mil per year (mpy).
 - 2) Uniform copper corrosion of not more than 0.08 mpy.
 - k. Microbiological Limits:
 - 1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - 2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - 3) Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - 4) Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
 - 5) Iron Bacteria: Maintain a maximum value of zero organisms/mL.
6. Coordinate with the controls and mechanical contractors on how the open system operation (shutdowns) can adversely affect water treatment effectiveness and how to correct this by periodic cycling of the pumps and opening of the control valves to get the chemicals to all parts of the piping system. Verify the agreed upon sequence operates as agreed to and submit this sequence with the O&M manual.
7. Supervise and instruct the Owner's operating personnel in the following:
- a. Initial introduction of water treatment to all systems and the control thereof.
 - b. How the open system operation (shutdowns) can affect water treatment effectiveness and how the control sequences have been modified to correct this by periodic cycling of the pumps and opening of the control valves to get the chemicals to all parts of the piping system.
 - c. Chemical product literature, identification for use and application procedure.
 - d. Testing procedure and interpretation of test results and proper control limits for each constituent, and
 - e. Log sheets with instructions in correct entry procedure.

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8. Furnish all required chemicals for proper treatment of all systems hereinafter described for the one (1) year period together with the necessary control testing kit or apparatus and reagents for field analysis of the water during the aforementioned one (1) year period.
 9. Provide written reports of water analysis results with recommendations.
 10. Provide a quarterly review of conditions with the Owner.
- B. Qualifications of the Water Treatment Subcontractor:
1. The Water Treatment Subcontractor shall have a minimum of five (5) years' experience in the water treatment business, have laboratory facilities and staff capable of performing all necessary analyses relating to this job. All treatment programs shall be performed under the direction of a graduate chemist or licensed professional engineer.
- C. Closed recirculation systems: Each closed recirculation system shall have a minimum [5] [10] gallon capacity [150] PSI rated bypass feeder complete with valves, funnel, drain, and fittings. The bypass shall be piped across the suction and discharge pipes of the system. Prior to the initial filling of the piping system, the pipes shall be thoroughly flushed and cleaned with non-toxic, environmentally friendly cleaners and charged with the required quantity of the most appropriate non-toxic, environmentally friendly corrosion inhibitors that will best protect the piping and system components. Chemicals shall be by Dearborn, Dow, Barclay, Nalco, or equal.
- D. Glycol Solutions: A [40] % concentration by volume of industrial grade propylene glycol shall be provided. The glycol shall be tested in accordance with ASTM D 1384 with less than 0.5 mils penetration per year for all system metals. The glycol shall contain corrosion inhibitors. Silicate based inhibitors shall not be used. The solution shall be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.
- E. Coupon Rack: Provide each water [and glycol] system with a schedule 80 PVC (or Schedule 80 black steel if required for operating temperature of hot water system) minimum 4-Station coupon rack. Coupons shall be installed as required for monitoring each system.
- F. Test Kits: All required test kits and reagents for determining the proper water conditions (to verify water chemistry is maintained within the limits listed above) shall be provided.
- G. Chemicals: Water to be used in each system shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the heating, cooling, condenser, and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.
- H. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, how to properly periodically operate or lay-up the system during short periods of off time (under 4-days) and lay-up the system for longer times such as seasonal shut-downs, how to start-up the system after shutdown, troubleshooting, servicing, and maintaining equipment and schedules. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Provide Owner with test equipment to monitor water

quality (for all previously listed water quality items). Schedule at least four (4) hours of training with Owner, through Architect, with at least seven (7) days' advance notice.

2.14 DUCTLESS SPLIT AIR CONDITIONING SYSTEM

- A. Furnish and install ductless split system air conditioner as shown and scheduled on the drawings and as detailed herein. The systems shall consist of a compact wall mounted packaged evaporator section and matching air cooled outdoor unit.
- B. Indoor Units:
1. Indoor, direct-expansion, ceiling-suspended fan coil. Fan coil shall be shipped complete with cooling coil, fan, fan motor, piping connectors, electrical controls, and mounting brackets.
 2. Units shall be rated per ARI Standard 210/240. Units shall be certified by UL and CSA.
 3. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting bracket shall be provided.
 4. Fans shall be centrifugal blower type with air intake in the bottom rear of the unit and discharge in the front. Automatic motor-driven vertical air sweep shall be provided.
 5. Coils shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins will be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for attachment of piping to remove condensate.
 6. Motors shall be permanently lubricated with inherent overload protection. Fan motor shall be 3-speed.
 7. Controls shall regulate space temperature and determine optimum fan speed. The temperature control range shall be from 64°F to 84°F. The unit shall have the following functions as a minimum:
 - a. An automatic restart after power failure at the same operating conditions as at failure.
 - b. Remote wireless controller to provide cooling set points and day/night setback modes.
 - c. Filter status indication after two hundred and fifty (250) hours of indoor fan operation.
 - d. Automatic airt sweep control to provide on or off activation of airt sweep louvers.
 - e. Cooling mode to provide modulating fan speed based on difference between temperature set point and space temperature.
 - f. Fan only operation to provide room air circulation when no cooling is required.
 - g. Fan speed control shall be user-selectable: high, medium, low, or automatic operation during all operating modes.
 8. Filters: Unit shall have filter track with factory-supplied cleanable filters.
 9. Electrical Requirements: Unit shall operate on the power as specified on the equipment schedule.
 10. Provide the following accessories:
 - a. Remote controller shall provide 7-day programmable scheduling. Remote controller shall also provide 3-speed fan switchover capability, air sweep auto changeover, and allow for multiple cooling set points.

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- b. Integral condensate pump shall be provided where continuously pitched gravity drain pipe is not possible.
 - c. Provide a high level water detector in the drip pan wired to de-energize the cooling and provide alarm. Provide auxiliary alarm contacts for alarm through the BAS.
- C. Outdoor Units:
- 1. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of R-410a refrigerant.
 - 2. Quality Assurance:
 - a. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with the NEC.
 - b. Units shall be constructed in accordance with UL standards.
 - c. Units shall be listed in the CEC directory.
 - d. Unit cabinet shall be capable of withstanding Federal Test Standard No. 141 (Method 6061) 500-Hour Salt Spray Test.
 - e. Air-cooled condenser coils shall be leak-tested at 660 PSIG air pressure with the coil submerged in water.
 - 3. Unit Cabinet:
 - a. Unit cabinet shall be constructed of galvanized-steel, bonderized and coated with a baked-enamel finish.
 - b. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
 - c. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
 - 4. Fans:
 - a. Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fan shall blow air through the outdoor coil.
 - b. Outdoor fan motors shall be totally enclosed, single-phase motors with class B insulation and permanently lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.
 - c. Shaft shall have inherent corrosion resistance.
 - d. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
 - e. Outdoor fan openings shall be equipped with PVC coated protection grille over fan and coil.
 - 5. Compressor:
 - a. Compressor shall be inverter driven (variable speed) scroll type.
 - b. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.
 - c. Motor shall be inverter duty, NEMA rated class F, suitable for operation in a refrigerant atmosphere.
 - d. Compressor assembly shall be installed on vibration isolators.
 - e. Compressors shall be single-phase as specified on the contract drawings.
 - 6. Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes which are cleaned, dehydrated, and sealed.

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7. Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.
 8. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
 - a. Controls:
 - 1) Automatic restart on power failure.
 - 2) A time delay control sequence provided through the fan coil board, thermostat, or controller.
 - 3) Liquid line low-pressure switches.
 - 4) Automatic outdoor-fan motor protection.
 - 5) Start capacitor and relay (single-phase units without scroll compressors).
 - b. Safeties:
 - 1) System diagnostics provided through some indoor controls.
 - 2) Compressor motor current and temperature overload protection.
 - 3) Outdoor fan failure protection.
 9. Electrical Requirements:
 - a. All units shall operate on the power as specified on the equipment schedule.
 - b. Unit electrical power shall be a single point connection.
 - c. Unit control voltage to the indoor-fan coil shall be 24 v.
 - d. All power and control wiring must be installed per NEC and all local building codes.
 - e. High and low voltage terminal block connections.
 10. Provide the following accessories:
 - a. Low-Ambient Kit: Control shall regulate fan-motor cycles in response to saturated condensing pressure of the unit. The control shall be capable of maintaining a condensing temperature of 100°F ± 10°F with outdoor temperatures to -20°F. Installation of kit shall not require changing the outdoor-fan motor.
 - b. Winter start control shall permit start-up cooling operation under low-load conditions and at low-ambient temperatures by bypassing the low-pressure switch for a three (3) minute delay period.
 - c. Crankcase heater shall prevent refrigerant migration to the compressor during the off cycle.
 - d. Wind Baffle Kit: Kit shall be a fabricated sheet metal wrapper used to provide improved unit operation during high winds, and low-ambient temperatures.
- D. Warranty: The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of five (5) years from date of installation.
- E. Additional Options:
1. Provide the optional refrigerant piping kits. Kits to include sufficient lengths of pre-insulated refrigerant liquid piping and pre-insulated refrigerant gas piping to connect indoor units to outdoor units. Pipe sizes shall be as directed by the

manufacturer for the final installation pipe routing. Piping shall be completely compatible with indoor and outdoor units. All pipe insulation installed outside shall be weatherproofed. Refer to "Insulation Section" for details. Installation to be in strict accordance with manufacturer's instructions. If optional refrigerant piping kit is not used, refrigerant piping shall be Type L hard drawn ACR tubing, conforming with ASTM B280. Fittings shall be wrought copper, conforming with ANSI B16.22. Joints shall be made with silver solder, minimum 45% silver brazing alloy, cadmium free, conforming to ASTM B32. Insulation to be closed-cell polyolefin foam insulation with a heat transfer coefficient not to exceed 0.24 BTU/hr/ft²/°F per inch of thickness. Density to be 1.5 lbs./cu.ft. Insulation to have pre-slit and pre-glued longitudinal seams with Mylar release liner. Thickness shall be 1/2 inch.

2.15 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. General

1. For each seismic restraint, provide certified calculations to verify adequacy to meet the following design requirements:
 - a. Ability to accommodate relative seismic displacements of supported item between points of support.
 - b. Ability to accommodate the required seismic forces.
2. For each respective set of anchor bolts provide calculations to verify adequacy to meet combined seismic-induced shear and tension forces.
3. For each weldment between structure and item subject to seismic force, provide calculations to verify adequacy.
4. Restraints shall maintain the restrained item in a captive position without short circuiting the vibration isolation.
5. Seismic restraint shall be installed in accordance with the State Building Code. As a minimum provide:
 - a. Maximum distance between braces in the lateral direction shall be 30 feet for piping two (2) inches and smaller and 40 feet for piping 2-1/2 inches and larger.
 - b. Maximum distances between braces in the longitudinal direction shall be 80 feet.
 - c. Tops of risers shall be provided with 4-way braces.
 - d. Flexible couplings shall be provided within twelve (12) inches of floor and wall non-breakable penetrations and within twenty-four (24) inches of all building expansion joints.
 - e. Hangers closest to the sway bracing shall be installed with an extended rod to the piping to resist upward movement of the piping.
 - f. Lateral sway bracing shall not be required on piping supported with rods less than six (6) inches long.
6. Seismic bracing for lateral and longitudinal bracing may be of the splayed wire (tension type), or pipe and fixed hanger (tension/compression type), and shall be complete with manufacturer's recommended sizing, locations, and calculations. One system only (tension or compression/tension) shall be installed.
7. C clamps for attachment to the building structure must be provided with retaining straps.
8. 4-Way bracing may be of the splayed wire type or fixed angle brace with U-bolt.

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- a. All vibration isolators shall be the product of a single approved manufacturer or as manufactured by an individual mechanical equipment manufacturer.
 - b. Model numbers hereinafter specified are from Mason Industries. Other equivalent units by Consolidated Kinetics, Vibration Mountings and Controls or equal are acceptable.
- B. Fan Coil Units, Exhaust Fans, Supply Fans, Return Fans, Transfer Fans, Unit Heaters, etc.
1. Steel spring and 0.3 inch deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
 2. Mason Model DNHS, one (1) inch deflection.
- C. Mechanical Room Piping and Pumps
1. Steel spring and double deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection, Mason style 30N, with minimum one (1) inch deflection.
 2. The first three (3) pipe hanger locations on both sides (suction and discharge) of each pump, 30° swing spring and double deflection neoprene hangers, precompressed to the rated deflection, Mason style PC30N, with minimum one (1) inch deflection.
 3. For floor mounted pumps over 100 HP (located on slabs on grade) and all floor mounted pumps over 2 hp (not located on slabs on grade), provide concrete inertia bases with minimum 1 ½ inch deflection springs. Minimum clearance under base shall be 1 ½ inch. Base size shall be large enough to include support of pump and associated vertical piping supports.
- D. Ductwork
1. The first five (5) hanger locations on the discharge side of each AHU and HV unit shall be provided with double deflection neoprene hangers.
 2. Mason Model HD or WHD.
- E. Flexible Connectors
1. Double sphere EPDM connectors with connection type to match adjacent equipment and water piping up to 175 PSIG and 210°F shall be equal to Mason Model SFDEJ. Units shall have construction equal to multilayered Kevlar tire cord fabric reinforcement with peroxide cured EPDM cover, liner and fabric fractioning. Units shall be rated for a minimum of 200 PSIG at 250°F. For flanged units, provide control rods or cables to restrict maximum travel to the manufacturer's standard limits. Flexible connectors shall be installed for pumps, chillers, cooling towers, and elsewhere as shown on drawings.
 2. For higher pressures and temperatures, up to 100 PSIG saturated steam, connectors shall be multi-ply stainless steel bellows type with tie rods, equal to Flexicraft. Over 100 PSIG steam, use expansion joints as specified in pipe expansion joint paragraph.
 3. Provide two (2) foot long fire retardant flexible hoses for water piping to and from fan coil units, heat pumps, unit and cabinet heaters, duct mounted coils and elsewhere as shown on drawings. Hoses shall be rated for a minimum of 300

PSIG with 1200 PSIG burst pressure with a minimum operating temperature range of 0°F to 200°F. Hoses shall have stainless steel braid over EPDM or corrugated stainless steel liner. Threaded hose connectors shall be permanently crimped or welded with swivels that have self-actuating fiber gaskets. Hose kits may be used providing all valves and components are arranged per the details shown on the drawings and the components meet the applicable specification section (such as Valves, Etc.). Install hoses to allow for a minimum one (1) inch pipe expansion or equipment movement in any direction. Hoses (and or hose kits), providing they meet these specifications, shall be by FDI, Hays, Trane or approved equal.

F. Roof-mounted Air Handling Units and Air Cooled Condensing Units

1. Resilient cross-ribbed neoprene elastomer pad bonded to a steel plate. Furnish with molded-in isolation washer and hole in center of steel plate to correspond to O.D. of bolts used to fasten mechanical equipment to structural steel. Minimum isolation efficiency to be 90%. Pads to be located at each mounting point. Pads to be selected for anticipated loading (in lbs. per sq. inch).
2. All vibration isolators shall be selected in accordance with the weight distribution of the equipment to be served so as to produce a uniform deflection. Deflections shall be as hereinbefore specified.
3. Submittals shall include all spring deflections, spring diameters, scale drawings, attachment details, and rated capacity indicating adequacy for each piece of equipment served.

2.16 DUCTWORK

A. Reference Standards

1. Material, construction and installation shall meet applicable requirements of the current editions (unless otherwise shown) of the following standards and references, unless more stringent requirements are specified or shown on the drawings (such as hazardous exhaust systems):

Standard	As Applicable to
SMACNA HVAC Duct Construction Standards (Metal and Flexible, 2005)	Sheet Metal Ductwork; Duct Liners; Adhesives; Fasteners; Flexible Ductwork
SMACNA HVAC Air Duct Leakage Test Manual (2012)	Duct Leakage Testing
NFPA 90A	Fire Dampers; Fire Resistance Standards for Ducts and Liners

B. General

1. Provide all required supporting and hanging devices to attach entire HVAC system including ductwork and equipment, and to prevent vibration. Include vertical and horizontal supports as required by codes to meet minimum applicable earthquake resistance standards.
2. Ductwork shall be free from vibration at all times.
3. No pipe, conduit, hanger, Architectural element or structural member shall pass through duct without Engineer's written approval. Where the pipe or conduit cannot possibly be relocated and when written approval has been obtained,

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increase duct size to maintain full cross-sectional area at point of interference. Provide streamlined enclosure for pipe or conduit, per SMACNA.

4. All offsets and transformations necessary due to structural conditions shall maintain the full cross-sectional area of ductwork shown on drawings.
- C. Ductwork Pressure Class, Seal Class, and maximum design velocities shall be as shown on the drawings and as specified herein.
- D. Hazardous Exhaust Systems:
1. Ductwork shall be built of minimum G-90 galvanized steel per the following table:

DIAMETER OF DUCT OR MAXIMUM SIDE DIMENSION	MINIMUM DUCT GAUGE		SEAL CLASS	TRAVERSE JOINTS	MINIMUM REINFORCEMENT SPACING
	NONABRASIVE MATERIALS	ABRASIVE MATERIALS			
0-8 inches	24	20	A	Min. 1" lap joint	5' – 0"
9-18 inches	22	18	A	Min. 1" lap joint	5' – 0"
19-30 inches	20	14	A	Min. 1" lap joint	5' – 0"
Over 30 inches	18	14	A	Min. 1" lap joint	2" – 6"

- E. Duct Construction
1. Unless otherwise specified, use the pressure classifications for the types of ductwork as shown on the drawings. Note: Some systems require minimum gauges (such as Kitchen Hood Exhaust and Sub-Ducts).
 2. Ducts required to be continuously welded, such as kitchen exhaust (hoods and dishwasher) and with all penetrations sealed (damper rods, access doors, etc.) shall be liquid-tight and shall be airtight. The leakage test shall yield a zero leak rate. All welding shall use inert gas shielding with filler rod equal to or exceeding the base metal properties.
 3. Non-welded duct seals and joints shall be as listed by SMACNA or Ductmate for the specified pressure class. Seal all pressure classes to meet Seal Class A.
 4. Material: Unless otherwise specified or shown on drawings, all ductwork shall be fabricated from G-60 galvanized steel or 316 stainless steel. Galvanized steel shall meet AST A525 and A527 standards and stainless steel shall meet ASTM A240 standards.
 5. Round ductwork shall be furnished where shown or called for on the drawings, and may be substituted for rectangular, except for shower exhaust, as an option to the Sheet Metal Sub Subcontractor when approved by the engineer, it can be easily fit in the available space and is round duct and fittings shall be of spiral lockseam construction.
 6. Elbows and Bends:
 - a. Wherever possible, all elbows and bends for rectangular ducts shall be full radius (centerline radius of 1.5 times duct width). Elbows for grease exhaust shall have a centerline radius of 2.0 times duct width, unless this physically can't fit, then full radius may be used. Turning vanes and mitered elbows are not allowed.
 - b. Where centerline radius must be less than 1.5 times duct width (on supply, return and exhaust ductwork other than grease exhaust) in the plane of bend, elbows shall be minimum two (2) inches inside (not

centerline) radius throat with radius heel and full length splitter vanes installed as shown on drawings or per SMACNA. Splitter vanes are not required on bends less than 30°. When centerline radius (r) divided by the duct width (w) is less than 1.5, provide the following number of splitter vanes:

r/w	No. of Vanes for Elbow Angle of 45° - 90°	No. of Vanes for Elbow Angle of 30° - 44°
1.49 – 0.70	1	0
0.69 - 0.60	2	1
Under – 0.60	3	2

- c. For round ductwork provide stamped elbows, with centerline radius equal to 1-1/2 times duct diameter, or sealed, gored elbows as follows:

Elbow Angle	No. of Gores
0 – 36	2
37 – 72	3
73 – 90	5

- d. Elbows for flat oval ducts shall have centerline radius equal to 1-1/2 times duct diameter in plane of bend, or sealed, gored elbows with gores as specified above for round ducts.
7. Transitions: Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.
8. Metallic Flexible Duct: Metallic flexible type duct shall be two-ply aluminum or single ply stainless steel, self-supporting to 8-foot spans. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of fifteen (15) inches water gauge at 350°F when duct is aluminum, and 650°F when duct is galvanized steel or stainless steel.
9. Insulated Nonmetallic Flexible Duct Runouts: Flexible duct runouts shall be used only where indicated. Runout length shall be as shown on the drawings, but shall in no case exceed four (4) to six (6) feet. Runouts shall be preinsulated, factory fabricated, and shall comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulated material and vapor barrier shall conform to the requirements of this specification 23 00 00, (Insulation paragraph). The insulation material surface shall not be exposed to the air stream.
10. General Service Duct Connectors: Flexible duct connectors approximately six (6) inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron

clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with NFPA 701 2004 (Standard of Methods of Fire Tests for Propagation of Textiles and Film) and be flame retardant.

11. High Temperature Service Duct Connections (such as kitchen grease duct): Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yard weight, plain weave fibrous glass cloth with, nickel/chrome wire reinforcement for service in excess of 1,200°F. Connections shall be listed and labeled for the application.

F. Ductwork Accessories

1. Access Doors shall be rated for the duct pressure class they are installed in. For hazardous exhaust systems, minimum gauge shall be the same as the duct.
 - a. Frame: same materials as duct with seal
 - b. Door: hinged, with exterior (and, for insulation ducts, interior) panel.
 - c. Locks: doors sixteen (16) inches and under, one lock doors over sixteen (16) inches, two (2) locks
 - d. Seals: foam gaskets for ultra-low leakage
 - e. Insulation (for insulation ducts): ½ inch foam board with aluminum foil face, 0.12K at 75°F.
 - f. Manufacturer: Ruskin model ADH-2, Inland Steel, Miami Carey or approved equal.
 - g. Sizes:

SCHEDULE OF DUCTWORK ACCESS DOOR SIZES	
Duct width (inches)	Access door size (inches)
≤10	10 x 6
12 - 16	12 x 8
Over 16	18 x 24

2. Provide at all fire dampers, air inlets, motorized dampers, smoke detectors, duct mounted coils, humidifiers, air flow switches, where specified for cleanouts and where shown on the drawings.
3. Fire Dampers
 - a. Fire dampers shall be 1-1/2 hour fire rated for use in up to two hour rated construction, unless otherwise indicated. Use three hour rated dampers when located in over two hour fire rated construction. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type (with spring loaded closure) and shall have a dynamic rating suitable for the maximum air velocity (minimum 2,000 feet per minute for low pressure up to two (2) inches and 3,000 feet per minute for all pressure classes above two (2) inches unless shown as higher on drawings) and pressure differential (based on construction class, with 4" minimum) to which it will be subjected. Fire dampers shall be approved for the specific application, and shall be installed according to their listing.
 - b. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or

- frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL-05.
- c. Fire dampers shall be curtain type with damper blades out of the air stream. Where duct dimensions are larger than the largest available fire damper, provide blade type dampers. Where blade type dampers connect to a vertical duct (in shaft) and are located within twenty-four (24) inches of the riser duct, the damper blades shall be vertical. Provide locking quadrant for blade type fire dampers that are also used for manual balancing. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. The installation details required for meeting their UL listing, as given in manufacturer's instructions for fire dampers shall be followed. Fire dampers link temperature shall be rated for 165oF [212oF] [250oF] [350oF]. Fire dampers used on stainless steel or aluminum duct systems shall be constructed of stainless steel.
4. Combination Smoke/Fire Dampers
- a. Smoke/Fire dampers shall be 1-1/2 hour fire rated for use in up to 2 hour rated construction, unless otherwise indicated. Use 3 hour rated dampers when located in over 2 hour fire rated construction. Smoke/Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Smoke/Fire dampers shall be automatic operating type (with spring loaded closure) and shall have a dynamic rating suitable for the maximum air velocity (minimum 2,000 feet per minute for low pressure up to two (2) inches and 3,000 feet per minute for all pressure classes above two (2) inches unless shown as higher on drawings) and pressure differential (based on construction class, with four (4) inches minimum) to which it will be subjected. Smoke/Fire dampers shall be approved for the specific application, and shall be installed according to their listing.
 - b. Smoke/Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL-05.
 - c. Smoke/Fire dampers shall be blade type. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. The installation details required for meeting their UL listing, as given in manufacturer's instructions for Smoke/Fire dampers shall be followed. Return and exhaust air Smoke/Fire Dampers shall be capable of being modulated for volume control and of being resettable automatically. Smoke/Fire dampers link temperature shall be rated for 250°F [350°F]. Actuators shall be out of the air stream. Modulating actuators shall allow for both open/close and modulating control. All actuators shall have feedback position indicators. Mechanical Contractor shall include power wiring in his cost.
 - d. Where dampers are located within five (5) feet of a fan discharge, the damper blades shall be vertical (perpendicular to the fan shaft).
 - e. Smoke/fire dampers used on stainless steel or aluminum duct systems shall be constructed of stainless steel.

5. Manual Volume Dampers
 - a. Manual volume dampers shall be provided where shown on the drawings at every branch take off from the main duct, and elsewhere as required by the Balancing Sub Subcontractor, and shall be single or multiple blade type with sleeve bearings, interlocking blades and frame shall be of the same material as the ductwork. In ducts over fifteen (15) inches deep provide multiple opposed blade type, gang operated dampers with a maximum blade width of eight (8) inches. Damper blades shall be fabricated of 16 gauge steel with hemmed edges, and a maximum length of forty-eight (48) inches. Damper operating rod shall be full blade length extended through the duct to externally mounted bearing plates. On insulated ductwork, bearing plates shall be installed flush with insulation finish and fastened to the duct. Operating lever shall be of the indicating type with locking quadrant. The integral dampers in diffusers and grilles, other than where these are directly attached to the mains, shall not be used for balancing.
 - b. For dampers in inaccessible locations, such as above gypsum ceilings provide remote cable actuated dampers.
6. Backdraft Dampers
 - a. Back draft dampers shall be provided where indicated and required, and shall consist of a set of externally adjustable counter weighted louvers that open automatically due to excess pressure and prevent reverse flow. The edges of the blades shall be provided with seals to prevent rattling and minimize air leakage. The damper blades shall be supported on metal frames designed for wall mounting as indicated. The dampers shall be rated for operation up to a minimum of 2,500 fpm and be standard catalog products of Ruskin, Vent Products, American Warming and Ventilating or approved equal.
7. Motor Operated Control and Smoke Dampers and Actuators
 - a. Motor operated control and smoke dampers and actuators shall be furnished by the Automatic Temperature Control Sub Subcontractor and installed by the Sheet Metal Sub Subcontractor unless specified as part of a piece of equipment.
8. Duct Smoke Detectors
 - a. Install duct smoke detectors as furnished by the Electrical Contractor in strict accordance with NFPA 72, Appendix A, and NFPA 90A.
 - b. Smoke detectors shall automatically stop their respective fan(s) upon detecting the presence of smoke. Wiring connection from each smoke detector to its respective fan(s) shall be by the Controls Contractor.
9. Air Deflectors and Branch Connections
 - a. Air deflectors shall be provided at duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections may be used in lieu of deflectors or extractors for branch connections. All air deflectors, except those installed in 90 degree elbows, shall be provided with an approved means of adjustment. Adjustment shall be made from easily accessible means inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, external adjustments shall be

provided with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Air deflectors shall be factory-fabricated units consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Air deflectors shall be factory or field assembled. Blade air deflectors, also called blade air extractors, shall be approved factory fabricated units consisting of equalizing grid and adjustable blade and lock. Adjustment shall be easily made from the face of the diffuser or by position adjustment and lock external to the duct. Stand-off brackets shall be provided on insulated ducts and are described herein. Fixed air deflectors, also called turning vanes, shall be provided in 90 degree elbows.

10. Volume Extractors

- a. Volume extractors Shall be manufactured by the drum louver or supply air register manufacturer of all aluminum construction. Position adjustment operator shall be key-operated screw with access through face of register. Extractor blades shall be spaced one (1) inch on center.

11. Blankoff Plates

- a. Any blankoff plates or conversions required for mounting control dampers or coils shall be the responsibility of the Sheet Metal Sub Subcontractor.

12. Insulated Metal Panels

- a. Provide 18 gauge, insulated double wall sandwich construction, 1½ inch thick where called for on the drawings and for blanking off unused portions of wall louvers.

13. Test Openings

- a. Provide instrument test opening enclosures in the ductwork at the discharge of each fan and fan coil, inlet of each fan and fan coil, and where directed by the Balancing Sub Subcontractor. The enclosures shall be installed before the application of the insulation and shall be of the proper height to extend beyond the insulation. The attachment of the test opening enclosure shall be made airtight.

14. Flexible connections shall be six (6) inches wide connections constructed of heavy glass fabric double coated with neoprene. Flexible connections shall meet the requirements of the National Board of Fire Underwriters.

15. Duct Clean Out Doors - Provide clean out doors, sixteen feet on center, for all horizontally installed ductwork and at each length of straight duct run less than 16 feet. Provide access door constructed of same material as duct work served. Provide two (2) hand operated plastic knobs with threaded brass inserts for opening and tight sealing of the door. Clean out doors shall be as specified for access doors.

G. Duct Sleeves, Framed Prepared Openings, Closure Collars

1. Duct Sleeves

- a. Duct sleeves shall be provided for round ducts fifteen (15) inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round

ducts larger than fifteen (15) inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide one (1) inch clearance between the duct and the sleeve or one (1) inch clearance between the insulation and the sleeve for insulated ducts.

2. Framed Prepared Openings
 - a. Openings shall have one (1) inch clearance between the duct and the opening or one (1) inch clearance between the insulation and the opening for insulated ducts.
3. Closure Collars
 - a. Collars shall be fabricated of galvanized sheet metal not less than four (4) inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts fifteen (15) inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than fifteen (15) inches and square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum six (6) inch centers, except that not less than four (4) fasteners shall be used.

H. Acoustic Duct Liner

1. Provide acoustic duct lining of the type and as specified in the INSULATION SECTION of these specifications. Duct sizes shown are clear internal dimensions, increase duct sizes to compensate for lining thickness. See insulation table on drawing for scope of acoustic duct lining. Factory fabricated double-wall internally insulated duct with perforated panel may be used in place of lining.
2. Ductwork Contractor shall coordinate with insulation Contractor and indicate (label) all locations where sheet metal nosing or other lining erosion protection has bridged the thermal barrier on ductwork supplying cool air (below 60°F) in concealed or unconditioned spaces. Since this bridges the insulation, these locations require exterior insulation to prevent possible condensation.

I. Air Vents, Penthouses, and Goosenecks

1. Air vents, penthouses, and goosenecks shall be fabricated from aluminum or stainless steel sheets with aluminum or stainless steel structural shapes. Sheet metal thickness, reinforcement, and fabrication shall conform to THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995. Louver blades shall be accurately fitted and secured to frames. Edges of louver blades shall be

folded or beaded for rigidity and baffled to exclude driving rain. Air vents, penthouses, and goosenecks shall be provided with bird screen.

J. Bird Screens and Frames

1. Bird screens shall conform to ASTM E 437, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Frames shall be removable type either stainless steel or extruded aluminum.

2.17 DIFFUSERS, REGISTERS AND GRILLES

- A. Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum (as scheduled) and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified according to ADC 1062:GRD. Inlets and outlets shall be sound rated and certified according to ADC 1062:GRD. Sound power level shall be as indicated (where level is not indicated, maximum level shall be NC30). Diffusers and registers (except linear slot diffusers or specialty air outlets) shall be provided with integral opposed blade volume damper with accessible operator, unless otherwise indicated. These integral damper are not to be used as a balancing device by the contractor as remote volume dampers are to be used for balancing. These integral dampers are for use by the buildings occupants only. Linear slot diffusers shall be provided with lined plenums with round or elliptical balancing dampers on the inlet(s). Where the inlet and outlet openings are located less than seven (7) feet above the floor, they shall be protected by a grille or screen according to NFPA 90A. Acceptable manufacturer's: Anemostat, Kreuger, Metalaire, Nailor, Price, Titus, or Tuttle and Bailey.
- B. Diffusers: Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL-03 for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.
- C. Registers and Grilles: Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least six (6) inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located six (6) inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in four (4) positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.18 FANS

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A. General

1. Fans shall be tested, rated and certified according to AMCA 210. Fans may be connected to the non-overloading motors either directly or indirectly with V-belt drive. Motors shall not, unless otherwise indicated, exceed 1,800 rpm, shall be premium efficiency, have open drip proof (ODP) or totally enclosed fan cooled (TEFC) housing and, where fans are shown on drawing as explosion proof, motors shall be explosion proof. Motors shown on the drawings as used with VFD's shall be VFD duty rated and labeled. Motors used on all smoke control fans shall have minimum Class F insulation. Motors and drives shall meet the requirements of the separate specification "Motors, Drives and Starters" paragraph. V-belt drives shall be designed for not less than 140% of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated. Sound power level shall be as indicated. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.
2. Provide each fan with motors and accessories as shown on the drawings, specified elsewhere, and as required for proper operation. In addition, all fans serving dust collection, lab hoods, print spray hoods, fuel storage rooms, battery rooms, pharmaceutical rooms, and similar potentially hazardous exhaust systems shall be of AMCA Type A or B spark resistant construction.
3. Fan manufacturer shall be as scheduled on the drawings, or provided they meet all requirements of these specifications, scheduled capacities and efficiencies, and fit with proper accessibility. Acceptable manufacturers shall be Greenheck, Twin City, Cook, Buffalo, Trane, Chicago, Hartzell, Kanalfakt, New York Blower, Pace or Penn.

B. Centrifugal and Plenum Fans

1. Centrifugal fans shall be fully enclosed (except for plenum fans which shall have protective guards for all moving parts), single-width single-inlet, or double-width double-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design fan size and speed (with the next higher class used if the fan is within 30 rpm of the maximum speed for the listed pressure class). Impeller wheels shall be rigidly constructed, accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined or airfoil design in wheel sizes up to thirty (30) inches. Fan blades for wheels over thirty (30) inches in diameter shall be Backward-inclined or airfoil design. Fan wheels over thirty-six (36) inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels thirty-six (36) inches or less in diameter may have one (1) or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs, or precision self-

aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L10 rated at not less than 80,000 hours as defined by ABEMA 9 and ABEMA 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections.

C. In-Line Centrifugal Fans

1. In-line fans shall have centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Fans shall be mounted in a welded tubular casing. Air shall enter and leave the fan axially. Inlets shall be streamlined with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt and shall be permanently lubricated, and shall be precision self aligning ball or roller type. Bearing life shall be L10 rated at not less than 80,000 hours as defined by ABEMA 9 and ABEMA 11.

D. Axial Flow Fans

1. Axial flow fans shall be complete with drive components and belt guard, and shall have a steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Fan wheels shall have radially projecting blades of airfoil cross section and shall be dynamically balanced and keyed to the fan shaft. Fan bearings and drive shafts shall be enclosed and isolated from the air stream. Fan bearings shall be sealed against dust and dirt, shall be permanently lubricated or with accessible grease fittings, and shall be precision self-aligning ball or roller type. Bearing life shall be L10 rated at not less than 80,000 hours of operation as defined by ABEMA 9 and ABEMA 11. Fan inlets shall be provided with an aerodynamically shaped bell and an inlet cone. Diffuser or straightening vanes shall be provided at the fan discharge to minimize turbulence and provide smooth discharge air flow. [Fan unit shall be provided with inlet and outlet flanges, inlet screen.]

E. Panel Type Power Wall Ventilators

1. Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than twenty-four (24) inches diameter shall be direct or V-belt driven and fans with wheels twenty-four (24) inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish.

2.19 COILS

- A. Liquid coils shall be fin-and-tube type constructed of seamless copper [red brass] tubes and aluminum copper fins mechanically bonded or soldered to the tubes. Copper tube wall thickness shall be a minimum of 0.016 inches. [Red brass tube wall thickness shall be a minimum of 0.035 inches.] Aluminum fins shall be 0.0055 inch minimum thickness. [Copper fins shall be 0.0045 inch minimum thickness]. Casing and tube support sheets shall be not lighter than 16 gauge galvanized steel (stainless steel for cooling coils),

formed to provide structural strength. When required, multiple tube supports shall be provided to prevent tube sag. Each coil shall be tested at the factory under water at not less than 400 PSI air pressure and shall be suitable for 200 PSI working pressure. Coils shall be mounted for counterflow service. Coils shall be rated and certified according to ARI 410.

- B. Direct-Expansion Coils: Direct-expansion coils shall be suitable for the refrigerant involved. Suction headers shall be seamless copper tubing or seamless or resistance welded steel tube with copper connections. Supply headers shall consist of a distributor which shall distribute the refrigerant through seamless copper tubing equally to all circuits in the coil. Tubes shall be circuited to ensure minimum pressure drop and maximum heat transfer. Circuiting shall permit refrigerant flow from inlet to suction outlet without causing oil slugging or restricting refrigerant flow in coil. Each coil to be field installed shall be completely dehydrated and sealed at the factory upon completion of pressure tests.
- C. Water Coils: Water coils shall be installed with a pitch of not less than 1/8 inch per foot of the tube length toward the drain end. Headers shall be constructed of cast iron, welded steel or copper. Each coil shall be provided with a plugged vent and drain connection extending through the unit casing.
- D. Steam Heating Coils: Steam coils shall be constructed of cast semisteel, welded steel or copper headers, and copper tubes. Headers shall be constructed of cast iron, welded steel or copper. Fin tube and header section shall float within the casing to allow free expansion of tubing for coils subject to high pressure steam service. Each coil shall be provided with a field or factory installed vacuum breaker. Coils shall be single-tube type with tubes not less than 1/2 inch outside diameter, except for steam preheat coils. Supply headers shall distribute steam evenly to all tubes at the indicated steam pressure. Coils shall be factory tested to ensure that, when supplied with a uniform face velocity, temperature across the leaving side will be uniform with a maximum variation of no more than 5%. Installation shall allow minimum 20 inch height available below coil outlet for trap assembly.
- E. Steam Preheat (Non-freeze) Coils: Non-freeze steam coils shall be steam-distribution-tube type with condensing tubes not less than one (1) inch outside diameter for tube lengths sixty (60) inches and over and 1/2 inch outside diameter for tube lengths under 60 inches. Headers shall be constructed of cast iron, welded steel, or copper. Coils shall be selected for not less than 5 psig entering steam pressure (to be coordinated with scheduled pressure). Distribution tubes shall be not less than 5/8 inch outside diameter for tube lengths sixty (60) inches and over and 3/8 inch outside diameter for tube lengths under sixty (60) inches with orifices to discharge steam to condensing tubes. Distribution tubes shall be installed concentric inside of condensing tubes and shall be held securely in alignment. Maximum length of a single coil shall be limited to 144 inches. Coils shall be factory tested to ensure that, when supplied with a uniform face velocity, temperature across the leaving side will be uniform with a maximum variation of no more than 5%. Orientation (unless it will not fit) should be vertical tubes with top steam inlet and bottom condensate outlet (with minimum twenty (20) inch height available below coil outlet for trap assembly).
- F. Electric Resistance Heating Coils:
 - 1. Provide electric resistance heating coils with all required safety interlocks, where shown on Drawings, of capacity and type indicated in schedule. Heaters shall be Indeeco, Warren, Brasch, Redd I, Titus, Price, or Envirotech. Coils shall be UL listed and shall meet requirements of National Electrical Code.

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2. Electric resistance heaters for duct-mounting shall consist of a Grade A resistance wire (80 percent nickel, 20 percent chromium), insulated with ceramic bushings, in aluminized steel frame, mounted on refractory material for attachment to ductwork. Provide insert heater casing.
3. Electric resistance heaters for air handling units over 2000 cfm shall be tubular finned type consisting of 80% nickel, 20% chromium, Grade A resistance wire, precisely centered in a stainless steel tube filled with granular magnesium oxide. A stainless steel fin shall be helically wound onto the tube. Elements shall be furnished with mounting flanges, making them individually removable.
4. Terminal studs, nuts and washers shall be stainless steel, insulated with phenolic terminal bushings. Terminals shall be machine crimped to coils.
5. Heater shall be suitable for zero clearance to combustible surface.
6. Heater shall be tested dielectrically at 2000 Volts before shipment.
7. Provide differential pressure air flow switch with remote mounting sensor to deenergize heater on lack of air flow. Install sensor upstream of volume box.
8. Provide built in automatic reset thermal cutout to break heater load directly upon over temperature.
9. Provide built in manual reset thermal cutout.
10. Thermal safety cutout's sensing elements shall project fully into the moving air stream. The cutouts shall not be subject to nuisance local overheating due to inadequate air flow. Provide recessed cabinets or other means recommended by the manufacturer, to ensure that nuisance trip-outs do not occur.
11. Provide dry control circuit transformer in heater terminal box, suitable for industrial applications.
12. Insulate duct mounted coil casings with same thickness required for the duct system (not less than 1" thick).
13. Provide at least the number of stages or, for modulation, SCR controller as shown on the schedules and the control sequences.
14. Provide remote control panels as indicated on Drawings.

2.20 AIR FILTERS

- A. Air filters shall be listed according to requirements of UL 900.
- B. The HVAC contractor shall furnish a minimum of three (3) additional complete sets of filters for all air handling equipment using filters. In addition to the filters furnished with each piece of equipment from the manufacturer, the HVAC Subcontractor shall provide a minimum of two (2) complete sets of filters to be used during the construction and then the testing and balancing period. Finally, a complete new set of filters shall be installed upon substantial completion of the project, prior to final acceptance by the Owner's Representative.
- C. Extended Surface Pleated Panel Filters: Filters shall be two (2) inch depth, sectional, disposable type of the sizes indicated and shall have an average efficiency rating of MERV-8 when tested according to ASHRAE 52.2 and shall maintain that rating as the filter goes from clean to dirty. This maintenance of the MERV-8 rating shall be documented shall be by testing according to Appendix J of ASHRAE 52.2. Initial resistance at 400 feet per minute shall not exceed 0.2 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. All four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity. Filter shall be equal to Farr 30/30.

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- D. Cartridge/Panel Filters: Filters shall be twelve (12) inch depth, sectional, disposable type of the sizes indicated and shall have an average efficiency rating of MERV-13 when tested according to ASHRAE 52.2 and shall maintain that rating as the filter goes from clean to dirty. This maintenance of the MERV-13 rating shall be documented shall be by testing according to Appendix J of ASHRAE 52.2. Initial resistance at 400 FPM shall not exceed [0.3] [0.35] inches water gauge. Filters shall be constructed by pleating a continuous sheet of filter medium into closely spaced pleats. Filters shall be equal to Farr Riga-Flo [100] [200].
- E. Holding Frames: Frames shall be fabricated from not lighter than 16 gauge aluminum or stainless steel sheet steel with rust-inhibitor coating may be used where indicated. Each holding frame shall be equipped with suitable filter holding devices. Holding frame seats shall be gasketed. All joints shall be airtight.
- F. Filter Gauges: Filter gauges shall be dial type, diaphragm actuated draft and shall be provided for all filter stations, including those filters which are furnished as integral parts of factory fabricated air handling units. Gauges shall be at least 3-7/8 inches in diameter, shall have white dials with black figures, and [graduations] [shall be graduated in 0.01 inch,] and shall have a minimum range of one (1) inch beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be furnished complete with two (2) static pressure tips with integral compression fittings, two (2) molded plastic vent valves, two (2) five (5) foot minimum lengths of 1/4 inch diameter aluminum or vinyl tubing, and all hardware and accessories for gauge mounting.

2.21 AIR HANDLING UNITS

A. MANUFACTURERS

- 1. Air Handlers shall be manufactured by the following vendors or approved equal
 - a. Daikin
 - b. Trane
 - c. Carrier
 - d. JCI/York

B. GENERAL DESCRIPTION

- 1. Configuration: AHU's shall be fabricated as detailed on drawings.
- 2. Performance: Performance shall be in conformance with AHRI 430, See schedules
- 3. Acoustics: Sound power levels (dB) for the unit shall not exceed the following specified levels. The manufacturer shall provide the necessary sound treatment to meet these levels if required .
- 4. IBC Certification
 - a. All components specified herein shall be designed, manufactured and independently tested, rated and certified to meet the seismic compliance standards of the 2009 International Building Code.
 - b. All components shall meet as a minimum, all load path and anchorage standards for components as outlined in IBC section 1621 .3 .3 & 1707 .7 .2 .
 - c. Certification shall be good for [Fp/Wp = 2.89 gs and Sds = 1 .29 gs obtained from a "maximum considered earth quake short period spectral response acceleration Ss of 1 .93 .] [Fp/Wp = 4 .42 gs and Sds = 1 .96

gs obtained from a “maximum considered earth quake short period spectral response acceleration S_s of 2 .94 .]

- d. All completed component assemblies shall be clearly labelled for field inspection. Seismic Compliance Labels shall include the manufacturer's identification, designation of certified models, definitive information describing the product's compliance characteristics, and the Independent Certifying Agency's name and report identification.
- e. In addition to all seismic requirements for IBC Certification listed elsewhere in the project specification, manufacturer's submittals shall include .
- f.
 - 1) Certificate of Compliance from the Independent Certifying Agency clearly indicating that components supplied on this project are included in the component manufacturer's Certificate of Compliance .
 - 2) Clear installation instructions including all accessory components that are part of the overall component installation .]

C. UNIT CONSTRUCTION

1. Fabricate unit with 16 gauge channel posts and panels secured with mechanical fasteners . All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket applied in the factory.
2. Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick; thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13 . The outer panel shall be constructed of G90 galvanized steel . The inner liner shall be constructed of G90 galvanized steel .
3. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum positive or negative 8 inches of static pressure . Deflection shall be measured at the midpoint of the panel height .
4. Panel assembly shall meet UL standard 1995 for fire safety. Panel assembly shall comply with the material requirements of NFPA 90A .
5. The casing leakage rate shall not exceed [0 .50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w .c . in positive pressure sections and -6" w .c . in negative pressure sections
6. Module to module assembly shall be accomplished with an overlapping, full perimeter, internal splice joint sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards .
7. A sound baffle shall be secured to the inner liner and constructed of G60 galvanized perforated steel filled with fiberglass insulation.
8. A 0 .044" thick aluminium treadplate shall be secured to the floor panel. Entire unit shall have a 6-inch full perimeter base rail for structural rigidity and condensate trapping.
9. Access Doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size (4 .5" minimum) handle assembly (provide inspection window for fan section) . Door shall swing outward for unit sections under negative pressure and inward for unit sections under positive pressure) . Doors limited from swinging inward (such as side access filter sections) on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
10. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection . Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping . Drain connections that protrude from the base rail

are not acceptable . There shall be a full 2" thickness of insulation under drain pan .

D. SUPPLY FANS

1. ECM fan array

- a. Provide ECM, motorized impeller supply fan(s) . Fan assembly shall include fan, fan base, and a motor and shall be dynamically balanced by the fan manufacturer .
- b. Inverter shall be integral to the motor and come as an assembly from the fan manufacturer.
- c. Motor shall be brushless DC type with a permanent magnet rotor .
- d. Fan section shall come equipped with a motor control panel mounted on the supply fan section.
- e. Both line voltage and low voltage wiring shall be done by the factory . Each fan shall have an isolation switch.
- f. Unit shall be provided with a ship loose motor control panel for the supply fan section. All motor wiring shall be field supplied and installed
- g. Motor control panel shall come equipped with a fused disconnect
- h. Motor control panel shall come with a low voltage terminal strip and shall include terminals for Fan ON/OFF, 0-10V signal, and fan fault .
- i. ECM motor control panel SCCR shall be at least 65kA
- j. Unit shall come equipped with an isolation damper upstream of each fan in the array . Damper shall be equipped with an adjustable, weighted counter balance to minimize static pressure loss
- k. The control box shall be UL or ETL listed. DDC controller shall be BACnet compatible. Controller shall be configurable for fan speed control via HMI, BACnet interface (MS/TP), 0-10 VDC input, 4-20 mA input, constant airflow, or duct static pressure (static pressure sensor to be field-provided and mounted). Controller shall be capable of monitoring the array's airflow, total static pressure, power consumption, RPM, individual fan alarm status, and specific cause of alarm. Control panel shall be equipped with relays for locking between other electrically driven components. A system alarm contact shall be provided to provide status feedback . A system enable contact shall be provided to enable/disable the fans.

E. ELECTRICAL

1. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22 .2 No . 236.
2. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated . Enclosed terminal lugs in terminal box sized to NFPA 70 .
3. Provide marine light and GFI receptacle in each section mounted and wired to a junction box and on-off switch mounted on the outside of the cabinet .
4. Fan motors shall be 3600 rpm, totally enclosed fan-cooled (TEFC) electronically commutated type and shall be premium efficiency.
5. Electrical characteristics shall be as shown in schedule .
6. Air handler manufacturer shall provide and mount conduit and wiring from each fan motor terminated at a fused type disconnect switch factory wired. The disconnect switch shall be furnished with a rotary or switch-blade type handle that can be padlocked in the 'off' position. A motor starter NEMA type shall be provided.

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7. Air handler manufacturer shall provide and mount variable speed drive with electrical characteristics as shown on project schedule. A two-contactor type bypass switch shall be provided. A line reactor shall be provided.
8. Air handler manufacturer shall provide and mount a handoff-auto (HOA) switch.
9. Air handler manufacturer shall provide and mount a 120V transformer.
10. Manufacturer must provide ASHRAE 90 .1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
11. Ultraviolet Light Germicidal Irradiation (UVGI) System
 - a. The UVGI surface irradiation system shall consist of heavy duty, factory assembled and tested light fixtures that emit short wave UVC light (200 nm – 270 nm)
 - b. Constructed and tested for HVAC environments: UL listed at 55°F to 135°F with airflow velocities up to 1000 FPM . Independently tested to verify output and performance .
 - c. UVGI system shall have UL Approval per Category Code ABQK (Accessories, Air Duct Mounted) UL Standards: UL153, UL1598 & UL1995 .
 - d. Assembly shall consist of double ended UVC florescent lamp and housing, power source and sockets shall be UL Drip proof construction .
 - e. The enclosure shall be made of drip-proof construction from galvanized steel . The ballast shall be a self-contained electronic type . The enclosure shall include safety mechanical interlocks which do not allow the UV assembly to light unless installed on its track . The multiple UV assemblies shall connect via interlock .
 - f. UVC Lamp shall be a standard output hot cathode, low pressure T8, double ended UVC lamp . Lamps shall be constructed with a thick wall glass of soda barium UV transparent glass with a base of metal . Lamps shall have 5 .5 milligrams or less of mercury .
 - h. Lamps shall produce adequate UV output and operate in environments of temperatures between 55°F to 135°F . Lamps shall produce a minimum of 80% of initial UV output at end of life (9000 hours minimum)
 - i. Power source shall be 120 VAC 60hz . Power connections shall be via a provided j-box or line cord from one end of the UV fixture. UV fixtures shall electrically connect via interlocks .
 - j. Installation shall be such that the cumulative sum length of UV fixtures end-to-end shall equal the coil width +/- three (3) inches . Modular coil system shall be installed and wired so that the entire surface of the coil and drain pan is bathed by UVC . System shall be installed using
 - k. "tracks" to allow UV fixture to slide into place, for ease of access during installation and annual maintenance . System shall be installed 8"-20" (14" ideal) from coil surface . System shall be installed utilizing one row of lamps for every 48" of coil height . System shall incorporate safety "cut-off" switches on access doors.
 - l. Approved manufacturers: UltraViolet Devices, Inc . (UVDI) or approved equal.

F. COOLING AND HEATING COIL SECTIONS

- a. Provide access to coils from both sides of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation . Drain and vent connections shall be provided exterior to unit casing . Coil connections must be factory sealed

with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly . If not factory packaged, Contractor must supply all coil connection grommets and sleeves.

b. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

c. Water Coils:

1) Certification - Acceptable water coils are to be certified in accordance with AHRI Standard 410 and bear the AHRI label . Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410 . Manufacturer must be ISO 9002 certified.

2) Headers shall consist of seamless copper tubing to assure compatibility with primary surface . Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.

3) Fins shall have a minimum thickness of 0 .0075" of aluminum or 0 .006" copper plate construction . Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer . Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates . Bare copper tubes shall not be visible between fins.

4) Coil tubes shall be 5/8 inch (16mm) OD seamless copper, 0 .020" nominal tube wall thickness, expanded into fins, brazed at joints. Soldered U-bends shall be provided to minimize the effects of erosion and premature failure having a minimum tube wall thickness of 0 .025"

5) Coil connections shall be O .D . sweat copper with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler . Vent connections provided at the highest point to assure proper venting . Drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up .

6) Coil casings shall be a formed channel frame of stainless steel. Water heating coils, 1 & 2 row only shall be furnished as uncased to allow for thermal movement and slide into a pitched track for fluid drainage.

d. Refrigerant Coils:

1) Manufacturer must be ISO 9002 certified.

2) Coils shall be designed for use with Refrigerant R410a . Fins shall have a minimum thickness of 0.0075" of aluminum or 0 .006" copper plate construction with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer . Tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression

bond over the entire finned length for maximum heat transfer rates . Bare copper tube shall not be visible between fins.

- 3) Refrigerant coils shall be provided with round seamless 5/8" O .D . copper tubes on 1-1/2" centers, staggered in the direction of airflow. All joints shall be brazed.
- 4) Sweat type copper suction connections located at the bottom of the suction headers for gravity oil drainage . Coils shall be uniformly circuited in a counterflow manner for single circuit capacity reduction . Pressure type liquid distributors shall be used . Coils shall be tested with 315 pounds air pressure under warm water, and suitable for 250 psig working pressure .

G. PARTICULATE FILTERS

1. Filter section with filter racks and guides with hinged and latching access doors on either, or both sides, for side loading and removal of filters
2. Filter media shall be UL 900 listed, Class I or Class II .
3. Flat arrangement with 2" deep pleated disposable MERV 13 panel filters.
4. Manufacturer shall supply minihelic gauge to read pressure drop across the filter bank for scheduling filter replacement. Design shall be equal to a Dwyer Minihelic 2 and be recessed into the cabinet to minimize chances for damage during shipment and installation
5. Manufacturer to provide and mount ultraviolet lights on the entering air side of the filter. Ultraviolet lights must meet agency approved to UL category Code ABQK specification, HVAC Accessories, Air Duct Mounted .

H. ECONOMIZER SECTION

1. Economizer section shall be provided with end outside air opening, top return air opening and no exhaust air opening.
2. Dampers shall be Tamco 9000, or equal by Greenheck or Ruskin, opposed blade, thermally insulated control dampers.
3. Return, outside, and exhaust air dampers shall be driven separately.
4. Extruded aluminum (6063-T5) damper frame shall be not less than 0 .080" in thickness . Damper frame shall be 4" deep × 1", with mounting flanges on both sides of frame .
5. Damper blades shall be extruded aluminum (6063-T5) air-foil profiles, internally insulated with expanded polyurethane foam and thermally broken .
6. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55 (tested to AAMA 1502 .7 Test Method) .
7. Blade seals shall be extruded EPDM . Frame seals shall be extruded silicone . Seals shall be secured in an integral slot within the aluminum extrusions .
8. Blade and frame seals shall be mechanically fastened to prevent shrinkage and movement over the life of the damper .
9. Bearings shall be composed of a Celcon inner bearing (fixed around a 7/16" aluminum hexagon blade pivot pin) rotating within a polycarbonate outer bearing inserted in the frame . Bearings shall not allow action between metal-to-metal or metal-to-plastic riding surfaces .
10. Adjustable 7/16" hexagonal drive rod, U-bolt fastener, and hexagonal retaining nuts shall be zinc-plated steel . These components shall provide a positive connection to blades and linkage .
11. Aluminum and corrosion-resistant zinc-plated steel linkage hardware shall be installed in the frame side, complete with cup-point trunnion screws for a slip-proof grip .

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13. Dampers shall be designed for operation in temperatures ranging from -40°F to 212°F.
14. Dampers shall achieve Leakage Class 1A at 1 in w .g. static pressure differential. Standard air leakage data shall be certified under the AMCA Certified Ratings Program.
15. Dampers shall be custom made to required size, without blanking off free area.

I. CONTROLS

1. Manufacturer shall furnish and mount 24V control components that shall be terminated at a sealed junction box on the unit exterior of each section in which the component is mounted . The components shall include low temperature limits (freeze-stats), air proving switches, discharge air, return air, exhaust air temperature sensors, and CO2 sensors as specified in the control schedule. The control components must be compatible with those indicated in the control specification. The manufacturer shall furnish and mount Belimo style actuators for all ampers .

2.22 ENERGY RECOVERY UNITS

1. MANUFACTURERS

- a. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1) Valent
 - 2) Greenheck
 - 3) Swegon

2. MANUFACTURED UNITS

- a. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, motorized intake damper, motorized exhaust damper, service receptacle, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

3. CABINET

- a. Materials: Formed double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1) Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with a high performance proprietary coating that has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 5,000 hours.
- b. Access doors shall be hinged.
- c. Cabinet shall have factory-installed duct flanges on all duct openings.

- d. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - 1) Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - a) Thickness: 1 inch (25 mm)
 - b) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - c) Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
 - 2) Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
 - 3) Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.
 - 4) Control panel / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
 - 5) Frost control: none.
 - 6) Motorized dampers / Exhaust Air, Intake Air, Motorized dampers of insulated low leakage type shall be factory installed.
 - 7) Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed by this contractor in a location designated by the A/E.

4. BLOWER

- a. Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.
- b. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- c. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.

- d. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
- e. Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

5. MOTORS

- a. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Minimum compliance with EPA's minimum energy-efficiency standards for single speed ODP and TEFC enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
- b. Fan motors shall be 60 cycle, 3 phase 208 volts.

6. UNIT CONTROLS

- a. The unit shall be constructed so that it can be controlled by a factory-supplied controller or it can be monitored and controlled by a Building Management System (BMS).
- b. Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drives for modulation of the blower motors. The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- c. Sensors
 - 1) Dirty filter sensor
 - 2) Temperature Sensors - OAI EAD RAI OAD
 - 3) Relative Humidity Sensor - OAH RAH
- d. Rotation Sensor

7. FILTERS

- a. Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 13 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

2.23 BLOWER COIL AIR HANDLERS

A. Manufacturers

- 1. The following manufacturers are approved for use:
 - a. Daikin
 - b. Carrier
 - c. JCI/York
 - d. Trane

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2. Fan Coil Type And Arrangement
 - a. The unit shall be furnished as a draw-through style air handler.
 - b. VRV cooling coils shall be factory-installed. Maximum operating pressure should not exceed 500 psig
 - c. A Secondary preheat steam coil located upstream of
 - d. the primary coil shall be factory-furnished. Operating
 - e. pressure should not exceed 25 psig

B. General Construction

1. The air handling unit shall include a blower, fan housing, coil, and drain-pan enclosed within and mounted to a rigid cabinet. Steel parts exposed to moisture shall be galvanized and insulated to prevent condensation. The complete fan assembly shall be wired via quick connect electrical contacts and easily removable for service and maintenance.
2. The air handling unit shall include a blower, fan housing, coil, and drain-pan enclosed within and mounted to a rigid cabinet. Steel parts exposed to moisture shall be galvanized and insulated to prevent condensation.
3. Cabinet
 - a. Unit will be supplied with 1-inch, double-wall panels. The cabinet is to be thermally isolated through injected foam insulation inside each cabinet. Single wall cabinets with fiberglass insulation exposed in the airstream are not acceptable. Frame channels which allow heat conductance between the inside and outside of the cabinet are not acceptable. Base rails used for unit mounting/hanging are acceptable. Panel shall have a minimum thermal insulation of R-6.5. Foam injected insulation conforms to:
 - 1) ASTM C1071 (including C665)
 - 2) UL 181 for erosion
 - 3) 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A

C. Supply Fan(s)

1. Supply fans shall be a DWDI forward-curved type fan. Fan assemblies shall be balance tested dynamically by the manufacturer. Manufacturer must ensure maximum fan RPM is below the first critical speed.
2. The complete fan assembly, including motor and main drain pan shall be easily removable.
3. Fan motor(s) assembly shall be direct-drive style.
4. Fan motor(s) shall be of Direct Current Brushless NEMA Premium Efficiency type.
5. Manufacturer's supply fan motor must have means to adjust motor speed for field balancing.
6. Units shall be certified in accordance with the Central Station Air Handler certification program that is based on AHRI Standard 430.
7. Forward-curved fan must be capable of delivering scheduled external and total static pressures at nominal cabinet CFM

D. Filters

1. Draw-through filter section shall be a 2" flat type furnished with MERV 8 deep-pleated panel filters.

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2. Final filter section shall be a 2" flat type furnished with MERV 13 deep-pleated panel filters.
3. Filter media shall be UL 900 listed, Class I or Class II.
4. Filters shall be easily accessible via a door or panel located on the bottom of the unit.
5. The filter media shall be of disposable type and rating of MERV 8 or 13 per above.

E. Electrical

1. Supply fans shall be driven by Electronically Commutated motors that are run-tested in the assembled unit and permanently lubricated. All motors shall have integral thermal overload protection with a maximum ambient operating temperature of 55°C. Motors shall be capable operating at 90 percent of rated voltage on all speed settings. Motors shall be able to operate up to 10 percent overvoltage.
2. Supply fans shall be driven by NEMA Premium Efficiency motors that are run-tested in the assembled unit and permanently lubricated. All motors shall have integral thermal overload protection with a maximum ambient operating temperature of 40°C. Motors shall be capable of operating 90 percent of rated voltage on all speed settings. Motors can operate up to 10 percent overvoltage.
3. Motor wires shall include a quick-disconnect motor plug.
4. All controls equipment including ECM control module, low voltage transformers, safety switches, disconnects, fusing, and terminal strips must be located inside the main unit cabinet.

F. Cooling and Heating

1. Cooling Coil
 - a. Cooling and heating performance shall be as scheduled
 - b. VRV fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
 - c. Direct Expansion coils shall be provided with a distributor. The return coil connection shall be a sweat connection with size to be determined by manufacturer based upon the most efficient coil circuiting.
 - d. All steel parts exposed to moisture shall be galvanized.
 - e. Unit shall include a stainless steel primary drain pan and a stainless steel secondary drain pan. The primary drain pan shall be positively sloped in every plane. Primary and secondary drain pans to be insulated with anti-microbial closed-cell insulation. The drain pan shall be designed to ensure no pooling of condensate water per ASHRAE 62.1 and 62.2.
 - f. Coils shall have stub-outs off of the headers extending through the unit paneling.
 - g. Coils shall have stub-outs off the headers that end within the internal cabinet.
2. Heating Coil
 - a. Heating performance shall be as specified on the unit schedule.
 - b. Steam coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless

copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

- c. Coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be female pipe thread connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections shall be provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point.

3. Economizer / Mixing Box

- a. A factory-installed mixing box for mixing two separate airstreams is to be furnished attached to the main unit. This component must be constructed of a similar cabinet that the main unit is constructed of.
- b. An economizer section shall be provided, controlling return, exhaust, and outdoor air.
- c. Dampers intended for modulating each airstream are to be furnished to cover the openings of the supplied mixing box. Return and outdoor air dampers shall be controlled independently
- d. Damper blades shall be of airfoil construction. Dampers shall be AMCA Class 1-A leakage rated
- e. Damper blades shall be interoperable via linkage shaft. Gear linkage dampers shall not be acceptable.
- f. Damper actuators are to be furnished factory-installed on the mixing box. These actuators are to be controlled via 0-10V modulating signal and factory-wired back to the control area within the main cabinet.

2.24 PACKAGED ROOFTOP UNITS

A. Manufacturers

1. Daikin
2. Aeon
3. Valent
4. Trane

B. GENERAL DESCRIPTION

1. Furnish as shown on plans, Single zone Heating and Cooling Unit(s). Unit performance and electrical characteristics shall be per the job schedule.
2. Configuration: Fabricate as detailed on prints and drawings:
 - a. Return plenum/economizer section
 - b. Filter section
 - c. Cooling coil section
 - d. Supply fan section
 - e. Condensing unit section
3. The complete unit shall be cETLus listed.
4. The unit shall be ASHRAE 90.1-2022 compliant and labeled.
5. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled

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and shipped in one piece. Packaged units shall be shipped fully charged with R-410a Refrigerant and oil.

6. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
7. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door.
8. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
9. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
10. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

C. CABINET, CASING, AND FRAME

1. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
2. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

D. OUTDOOR/RETURN AIR SECTION

1. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle

100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.

2. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
3. Unit shall be provided with a 100% outdoor air hood. The 100% outdoor air hood shall allow outdoor air to enter from the back of the unit, at the draw-through filter section. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign materials and a rain lip to drain water away from the entering air stream.
4. Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15% accuracy down to 40 cfm per ton.

E. EXHAUST FAN

1. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
2. The fan motor shall be a totally enclosed Electronically Commutated (EC) motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
3. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

F. FILTERS

1. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" post filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

G. COOLING COIL

1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
2. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency

aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
4. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
5. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

H. SUPPLY FAN

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
2. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
3. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
4. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
5. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
6. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

I. HEATING SECTION

1. Electric Heat
 - a. The rooftop unit shall include an electrical resistance heating coil section. Staged electric heating coil modules shall be factory installed downstream of the supply air fan in the heating section of the rooftop unit. Heating coils shall be constructed of a low watt density, nickel - chromium alloy resistance wire with intermediate supports that include ceramic bushings. The electrical contactors shall be of the full line-breaking type with all the electrical power legs being disconnected when the contactors are not energized. All electrical circuit wiring shall be designed with copper conductors, aluminum wires are not acceptable. Heating element branch circuits shall be individually fused to a maximum of 48 Amps per NEC requirements. The power supply for the electric heater shall be factory wired into the units main power block or disconnect switch.

- b. The heating modules shall have an automatic reset, high temperature limit safety protection. A secondary high limit protection shall also be provided that requires a manual reset. An airflow switch shall be provided with the heating module to prevent the electric heater from operating in the event of no airflow.
- c. The electric heater elements shall be controlled by the factory installed DDC unit control system. The heater shall have silicon-controlled-rectifier (SCR) control.
- d. Field installed heating modules shall require a field ETL certification. Duct heaters mounted within the rooftop unit in the field shall not be acceptable. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the electric heating modules.

2. HEAT PUMP HEATING

- a. The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heatpump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heatpump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.
- b. The refrigerant system shall have a pump-down cycle.
- c. The unit shall have a electric resistance heat for hybrid heating. When the heatpump operation cannot maintain the discharge air temperature setpoint the natural electric resistance heat shall temper the airstream to the discharge air temperature setpoint.

3. CONDENSING SECTION

- a. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- b. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0-120°F. Mechanical cooling shall be provided to 0°F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- c. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material
- d. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.
- e. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

- f. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

4. ELECTRICAL

- a. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 120-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

5. CONTROLS

- a. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
- b. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
- c. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- d. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
- e. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
- f. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4

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lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

- 1) Return air temperature.
- 2) Discharge air temperature.
- 3) Outdoor air temperature.
- 4) Space air temperature.
- 5) Outdoor enthalpy, high/low.
- 6) Compressor suction temperature and pressure
- 7) Compressor head pressure and temperature
- 8) Expansion valve position
- 9) Condenser fan speed
- 10) Inverter compressor speed
- 11) Dirty filter indication.
- 12) Airflow verification.
- 13) Cooling status.
- 14) Control temperature (Changeover).
- 15) VAV box output status.
- 16) Cooling status/capacity.
- 17) Unit status.
- 18) All time schedules.
- 19) Active alarms with time and date.
- 20) Previous alarms with time and date.
- 21) Optimal start
- 22) Supply fan and exhaust fan speed.
- 23) System operating hours.
 - a) Fan
 - b) Exhaust fan
 - c) Cooling
 - d) Individual compressor
 - e) Heating
 - f) Economizer
 - g) Tenant override

g. The user interaction with the keypad shall provide the following:

- 1) Controls Mode
 - a) Off Manual
 - b) Auto
 - c) Heat/Cool
 - d) Cool only
 - e) Heat only
 - f) Fan only
- 2) Occupancy mode
 - a) Auto
 - b) Occupied
 - c) Unoccupied
 - d) Tenant override
- 3) Unit operation changeover control
 - a) Return air temperature

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- b) Space temperature
- c) Network signal
- 4) Cooling and heating change-over temperature with deadband
- 5) Cooling discharge air temperature (DAT)
- 6) Supply reset options
 - a) Return air temperature
 - b) Outdoor air temperature
 - c) Space temperature
 - d) Airflow (VAV)
 - e) Network signal
 - f) External (0-10 vdc)
 - g) External (0-20 mA)
- 7) Temperature alarm limits
 - a) High supply air temperature
 - b) Low supply air temperature
 - c) High return air temperature
- 8) Lockout control for compressors.
- 9) Compressor interstage timers
- 10) Night setback and setup space temperature.
- 11) Building static pressure.
- 12) Economizer changeover
 - a) Enthalpy
 - b) Drybulb temperature
- 13) Currently time and date
- 14) Tenant override time
- 15) Occupied/unoccupied time schedule
- 16) One event schedule
- 17) Holiday dates and duration
- 18) Adjustable set points
- 19) Service mode
 - a) Timers normal (all time delays normal)
 - b) Timers fast (all time delays 20 sec)
- h. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
 - 1) Airflow
 - 2) Outside air temperature
 - 3) Space temperature
 - 4) Return air temperature
 - 5) External signal of 1-5 vdc
 - 6) External signal of 0-20 mA
 - 7) Network signal

2.25 VARIABLE SPEED HEAT PUMP OUTDOOR UNITS

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- A. All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.
- B. The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- C. All wiring shall be in accordance with the National Electric Code (NEC).
- D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- E. The system and the design shall be in compliance with ASHRAE 15 Mechanical Refrigerant Code.
- F. Acceptable manufacturers:
 - 1. Daikin, distributed by DXS New England
 - 2. Mitsubishi/Trane
 - 3. LG
- G. Alternate manufacturers shall send approval requests to consultant 14 days prior to bid day, and include all information relevant to the alternate VRF system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with ASHRAE 15 analysis, branch selector box layout and locations, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the basis of design.
- H. System shall be a two pipe heat pump switchover VRF system. The specified system is not a simultaneous heating and cooling heat recovery system.
- I. Installing contractor must be certified by VRF manufacturer. The bidders shall be required to submit training certification proof with bid documents and submittal documents. Untrained contractors who wish to bid this project may contact DXS New England (978-977-9911) to arrange training prior to bid day.
- J. The manufacturer shall provide a factory trained service technician to start-up each unit. Manufacturer shall provide instruction to the owners' personnel on proper unit operation and maintenance.
- K. The warranty period on all parts and compressors shall commence on the date of initial start-up and shall continue for a period of Ten (10) years not to exceed one hundred and twenty six (126) months from date of shipment. Proper maintenance of the equipment shall be conducted by certified technicians as per the manufacturer or manufacturer's representative requirements. Maintenance logs shall be supplied by the owner upon request.
- L. All manufacturer warranty shall be for parts only. All diagnosis and labour warranty shall be carried out by installing contractor as per the warranty requirements of this project.
- M. All refrigerant piping shall comply with the more stringent requirement of this spec, the manufacturer's recommendations, manufacturer's requirements, and governing codes.

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- N. The condensing unit shall be factory assembled in North America and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, heat exchanger, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver (heat recovery only) and suction accumulator.
- O. The system shall automatically restart operation after a power failure and will not cause any settings to be lost.
- P. The unit shall incorporate an auto-charging feature to ensure proper refrigerant charge.
- Q. The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers.
- R. Inverter scroll compressors shall be high efficiency reluctance DC (digitally commutating), hermetically sealed, variable speed type. Temperatures and pressures shall be read every 20 seconds and calculated. With each reading, the compressor capacity (inverter frequency) shall be controlled to eliminate deviation from target value. Non inverter-driven compressors shall not be accepted.
- S. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. Upon complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
- T. The compressors' motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
- U. Inverter board shall be refrigerant-cooled to prevent inefficient and unstable operation that can result from air-cooled inverter boards due to varying ambient conditions.
- V. The compressor shall be internally isolated to avoid the transmission of vibration.
- W. In the case of multiple condenser modules, operation hours of the compressors shall be balanced by means of the Duty Cycling Function.
- X. The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Motors shall be capable of delivering design air at high external static pressures up to 0.32 in WG (factory set as standard at 0.12 in. WG) to accommodate field applied condensing unit discharge ductwork..
- Y. Night setback control for low noise operation shall automatically limit the maximum speed of the fan motor.
- Z. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

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- AA. The fins are to be covered with an anti-corrosion hydrophilic blue coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test of 500hr (ASTM G85 & Blister Rating:10).
 - BB. The outdoor unit shall be capable of heating operation down to -13°F ambient temperature. Tested factory data on heating capacity and efficiency shall be available. Continuous heating shall be provided during defrost mode for all single module systems 16-tons and above and for all multi-module systems.
 - CC. The outdoor unit shall be capable of cooling operation down to +23°F without any additional low ambient controls.
 - DD. The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be used for inverter cooling, enhancing defrost during heating operation.
 - EE. Single-module outdoor units shall be available from 6 to 20 T in nominal cooling capacity and can be combined to offer up to 40 T in a dual-module configuration
 - FF. Systems shall have a vertical (height) separation of up to 361 ft between the condensing unit and the indoor units.
 - GG. Each system shall include a built-in data recorder that can store up to 45 minutes of operational data which can help identify the issue in case of a product failure
 - HH. Each condensing unit shall have a three-segment removable panel design which allows for direct separate access to outdoor fans, critical mechanical and electrical components for ease of installation and service, and shall have separate knock-outs for refrigerant piping and wiring on the bottom panel.
- II. ELECTRICAL
- 1. Independent electrical power for fan coils and branch selector boxes shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.
 - 2. Electrical power for condensing units shall be 208/230 volts, 3 phase, 60 hertz. The unit shall be capable of operating within the limits of 187 volts to 253 volts.
 - 3. The control voltage between the indoor and outdoor unit shall be 16VDC. The control wiring shall be communication type stranded non-shielded 18-2 AWG.
 - 4. Control wiring shall be installed in a daisy chain configuration between all VRF components as per Manufacturer.

2.26 FAN POWERED TERMINAL UNITS

- A. Units shall be as manufactured by: Krueger, Metal-Aire, Nailor, Price, Titus, Trane, or approved equal. Units shall be type shown on drawings, series or parallel.
- B. The entire terminal unit shall be designed and built as a single unit. Unit shall be provided with a primary variable air volume damper that controls the primary air flow in response to a temperature sensor, and an integral induced air inlet attenuator section. Space limitations shall be reviewed by the installer to ensure all units will fit into the available space. Controls shall be as shown on drawings and specified in controls specification.

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- C. Unit casing shall be a minimum 20 gauge galvanized steel and fully lined with minimum ½ inch thick, hospital grade closed cell foam insulation. The insulation shall comply with UL-181 for erosion and NFPA-90A for fire resistivity and smoke developed.
- D. Unit casing shall have bottom access door which shall allow removal of fan and servicing of unit without disturbing duct connections.
- E. Unit casing shall have round duct collar for the primary air connection and a rectangular discharge air connection. All control components and wiring, except the remote sensors and valves, shall be factory installed and mounted.
- F. Provide a calibrated air volume sensing device, air valve or damper, actuator, and rewired accessories, such as relays, etc. Units shall control minimum and maximum primary CFM of the unit as called for on the drawings with +/- 5% with variations in inlet pressures from ½ inch to six (6) inch water gauge. Air flow (CFM) shall be factory set. A flow chart shall be attached to each unit. Thermostat signal shall reset the flow control device to control primary air CFM to match load requirements. Control of the fan powered unit shall be pressure independent.
- G. Primary air damper leakage at shutoff shall not exceed 2.0% at three (3) inch wg pressure. Damper shall be located inside the unit and shall be mechanically connected to the shaft. Provide self-lubricating bearings for the shaft. Nylon is not acceptable as bearing material.
- H. Terminal shall be capable of operation as described herein and on the drawings.
- I. Fan blowers shall be constructed of steel with forward curved blades, dynamically balanced wheels and direct drive motor. Motors shall be of energy efficient design with integral resettable thermal overload protection, permanently lubricated sleeve type bearings, ECM type and shall be designed for use with fan speed controller. Provide anti-backward rotation device. Provide torsion flex suspension and install isolation between motor and blower assembly. Provide backdraft damper as required to prevent cold primary air from flowing back into the ceiling plenum.
- J. Provide a manual speed control system which shall allow continuously adjustable fan speed from maximum to minimum. Speed control shall be electronic and shall be matched to operate with the motor. Speed control shall incorporate a minimum voltage stop to insure motor cannot operate in a stall mode. Three speed switches which are not continuously adjustable are not acceptable.
- K. Units shall incorporate a single point electrical and control connection for the entire unit with factory mounted and wired disconnect switch (NEMA rated). Provide any required control voltage transformers. All electrical components shall be UL listed and installed in accordance with the National Electric Code. All line voltage electrical components shall be mounted in a NEMA 1 enclosure. The entire assembly shall be UL listed.
- L. Provide one (1) inch thick MERV-3 throw away filters on the return air inlet assemblies. Provide one (1) set of spare filters for all units. Install spare filters after start-up and balancing.
- M. Provide either factory installed return air sound attenuators or the field mounted sound diverter per NV5 detail H203 (series) or H204 (parallel).

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- N. Hot Water Heating Coils: Hot-water coils shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to the tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 16 gauge, galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. At the factory, each coil shall be tested at not less than 250 PSIG air pressure and shall be suitable for 200 PSIG working pressure. Drainable coils shall be installed in the air handling units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils shall conform to the provisions of ARI 410.
- O. Electric Resistance Heaters: Electric resistance heaters shall be of the duct-mounting type consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Electric duct heater shall meet the requirement of Underwriters Laboratories and NFPA 70 and shall be provided with a built-in or surface-mounted high-limit thermostat. Electric duct heaters shall be interlocked electrically so that heaters cannot be energized unless the fan is running.

2.27 UNIT HEATERS (HOT WATER OR STEAM)

- A. Unit heaters shall be as manufactured by Trane, Sterling, Modine, Beacon/Morris, AirTherm, or approved equal. Units shall be as specified below, and shall have a heating capacity not in excess of 125% of the capacity indicated on drawings.
- B. Heaters shall be designed for suspension and arranged for [horizontal] [vertical] discharge of air as Indicated. Casings shall be not less than 20 gauge black steel and finished with lacquer or enamel. Suitable adjustable deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Fans shall operate at speeds not in excess of 1,200 rpm (1800 rpm maximum for motors 1/3 hp and larger) and shall have discharge or face velocities not in excess of 1,000 fpm.
- C. Heating coils and radiating fins shall be of suitable nonferrous alloy with [threaded] [brazed] fittings at each end for connecting to external piping. The heating elements shall be free to expand or contract without developing leaks and shall be properly pitched for drainage. The elements shall be tested under a hydrostatic pressure of 200 [400] PSIG and a certified report of the test shall be submitted to the Owner's Representative. Coils shall be suitable for use with water up to 250°F and up to 126 PSIG saturated steam. Provide disposable filters to protect the coil.
- D. Provide aluminum fans with ball or roller bearings for motors over 1/8 horsepower (hp) and sleeve bearings for motors 1/8 hp and under. Provide sleeve bearings with oil reservoir, if not permanently lubricated. Fans shall be of aluminum blade, steel hub type construction, spark proof, balanced, of capacity as indicated on Drawing Schedule. Provide welded steel, zinc plated or painted fan guard.
- E. Motors shall be resiliently mounted and shall meet the requirements of the Motors, Drives and Starters Paragraph of these specifications. Provide continuous-duty motor with built-in automatic reset thermal overload protection. For motor 1/2 hp and larger, use three-phase. Provide single-phase motor of permanent split capacitor or capacitor start. Limit motor speed at 1800 rpm. Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

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- F. Furnish and install [line] [low] voltage wall thermostat with bimetal thermometer, knob-type set point adjustment, 40°F to 80°F range. Heavy duty summer/winter fan on/auto selector switch shall be provided.
1. Thermostat shall be single set point/single output signal controllers.
 2. The control system provided shall consist of thermostats, valves, valve operators and all other necessary control components to fill the intent of the specification and provide for a complete and operable system. Furnish all necessary relays, controllers, etc., to allow use of thermostats with new heating equipment. Furnish thermostats with mounting kit and cast aluminum locking covers.
 3. Provide strap on aquastat and connection to unit fan.

[Controls shall be provided as specified in controls specification.]
- G. Mounting/Support: Provide unit complete with manufacturer's optional ceiling or wall mounting equipment.
- H. Source Quality Control: Special protection is not required for equipment that has a zinc coating conforming to ASTM A 123. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B 117. Test indoor and outdoor equipment for one hundred and twenty-five (125) hours; test outdoor equipment used in a marine atmosphere for five hundred (500) hours. For each specimen, perform a scratch test as defined in ASTM D 1654.

2.28 FACTORY PAINTING

- A. Units which are not of aluminum, stainless steel, or galvanized construction (according to ASTM A 123 or ASTM A 525) shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatised and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of one hundred and twenty-five (125) hours for units to be installed indoors and five hundred (500) hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than six (6), average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than ten (10), no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

2.29 INSULATION

- A. Scope: Provide all labor, equipment, materials and accessories, and perform all operations required, for the correct installation of insulation on the following systems and all other necessary items connected into the systems subject to condensation, loss of heat, or personnel protection (above 120°F):
1. Piping insulation (other than pre-insulated underground piping), jackets and accessories (including all valves and fittings with easily removable sections for maintenance of strainers, balance valves, and unions).
 2. Equipment and flue gas breeching insulation, and covering (including easily removable sections for maintenance).
 3. Ductwork insulation, jackets, and lining (including all fittings).

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4. Fire wrap insulation where indicated or required to maintain fire separation.
- B. Environmental Requirements: Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Quality Assurance: Insulation materials must be asbestos free, UL listed, and manufactured at facilities certified and registered to conform to ISO 9000 Quality Standard. All insulating products and jackets shall carry a 25/50-flame spread/smoke developed rating as tested in accordance with ASTM E 84.
- D. Workmanship: All insulation shall be installed by a licensed applicator and applied in accordance with the manufacturer's recommendations. All work shall comply with all applicable federal, state, and local codes including, but not limited to, OSHA. All work shall conform to industry and trade accepted standards for commercial and industrial insulations. Verify that piping, heat trace, and ductwork has been tested (including applicable pressure/leakage tests) before applying insulation materials. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease. No vapor barrier leaks or insulation voids will be accepted. Continue insulation vapor barrier through penetrations except where prohibited by code. All fire rated walls and penetrations shall be sealed with fire stopping. Locate insulation and cover seams in least visible locations. Neatly finish insulation at supports, protrusions, and interruptions. For all systems requiring a vapor barrier seal all terminations including fittings, wall penetrations, and supports with vapor barrier mastic such as Foster 30-65, Childers CP-35 or approved equal. In addition, in brine or chilled water pipe systems vapor seal pipe terminations every four (4) pipe sections, using Foster 30-65, Childers CP-35 or approved equal. Bevel and seal ends of insulation at equipment, flanges, and unions. Where insulation is used over stainless surfaces, the material shall be chlorine free.
- E. Delivery and Storage of Materials
 1. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.
 2. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.
 3. Installed insulation that has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.
- F. Manufacturers: Johns Manville (JM), CertainTeed, Owens-Corning, 3M, Armstrong, Knauf, Armacell, or approved equal. Note that the listed manufacturers may not be able to supply all the insulation products required for the project. Unless otherwise noted, JM insulation products are listed to provide the minimum standards required for each type of insulation.
- G. Pipe Insulation: Provide the following products depending on temperature of each system. Insulation shall be marked to show the locations of all unions, break flanges, strainers, check and balancing valves.
 1. For piping with a service temperature between 40°F and 600°F such as chilled water, hot water, dual temperature water, make-up and feed water, blow-down, all outdoor condenser water piping, all indoor condenser water supply piping from the towers to the free cooling heat exchanger, condensate drain, glycol heat

recovery (with down to 0°F minimum winter temperature), boiler feed water, heated oil, water defrost piping in refrigerated rooms, steam, and steam condensate, provide glass fiber insulation equal to JM Micro-Lok. Insulation shall be rigid molded and noncombustible, meeting ASTM C 547, Type I. K-factor shall be 0.23 at 75°F mean temperature. All purpose vapor retardant jacket shall be JM AP-T PLUS. Jacket shall be white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples (coated with vapor barrier mastic for all chilled water, dual temperature water and glycol heat recovery systems). A breather mastic for applications above ambient pipe service temperatures (fittings, tees, valves, etc.) shall be water based Foster 46-50 or Childers CP-10 / CP-11. A rigid, non-compressible insulation, equal to Pittsburg-Corning FoamGlas or KingspanTarec Kooltherm shall be used at all pipe hangers and supports for all steel chilled water piping where the pipe is supported by hangers, anchors, and guide with a minimum length of eighteen (18) inches.

2. For all refrigerant suction and cold chilled water/brine solutions (below 60°F) and all outdoor refrigerant liquid and hot gas piping with a service temperature between -40°F and 200°F, provide PBDE (polybrominated diphenyl esthers) free elastomeric foam insulation equal to Armacell AP/Armaflex (up to 1" thick) or AP/Armaflex/FS (over one (1) inch thick). This insulation type may also be used for condensate drain and chilled water piping and fittings that are not heat traced. If used in computer room plena or over stainless steel pipe or fittings, the material shall be chlorine free equal to Armacell NH/Armaflex. Insulation shall be flexible, cellular elastomeric, meeting ASTM C 534, Type I. K-factor shall be 0.27 at 75°F mean temperature. Insulation shall be rated for no more than 25/50-flame spread/smoke developed rating. Provide waterproof vapor retardant adhesive as needed for installation. Provide 2 coats of waterproof Foster 30-64 Elastomeric Foam Coating, or equal UV protective coating for all outdoor insulation that is not jacketed (allowed up to one (1) inch pipe diameter).

H. Minimum pipe insulation thicknesses shall be as shown on the drawings.

I. Field Applied Piping and Fitting Jackets

1. Provide covers for insulation of all pipe fittings (i.e. elbows, tees, end caps, reducers, unions, flanges, mechanical joints), strainers and valves with surface temperatures between -20°F and 150°F (all water, low pressure steam and condensate systems with glass fiber insulation and over one (1) inch foam insulation on refrigerant piping). Provide easily removable sections for cleaning and maintenance of unions, balancing valves, and strainers. Fitting covers shall be 30-mil thick white PVC equal to JM Zeston 2000 molded high impact, UV resistant covers. Attach with water-resistant pressure sensitive color matching vinyl tape to maintain vapor barrier. Insulate all fittings per manufacturer's recommendations to prevent surface temperature from exceeding the 150°F limit.
2. Other than where foam type insulation is used on up to one (1) inch outdoor pipe, with 2 coats of UV protection, protect all piping insulation that passes through walls and floors, and all outdoor pipe insulation with 0.016 inch thick smooth or embossed aluminum sheet jacket or 0.01 inch thick smooth or corrugated type 304 stainless steel or 30 mil thick Zeston 2000 perma-weld high impact UV resistant PVC jacket with perma-weld fitting covers. Seams shall be on the bottom half of the pipe arranged to shed water. Provide minimum two (2) inch overlap for all longitudinal and transverse joints. All seams of outdoor jacket

shall be filled with waterproof adhesive. Provide one (1) inch wide draw bands (same material as jacket) on twelve (12) inch centers.

3. Protect all indoor piping insulation in mechanical and electrical rooms and all other equipment containing rooms with exposed pipe insulation and elsewhere where called for on drawings with 0.016 inch thick smooth or embossed aluminum sheet jacket or 0.01 inch thick smooth or corrugated type 304 stainless steel or 30 mil thick Zeston 2000 perma-weld high impact UV resistant PVC jacket with perma-weld fitting covers. Seams shall be on the bottom half of the pipe arranged to shed water. Provide minimum two (2) inch overlap for all longitudinal and transverse joints. All seams of outdoor jacket shall be filled with waterproof adhesive. Provide one (1) inch wide draw bands (same material as jacket) on twelve (12) inch centers.

J. Ductwork Insulation – General

1. Provide duct and plenum insulation of type(s) indicated in these specifications. Minimum total R-value for each location and duct system shall be as shown on the drawings.
2. R-values shown on drawings may be obtained by adding the individual R-values of both the lining (where used) and external duct insulation.

K. Ductwork Insulation (External Wrap) - General

1. Where duct is internally lined (coordinate locations with ductwork sub-Contractor), exterior insulation is not required unless called for in the specifications, shown on the plans, or where required to provide the minimum R-value shown on the drawings.
2. Where ducts are insulated or lined, flexible connectors to equipment shall be insulated. Duct flanges and standing seams shall be insulated the same as the duct.
3. Where service access is required, bevel and seal ends of easily removable insulation. Removable sections shall also be provided (and labeled) at all duct test holes.
4. The underside of duct work twenty-four (24) inches or greater shall be secured with mechanical fasteners and speed clips spaced approximately eighteen (18) inches on center. The protruding ends of the fasteners should be cut off flush after the speed clips are installed, and then, when required, sealed with UL listed tapes or vapor-retardant adhesive.

L. Ductwork Insulation (External Wrap): Provide the following insulation types for the listed ductwork.

1. Insulate indoor concealed ducts and plenums, depending upon the required R-value (see drawings) for the duct and its location, with 0.75 lb/cu ft dense fiber glass insulation equal to JM Microlite or Owens Corning SOFTR Type 75. Insulation shall meet ASTM C 1290 Type III, flexible blanket with a maximum K-factor of 0.30 at 75°F mean temperature. Operating service temperature range shall be 40°F to 250°F. Vapor barrier jacket shall be FSK aluminum foil reinforced with fiberglass scrim laminated to UL rated kraft paper with maximum permeance of 0.02 perms. Jacket shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples (with minimum two (2) inch lapped vapor barrier) and vapor barrier mastic as needed. K-factors and R-values listed assume 25% compression during installation. The minimum R-value based on thickness, shall be:

<u>Thickness</u>	<u>R-value</u>
1 ½"	4.2

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2"	5.6
3"	8.3

2. Insulate indoor exposed ducts and plenums, depending upon the required R-value (see drawings) for the duct and its location, with 3.0 lb/cu ft dense fiber glass insulation. Insulation shall be equal to JM Type 814 Spin-Glas or Owens Corning Type 703 meeting ASTM C 612, Type 1A & IB; rigid board with a maximum K-factor of 0.23 at 75°F mean temperature. Operating service temperature range shall be 0°F to 450°F. Vapor barrier jacket shall be AP type (kraft paper bonded to aluminum foil, reinforced with fiber glass yarn) with maximum permeance of 0.02 perms. Jacket shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples (with minimum two (2) inch lapped vapor barrier) and vapor barrier mastic as needed. The minimum R-value, based on thickness, shall be:

<u>Thickness</u>	<u>R-value</u>
1 ½"	6.5
2"	8.6

3. Insulate outdoor exposed heating and cooling ducts with a minimum of two (2) inches thick (or thicker if required to meet the scheduled R-value) and exhaust ducts from humidified areas of the building with a minimum of one (1) inch thick (or thicker if required to meet the scheduled R-value) closed cell foam insulation equal to Armacell AP/Armaflex/FS meeting ASTM C 534 Type II flexible, cellular elastomeric, roll or sheet with flame spread/smoke developed rating of no more than 25/50 with K-factor of 0.30 at 75°F mean temperature. Provide waterproof vapor retardant adhesive. Outdoor rectangular ducts shall have additional tapered insulation for outdoor equipment to insure no pooling of water on top of ducts. Provide protective cover using a self-adhering double layer (aluminum facing with high-density polyethylene base) waterproofing membrane, such as MFM Flex-Clad 400, Venture Tape Corp. VentureClad 1577CW, Foster 62-05 Vapor FAS or equal. Color shall be as selected by Architect (aluminum, white, gray, or tan).
4. Protect all outdoor exposed non-insulated round galvanized ducts with a self-adhering double layer (aluminum facing with high-density polyethylene base) waterproofing membrane, such as MFM Flex-Clad 400, Venture Tape Corp. VentureClad 1577CW, Foster 62-05 Vapor FAS or equal. Color shall be as selected by Architect (aluminum, white, gray, or tan). Outdoor exposed non-insulated rectangular galvanized ducts shall have a layer of tapered insulation on top to insure no pooling of water on the ducts under the self-adhering double layer (aluminum facing with high-density polyethylene base) waterproofing membrane. Alternatively these uninsulated outdoor ducts can be protected by being constructed of aluminum or stainless steel in lieu of galvanized steel with a waterproofing membrane.

M. Acoustic Duct Liner – General:

1. Liner minimum thickness shall be minimum one (1) inch (unless otherwise noted on drawings) or as required to provide the minimum R-values shown on the drawings. Ductwork dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness. Do not use liner on kitchen, pool, shower, fume exhaust, hospital operating rooms (and similar areas) or other wet, grease ladened, or potentially hazardous exhaust systems.
2. Liner shall have rugged coating system installed on the air side of liner and all edges. Coating shall be cleanable by dry cleaning methods without damage. Maximum pressure drop of lined ductwork shall not exceed 5% more than

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unlined ductwork of the same inside dimensions. Liner shall be roll type or board type as required for duct size and to meet specified requirements.

3. Liner shall be rated up to 5,000 ft/min.
 4. For all medium and high pressure ductwork (all ductwork above two (2) inch pressure class) install a metal nosing at all liner leading edges. A metal nosing shall also be installed at all fan discharges and at any point where lined duct is preceded by unlined duct. Provide exterior insulation over metal nosings (these bridge the insulation and can lead to condensation) on all cooling supply ducts (with below 60°F air) in concealed or unconditioned spaces.
 5. Repair liner surface penetrations with manufacturer's approved adhesive Foster 85-00/85-60 or Childers CP-127, meeting ASTM C 916.
- N. Duct Liner: Provide flexible duct liner equal to JM Permacote Linacoustic (rectangular duct) or Spiracoustic (round duct) meeting ASTM C 1071 with K-factor shall be 0.25 (one (1) inch thick) at 75°F mean temperature when tested per ASTM C 518. Liner shall have an air surface coated with acrylic coating treated with EPA register anti-microbial agent proven to resist microbial growth as determine by ASTM G 21 and G 22. Noise reduction coefficient shall be minimum 0.65 for one (1) inch thick liner or higher for thicker liner based on type "A" mounting and tested in accordance to ASTM C 423. Install liner with full coverage adhesive meeting ASTM C 916 equal to Foster 85-00/85-60, Childers CP-82 or JM SuperSeal. Secure liner with galvanized steel pins, welded or mechanically fastened. Weld pins shall not mar the exterior finish or surface of the duct. Liner shall be attached to pin with pressed on washer. Mechanical liner fasteners shall be spaced as indicated by SMACNA, NAIMA, or manufacturer. Pin length should be such as to limit compression of liner. All exposed edges of the liner must be factory or field coated. The minimum R-value, based on thickness, shall be:

<u>Thickness</u>	<u>R-value</u>
1"	4.0
1 1/2"	6.0
2	8.0

2.30 ROOF CURBS

- A. As supplied by equipment manufacturer for roof mounted equipment. Provide pre-fabricated adjustable curbs for duct penetrations through roofs.
- B. Provide roof curbs shop-fabricated from 0.064-in. aluminum sheet with heliarc welded joints, integral cants, and flanges, and wood nailer. Sizes as indicated or as required for equipment.
- C. Provide insulation liner of 1 1/2-in. minimum thickness glass fiber: NFPA 90A Standards, flame spread rating of 25 or less, smoke rating 50 or less; coated with neoprene or equal as protection from erosion.
- D. Provide integral pipe chase for roof mounted air handlers with coils.
- E. Provide roof curbs with sound attenuators where indicated and as specified.

2.31 AUTOMATIC TEMPERATURE CONTROLS

- A. Automatic Temperature Controls shall be as specified in Section 23 09 23 BUILDING AUTOMATION SYSTEM, which is hereby made a part of this specification section.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Refer to the drawings for demolition scope applicable to the project.

3.2 GENERAL

- A. Install all items specified under PART 2 - PRODUCTS, according to the manufacturer's requirements and best quality recommendations, shop drawings, the details as shown on the drawings and as specified in this specification section.
- B. Earthwork: Excavation and backfilling for underground piping and tanks shall be as specified in the EXCAVATION, TRENCHING AND BACKFILLING section.
- C. Install all work so that parts requiring inspection, replacements, maintenance and repair shall be readily accessible. Minor deviations from the drawings may be made to accomplish this, but any substantial change shall not be made without prior written approval from the Owner.
- D. Equipment bases mounted on concrete slabs and pads, or mounted on stands, gratings, platforms, or other, shall not be set in any manner, except on the finished and permanent support.
- E. Support of equipment on studs or other means, and the placing or building of the supporting slab, pad, pier, stand, grating, or other "to the equipment", is prohibited.
- F. Concrete supporting structures shall have been constructed and cured a minimum of fourteen (14) days before equipment is mounted.
- G. All welding done under this section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.9 and B31.1 for Pressure Piping and certified by the AWS, ASME or an approved independent testing laboratory, and each such welder shall present certificate attesting his/her qualifications to the Architect's representative whenever requested to do so on the job.
- H. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall accurately match intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.
- I. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.
- J. Care shall be taken when working on the roof. Protect the roof from damage.

3.3 DUCT CLEANING

- A. All new and existing supply and return diffusers, grilles, registers, dampers and ductwork shall be cleaned internally and externally. Prior to cleaning, all airflows shall be measured and recorded by a firm certified for testing and balancing by either Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). Submit four (4) copies of a balancing report for existing conditions.
1. A member of the National Air Duct Cleaners Association (NADCA) shall perform all cleaning.
 2. The Contractor shall cut access ports in the existing ducts and install removable plates/clean-out doors after ducts are cleaned. Provide clean-out doors, sixteen feet on center, for all existing horizontally installed ductwork and at each length of straight duct run less than 16 feet. Provide access door constructed of same material as ductwork served. Access doors shall consist of a double wall inside door with high-density insulation. The inside door shall have a neoprene gasket permanently bonded to it. Provide conical springs over the bolts between the inner and outer door to facilitate opening. The outer door shall be constructed of one gauge heavier material than that of the duct itself. Provide two (2) hand-operated knobs with threaded brass inserts for opening and tight sealing of the door. Clean-out doors shall be a minimum of 10" x 6" for ducts less than ten (10) inches wide; 12" x 8" for ducts less than sixteen (16) inches wide; and 18" x 14" for all ducts greater than sixteen (16) inches wide.
 3. Remove, clean and reinstall clean registers, vents, grilles and diffusers. The Contractor shall wash, dry, and use hepa-filter vacuums to completely clean all existing ducts, dampers, diffusers, grilles and registers.
 4. The Contractor shall include removal, storage, and reinstallation of ceiling tiles. The Contractor shall replace any tiles damaged during the work.
 5. After cleaning, all airflows shall be balanced (by the same balancing Contractor) to the existing readings that were taken before the cleaning began (+/- 5%) or where shown the new air flows listed on the drawings. Submit 4 copies of documentation for the cleaning and the final balancing report to the Owner.

3.4 IDENTIFICATION

- A. General
1. All piping, ductwork, equipment, panels, and valves furnished and/or installed under this section of the specifications shall be marked for ease of identification.
 2. Marking shall be done using self-adhering (screw or rivets for equipment) labels applied to clean, smooth surfaces. All lettering shall have sharply contrasting background for ease of identification. Colors shall be in accordance with ANSI A13.1 Standards. Samples of stickers together with color schedules shall be submitted for approval.
- B. Ductwork and Fire and Smoke Dampers
1. Ductwork marking labels shall be prominently mounted on all ductwork. Locate labels near points where ducts enter into and exit from concealed spaces and maximum intervals of forty (40) feet along each run. Reduce intervals to twenty (20) feet in areas of congested ducts and above ceilings. In finished occupied spaces without ceilings (exposed ducts) labels shall be located just before the duct enters the space and just after the duct exits the space and at intervals of 100 feet within the space. For ductwork in shafts, marking shall be at each floor.

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2. Ductwork markers shall indicate the direction of airflow with ductwork designation (supply, exhaust, return) and which system (i.e. VAV-1, AHU-1, EF-1, etc.) it is connected to.
3. Provide permanently mounted labels on the access doors for all duct mounted Fire, Smoke and Combination Fire/Smoke Dampers. Labels shall have minimum ½ inch high lettering as follows for the type of damper installed: FIRE DAMPER, SMOKE DAMPER, FIRE/SMOKE DAMPER.

C. Pipe Identification

1. Provide color-coded pipe identification markers prominently located on all piping in the building installed under this section. Pipe markers shall be heavy plastic faced cloth labels with heat resistant backing, "Set Mark" by Seton Nameplate Corporation, Zipper Tubing Co., or equal by the W. H. Brady Company or approved equal.
2. Provide each pipe with markers/labels indicating the service, size (in inches), and arrow markers to indicate the direction(s) of flow.
3. Pipe labels shall be spaced at maximum intervals of forty (40) feet along each run. Reduce intervals to twenty (20) feet in areas of congested piping and equipment and above ceilings. In finished occupied spaces without ceilings (exposed piping) labels shall be located just before the piping enters the space and just after the piping exits the space and at intervals of 100 feet within the space. Provide labels near each valve and control device. This work shall be done after finish painting has been completed.
4. The following color coding shall be used with names in black letters on backgrounds indicated:

SCHEDULE OF PIPING IDENTIFICATION		
Service	Legend	Background Color
Condensate drains	Condensate Water	Green
Steam	S (xx)	Yellow (note: xx=PSIG of steam system)
Steam condensate	C (xx)	Yellow (note: xx= PSIG of steam system)
Pumped steam condensate	PC	Yellow
Steam Relief	STM/RLF	Yellow
Make up water	MUW	Green
Refrigerant suction	RS	Yellow
Refrigerant liquid	RL	Yellow
Refrigerant hot gas bypass	RHGB	Yellow
Refrigerant Vent	RV	Yellow
Hot water supply	HWS	Yellow
Hot water return	HWR	Yellow

5. In general, a two (2) inch high legend shall be used for pipe lines four (4) inch diameter and larger, and a ¾ inch high legend shall be used for pipe lines three (3) inch diameter and smaller.
6. All markers shall be OSHA approved.

D. Equipment Identification (by Unit Manufacturer)

1. Equipment marking shall be prominently located and securely attached with screws or rivets (no adhesives or cements are permitted) on the normally visible side of the equipment.

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2. Equipment identification designations shall be taken from equipment callouts as shown on drawings and coordinated with the Owner's facility group to assure designations match up with Owner's maintenance management system identification database.
3. Provide on the label (or on a prominently located second label) all required routine maintenance action (per manufacturer). Label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

E. Valve Tags

1. All valves on pipes of every description shall have numbering tags. The valve numbers shall correspond with numbers indicated for valves and controls on two-printed Valve Lists prepared using electronic database by the HVAC Subcontractor. These printed lists shall state the numbers and locations of each valve and control and the section, fixture or equipment which it controls, and other necessary information, such as requiring the opening or closing of another valve when one valve is to be opened or closed.
2. Provide flow diagrams showing all valves. Use the Valve List for callouts of all valves on the flow diagrams, prepared in a form to meet the approval of the Architect. Include this info in the operating and maintenance (O&M) manuals, and, for all mechanical rooms, provide the information laminated, mounted and framed under glass at the direction of the Owner. All valve interior diameters shall be shown in the O&M manuals and on the final Record Drawings.
3. Valve tags shall have neat circular black and white laminated fibre-engraved white showing through tags of at least 1 ½ inch in diameter, attached with a brass hook to each valve stem. Stamp on these valves tags in letters, as large as practical, the number of the valve and the service such as indicated on the "Valve List". The numbers on each service shall be consecutive. All valves on tanks and pumps shall be numbered by three (3) inch black and white laminated fibre-engraved white showing through discs with white numbers two (2) inches secured to stem of valves by means of brass hooks or small solid link brass chain.

3.5 PIPING

A. General

1. Piping shall be cut accurately to measurements established at the jobsite, shall be installed without cold springing, and shall properly clear windows, doors and other openings and electrical gear. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Piping shall be free of burrs, oil, grease, and other foreign matter. Piping shall be installed to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings. Vent pipes shall be carried through the roof and shall be properly flashed.
2. Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. A waterproofing clamping flange shall be installed as indicated. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its specified wall, floor, or roof, and shall be cut flush with each surface, except that sleeves through floors and roofs shall extend above the top surface at least six (6) inches for proper flashing or finishing. Membrane clamping rings

shall be provided where membranes are penetrated. Unless otherwise indicated or required by the sealing system, sleeves shall be sized to provide a minimum clearance of 1/4 inch between bare pipe and sleeves or between jacket over insulation and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall be galvanized steel pipe. Sleeves in nonbearing walls, floors, or ceilings may be galvanized steel pipe or galvanized sheet metal with lock-type longitudinal seam. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in non-fire rated walls, partitions, and floors shall be sealed as indicated and specified. Metal jackets shall be provided over insulation passing through exterior walls, fire walls, fire partitions, floors, or roofs, shall not be thinner than 0.006 inch thick aluminum, if corrugated, and 0.16 inch thick aluminum, if smooth, and shall be secured with aluminum or stainless steel bands not less than 3/8 inch wide and not more than eight (8) inches apart. When penetrating roofs, before fitting the metal jacket into place, a 1/2-inch wide strip of sealant shall be run vertically along the inside of the longitudinal joint of the metal jacket from a point below the backup material to a minimum height of thirty-six (36) inches above the roof.

3. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the backup material to a minimum distance of two (2) inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point twelve (12) inches above floor; or when passing through walls above grade, jacket shall extend at least four (4) inches beyond each side of the wall.
4. Pipes Passing through Waterproofing Membranes: In addition to the pipe sleeves referred to above, pipes passing through roof or floor waterproofing membranes shall be provided with a 16 ounce copper flashing, each within an integral skirt or flange. Flashing shall be suitably formed, and the skirt or flange shall extend not less than eight (8) inches from the pipe and shall set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing shall extend up the pipe a minimum of ten (10) inches above the roof or floor. The annular space between the flashing and the bare pipe or between the flashing and the metal-jacket-covered insulation shall be sealed as indicated. Pipes passing through roof or floor waterproofing membrane shall be installed through a galvanized steel sleeve. The annular space between pipe and sleeve or conduit and sleeve shall be sealed by a modular mechanical-type sealing assembly (equal to Link-Seal). The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide a water-tight seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor shall provide sleeves of the proper diameters and gauge.

B. Water Piping:

1. Unless otherwise indicated, horizontal water piping shall pitch down in the direction of flow with a grade of not less than one (1) inch in 40 feet and condensate drain piping shall pitch down in direction of flow with a grade of not less than one (1) inch in ten (10) feet. Unless otherwise detailed, horizontal

reducers shall be the eccentric type, flat on bottom (FOB), to allow for complete drainage. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated.

2. Unless otherwise allowed in Part 2 Piping and Fittings, or shown on the drawings, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe two (2) inches or less in diameter and with flanges or grooved joint couplings for pipe 2-1/2 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric waterway as specified in the Part 2 Piping and Fittings section of this specification. Where the temperature or pressure of the system is beyond the waterway limits, dielectric couplings or other approved methods shall be used. Reducing fittings shall be used for changes in pipe sizes.
3. Pipe joints between sections of pipe shall be as listed in the Part 2 Piping and Fittings section in the Schedules for Piping and Fittings tables. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded, soldered or brazed. Some joint types or materials listed may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.
4. Welded joints shall be fusion welded in accordance with ASME B31.1 for all water piping over 160 PSIG and any other piping where B31.1 is required. All other piping shall be welded in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.
 - a. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
 - b. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
 - c. Erection: Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to within 100°F of the system's maximum design temperature for a distance of three (3) feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 200°F of the maximum design temperature.
 - d. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with the applicable standard: ASME B31.9 or B31.1.
 - e. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding

properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.

5. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.
6. Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with Teflon (polytetrafluoroethylene) tape or equal. Teflon tape shall be non-toxic and rated for piping systems with temperatures to at least 450°F and pressures to at least 1,000 PSIG. Tape shall be applied the male threads only, and in no case to the fittings.
7. Malleable iron pipe press fittings equal to IMS Fastlock may be used (where allowed in the Part 2 Piping and Fittings section of these specifications) and shall be installed in accordance with the manufacturer's guidelines and recommendations. Pipe shall be certified for use with the IMS Fastlock system. Pipe shall be square cut, properly deburred, and cleaned. Pipe ends shall be marked at the required location to ensure full insertion into the coupling or fitting during assembly. Use an IMS Fastlock approved tool with the proper sized jaw for pressing. Prior to putting the system into operation, Contractor shall perform an air pressure test to provide quick and easy identification of connections which have not been pressed.
8. Grooved joint piping systems may be used (where allowed in the Part 2 Piping and Fittings section of these specifications) and shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. Provide all additional hangers required by the system (at least one hanger per flex coupling) where expansion joints are used. A factory trained field representative (a direct employee) shall provide on-site training to Contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
9. Soldered and Brazed Joints: Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Changes in direction of piping shall be made with soldered or brazed fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder, or as specified in the Part 2 Piping specification for the system. Cored solder shall not be used. Joints for brazed fittings shall use brazing alloys with strength equal to B-Ag alloy and have a melting point above 1000°F. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Care shall be taken to ensure solder is uniformly (360 degrees) drawn into the joint.

10. Viega ProPress press fittings may be used where allowed in the Part 2 Piping and Fittings section of these specifications. Prepare copper tube and install in strict accordance with manufacturer's installation instructions. Pipe ends shall be cleaned, free from indentations, projections, burrs and foreign matter. Use a tube preparation tool as supplied by manufacturer to clean and make installation mark. Push copper tube into fittings to installation depth mark, per manufacturer's installation instructions. Keep fittings free of dirt and oil. Prior to putting the system into operation, Contractor shall verify all connections have been properly pressed.
11. Vic Press 304™ or ProPress stainless steel crimped joints may be used where allowed in the Part 2 Piping and Fittings section of these specifications. Install in strict accordance with manufacturer's installation instructions. Pipe shall be certified for use with the system manufacturer. Pipe shall be square cut, properly deburred, and cleaned. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly. Use a system manufacturer's recommended tool with the proper sized jaw for pressing. Prior to putting the system into operation, Contractor shall verify all connections have been properly pressed.

C. Steam Piping

1. Unless otherwise indicated, horizontal steam piping shall pitch down in direction of flow with a grade of not less than one (1) inch in twenty (20) feet, and steam condensate piping shall pitch down in direction of flow with a grade of not less than one (1) inch in ten (10) feet. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated.
2. Unless otherwise specified or shown, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe two (2) inches or less in diameter and with flanges for pipe 2-1/2 inches or more in diameter. Reducing fittings shall be used for changes in pipe sizes. In horizontal steam and steam condensate pipes, reducing fittings shall be the eccentric type to keep the pipes flat on bottom (FOB). Vertical reducers can be the concentric type.
3. Pipe joints between sections of pipe shall be as listed in the Part 2 Piping and Fittings section in the Schedules for Piping and Fittings tables. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded. Some joint types or materials listed may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded. Grooved mechanical joints shall not be used.
4. Welded joints shall be fusion welded in accordance with ASME B31.1 for steam boiler external piping over 15 PSIG, all steam and condensate piping over 150 PSIG or 366°F, and all water piping over 160 PSIG, any other piping where B31.1 is required. All other piping shall be welded in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.
 - a. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame

- cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
- b. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
 - c. Erection: Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to within 100°F of the system's maximum design temperature for a distance of three (3) feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 200°F of the maximum design temperature.
 - d. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with the applicable standard: ASME B31.9 or B31.1.
 - e. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.
5. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall be rated for the maximum pressure with at least a 100 PSI safety factor and for the maximum temperature with a 50°F safety factor. contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, control valves, and other similar items.
6. Threaded joints can be used in systems that will not exceed 450°F and shall be made with tapered threads properly cut and shall be made perfectly tight with a 500°F rated non-hardening, non-toxic, self-lubricating, heavy duty pipe thread paste equal to TFT™ Pipe Thread Sealant w/PFTE (as manufactured by Anti-Seize Technology) applied to the male threads only, and in no case to the fittings.

D. Refrigerant Piping

1. Flared, Soldered and Brazed Pipe and Tubing: Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation shall be made in accordance with the manufacturer's recommendations. Changes in direction of piping shall be made with flared, soldered, or brazed fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder. Cored solder shall not be used. Joints for brazed fittings shall use brazing alloys with strength equal to B-Ag alloy and have a melting point above 1,000°F. Flared-tube joint fittings conforming to ASME B16.26 and ASTM B62 may be

used at equipment connections where operating pressures allow. Joints for flared fittings shall be of the compression pattern.

2. Welded Steel Piping: Joints shall be welded in accordance with ASME B31.5. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Unless otherwise detailed, horizontal reducers shall be eccentric, flat on bottom (FOB) type, to allow complete drainage of the refrigerant oil.
 - a. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.
 - b. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.
 - c. Erection: Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to within 100°F of the system's maximum design temperature for a distance of three (3) feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 100°F of the maximum design temperature.
 - d. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with ASME B31.5.
 - e. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.6 FIRE STOPPING INSTALLATION

- A. Install fire stopping assembly at locations shown and as specified in accordance with UL FRD systems or FM P7825 designs, and as recommended by manufacturer. Do not cover or enclose fire stopped areas until approved by the Owner's Representative.
- B. Completely fill openings around penetrating items with fire stopping material to prevent spread of fire in the following locations:
 1. Around duct, cable, conduit, piping, and their supports that penetrate fire-rated above grade floor slabs, interior partitions, and exterior walls.
 2. Around openings and penetrations through fire-rated ceiling assemblies.
 3. Around penetration of vertical fire-rated service shafts.
 4. Around openings and penetrations through fire-rated enclosures.
 5. Other locations indicated.

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6. At all air barrier penetrations as defined in the State's Energy Code.
 - C. Completely fill voids flush with the surface; the depth of material shall be in accordance with UL FRD or FM P7825. Fire stopping for filling voids in floors in which smallest dimension of a void is four (4) inches or more shall support the floor design load or be protected by a permanent barrier. Damaged, disrupted, or removed fire stoppings shall be replaced with new fire stoppings as specified in this section.
 - D. Insulated Pipes and Ducts: Cut and remove thermal insulation where pipes or ducts pass through fire stoppings. Replace thermal insulation with a material having equal thermal insulating characteristics and equal fire stopping characteristics.
 - E. Wall and Floor Penetration by Plastic Drain, Waste, and Vent Pipes: A 2 hour fire resistive chase enclosure shall be maintained by encasing the pipe in an eighteen (18) inch steel sleeve and penetrating the chase at a 45 degree downward angle. Chases shall be fire stopped at each floor.

3.7 CONNECTIONS TO EQUIPMENT

- A. Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

3.8 BRANCH CONNECTIONS

- A. Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

3.9 RISERS

- A. The location of risers is approximate. Exact locations of the risers shall be as approved. Steam supply risers shall terminate in a dirt pocket and shall be dripped through a trap to the return line.

3.10 SUPPORTS

- A. Hangers used to support piping two (2) inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.
- B. Piping and attached valves shall be supported and braced to resist seismic loads as specified under the SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT section. Structural steel required for reinforcement to properly support

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piping, headers, and equipment, but not shown, shall be provided under this section. Material used for supports shall be as specified under the STRUCTURAL STEEL section.

1. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under the STRUCTURAL STEEL section. Pipe hanger loads suspended from steel joist panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.
 2. Multiple pipe runs on a common base member shall be supported by clamps where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.
- C. Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:
1. Types 5, 12, and 26 shall not be used.
 2. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.
 3. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.
 4. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
 5. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.
 6. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
 7. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe four (4) inches and larger.
 8. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over one (1) foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.
 9. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, except that pipe shall be supported not more than eight (8) feet from end of risers, and at vent terminations.
 10. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping four (4) inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under four (4) inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least four (4) inches, or by an amount adequate for the insulation, whichever is greater.

11. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.
- D. Piping in trenches shall be supported as indicated on drawings and as required by the manufacturer.
- E. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.11 STRAINERS

- A. Provide a full size strainer on the inlet side of each modulating automatic control valve over one (1) inch, pump, and elsewhere as shown on the drawings and details. Full pipe size (non-reducing) suction diffusers may be substituted for pump suction strainers.
- B. Each strainer shall be provided with a full size blow down valve located six (6) inches to twelve (12) inches below the strainer. Blow down connection shall be as the low point of the strainer.
- C. Horizontal strainers in steam piping shall be rotated horizontally to avoid having a low point where condensate can collect. If this is not practical, provide a removable steam trap assembly for the strainer's blow down connection.
- D. Strainer shall have stainless steel screens with maximum 1/8 inch perforations (for pumps). Minimum perforations shall be 3/32 inch.

3.12 GAUGES AND THERMOMETERS

- A. Pressure Gauges
 1. Provide at the following locations:
 - a. At the discharge connection of each pump as well as the inlet and outlet of each pump suction diffuser or strainer.
 - b. At inlet and outlet of each chilled and hot water heating coil (except fan coils, reheat coils, and unit type heaters).
 - c. At inlet and outlet of each heat exchanger.
 - d. In addition to the above, as indicated on diagrams.
 2. All gages shall be provided with isolation valves. Snubbers shall be provided on all pressure gauge connections.
 3. Gauges on piping in the Mechanical Room shall be so placed as to be easily read from the floor without parallax.
- B. Thermometers, Wells, and Pressure/Temperature Plugs
 1. Provide, where shown on the drawings and where specified herein. Thermometers located over seven (7) feet above floor shall be remote bulb type.

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2. All thermometer wells shall be installed in such a manner that a minimum of restrictions will be caused to the flow in the pipes and so the thermometers can be easily read from the floor. For piping under three (3) inches, wells shall be installed at a 45° angle in the piping.
3. Pressure/temperature plugs (P/T plugs) shall be installed at:
 - a. Inlet and outlet of each strainer (that does have a pressure gauge), control valve (that doesn't have either a pressure gauge or integral P/T plus), duct mounted coil, unit heater, cabinet unit heater, fan coil unit, and unit ventilator.
 - b. Elsewhere as indicated on drawings.
4. Thermometers shall be permanently installed at:
 - a. Water inlet and outlet of each chiller, heat exchanger, and air handling unit water coils.
 - b. Elsewhere as indicated on drawings.
5. Additional thermometer wells shall be installed at each point of temperature sensing and control (coordinate with ATC contractor and control drawings).

3.13 ANCHORS AND GUIDES

- A. Anchors and guides shall be provided where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed using turnbuckles where required. Supports, anchors, guides, or stays shall not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

3.14 PIPE EXPANSION

- A. The expansion of supply and return pipes shall be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated or as required.
 1. Expansion Loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops shall be cold-sprung only where indicated or required. Pipe guides shall be provided as indicated and as required.
 - a. Expansion loops in grooved piping systems shall utilize flexible couplings. Rigid couplings shall not be used. Hanging guidelines shall conform to either manufacturer's published suggested spacing guidelines; or the requirements of the pipe hanger of this specification; whichever is more stringent.
 2. Joints of the type specified shall be used for steam and low temperature water systems and shall be installed where indicated. The joints shall provide for either single or double expansion of the connected pipes as indicated and for the traverse indicated. The joints shall be designed for a working temperature and pressure suitable for the application and in no case less than 125 PSIG. The joints shall be in accordance with applicable requirements of EJMA-01 and ASME B31.1. End connections shall be flanged or grooved. Anchor bases or support bases shall be provided as indicated or required. Initial setting shall be made in accordance with the manufacturer's recommendations to allow for

ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but in any case shall be not more than 5 feet from expansion joint, except in lines four (4) inches or smaller where guides shall be installed not more than two (2) feet from the joint.

3.15 VALVES AND EQUIPMENT ACCESSORIES

- A. Valves shall be of the type and construction specified for the service and installed at the locations shown or specified, and where required for the proper functioning of the system as directed. Valves shall be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping shall have threaded or flanged ends and threaded or sweat-type connections for copper tubing. Non-flanged valves shall have unions for ease of maintenance.
- B. Gravity flow-control (check) valves to control the flow of water shall be installed where specified or indicated on the drawings. The valve shall operate to prevent reverse flow and so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve shall be constructed with a cast iron body and shall be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve shall be designed for the intended purpose, and shall be installed as recommended by the manufacturer.
- C. Relief valves shall be installed where specified or indicated on drawings. Every closed loop piping system shall have system relief valve(s). For glycol systems, discharge shall be piped for gravity flow into a funnel to the glycol fill tank.
- D. A thermometer well (or Pete's plug) shall be provided in each return line for each circuit in multicircuit systems.
- E. All branches from main piping (including mains that serve different wings or buildings) shall be provided with isolation valves.
- F. Air vents shall be installed where indicated, and on all high points and piping offsets where air can collect or pocket.
 - 1. Water air vents shall be high capacity type, automatic or manual, as specified and shown on drawings. For glycol systems, discharge shall be piped for gravity flow into a funnel to glycol fill tank.
 - 2. Steam air vents shall be a quick-acting thermostatic valve that continuously removes air. Valve shall be constructed of corrosion-resisting metal, and be designed to withstand the maximum piping system pressure, and shall automatically close tight to prevent escape of steam and condensate. Vent shall be provided with a manual isolation valve. A vent shall be provided at all locations shown on drawings.

3.16 UNIT HEATERS

- A. Unit heaters shall be installed as indicated and in accordance with the manufacturer's instructions.

3.17 COOLING SYSTEMS INSTALLATION

- A. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for condensers, pumps, cooling towers, chillers and similar items. All rotating equipment shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a four (4) inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three (3) times the weight of the components, pump, base plate, and motor to be supported. Isolators shall provide at least 90% isolation efficiency at all speeds. Pipes connected to isolation mounted equipment shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.
- B. Refrigerant Piping and Charging
1. Pipe sizing on drawings is approximate, confirm and provide all pipe sizes as recommended by unit manufacturer based on actual field routing. Provide bypass circuits, control equipment, any recommended double suction risers, traps, appurtenances, and any hot gas bypass and reheat piping as recommended sized and diagrammed by the unit manufacturer. Install refrigerant piping per manufacturer's best recommended practice and layout and test pipe for leakage. Submit piping diagram (with all recommended components) along with calculations and sizing charts for engineer's review.
 2. Initial Charge: Upon completion of all the refrigerant pipe tests, add the required charge of refrigerant and oil for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, any service valve seal caps and blanks over gauge points shall be installed and tightened.
 3. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.
 4. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 oz. of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.
- C. Oil Charging: Except for factory sealed units, two (2) complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the

performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

3.18 FIELD PAINTING AND COATING

- A. Except as otherwise specified, ferrous metal shall be cleaned, prepared, and painted as specified in the PAINTING section. Exposed pipe covering shall be painted. Aluminum sheath over insulation shall not be painted unless otherwise noted.

3.19 HYDROSTATIC TESTS

- A. Prior to flushing and cleaning and before the application of any insulation, hydrostatic tests shall be made in accordance with applicable ASME requirements. Coordinate with Owner's Representative for witnessing of tests. Test reports shall be submitted to the Engineer and Owner's Representative. The systems shall be proved tight for four (4) hour tests (with no loss in pressure) under gauge pressures of 1-1/2 times the working pressure specified, but not less than the following:

1. Water piping (including pumped steam condensate)	150 PSI
2. Low-pressure steam and condensate lines	50 PSI
3. Medium-pressure steam and condensate lines	100 PSI
4. High-pressure-steam, feed and condensate lines	200 PSI
- B. Retesting: If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional costs to the Owner.

3.20 PIPING SYSTEM, CLEANING AND FLUSHING

- A. Supply all materials, labor and power required for cleaning and flushing. Cleaning shall be started only after all piping has been successfully hydrostatically tested and all systems have been completely connected up.
- B. Piping Cleaning and Flushing
 1. Exercise every precaution to avoid introducing foreign matter such as welding beads and slag or dirt into the piping system. All completed welds shall be hammered to loosen debris. All piping, valves and fittings shall be internally cleaned of oil, grease or dirt, prior to assembly into system by use of wire brush and swab.
 2. All cleaning and flushing work shall be coordinated with and supervised by the Water Treatment Sub Subcontractor for chemicals and procedures to be followed. See the Water Treatment section of these specifications.
 3. Following the successful testing of the piping systems, they shall be cleaned under the supervision of the Water Treatment Sub Subcontractor.
 4. Before submitting piping systems for acceptance, all strainers shall be inspected and thoroughly cleaned.
 5. Cleaning shall be started only after all piping has been hydrostatically tested and all systems have been completely connected up.
 6. Operate pumps or provide other means of circulating water throughout system for period of eight (8) hours. At the end of circulation, remove and clean all strainer baskets and blow off all low points.

3.21 REFRIGERATION SYSTEMS TESTS

- A. Field tests shall be conducted in the presence of the Owner's Representative. Electricity required for the tests will be furnished by the Owner. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Reports shall be on industry standard forms. Submit test reports to the engineer and Owner's Representative.
- B. Refrigerant Pipe Testing (Packaged Equipment Piping)
 - 1. After all components of the refrigerant systems have been installed and the piping connected, each system shall be subjected to refrigerant leakage tests. The refrigerant leakage tests shall be done before any refrigerant pipe is insulated or covered. The first test shall be done after charging the system to half normal operating pressure. All piping shall then be test for leakage using electronic leak detectors. Fix any leaks found and retest until there are no more leaks.
 - 2. The final test of the high and low side of the refrigerant system shall be tested for the minimum refrigerant leakage test pressure specified in ASHRAE 15, for the refrigerant used. System shall be proved tight and free of leaks by allowing the refrigerant leakage test pressure to remain on the system for a minimum of twelve (12) hours with no drop in pressure.
 - 3. Leaks, damage, and defects discovered or resulting from testing shall be repaired or replaced to like-new condition with acceptable materials. Tests shall be continued until systems operate without leaks or repairs. When the final test is successful, the refrigerant levels shall be set at manufacturer's recommended pressures.

3.22 DUCTWORK

- A. Installation shall be according to the standards referenced in PART 2 for the system. Duct supports for sheet metal ductwork shall be according to THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995, unless otherwise specified. Friction beam clamps indicated in THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995 shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.
- B. Dust Control: To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return and exhaust) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.
- C. Power Roof Ventilator Mounting: Foamed 1/2 inch thick, closed-cell, flexible elastomer insulation shall cover width of roof curb mounting flange. Where wood nailers are used, holes shall be pre-drilled for fasteners.

- D. Power Transmission Components Adjustment: V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after seventy-two (72) hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50% of manufacturer's maximum allowable range of misalignment.

3.23 DUCTWORK LEAKAGE TEST

- A. Ductwork leakage tests shall be performed for all duct systems (supply, return, outdoor and exhaust air systems, including fans, coils, etc.) that are designated as Static Pressure Class three (3) inch water gauge or greater and all ductwork located outdoors. See Ductwork Pressure and Seal Class table on drawings for scope. Test procedures, apparatus, and reports shall conform to the SMACNA Leakage Test Manual using the maximum static pressure design for each duct system. The maximum allowable leakage rate is defined by the specified SMACNA Static Pressure and Seal Classes. Ductwork leak tests shall be completed with satisfactory results prior to applying insulation to ductwork exterior. Submit test reports to engineer and Owner's Representative.

3.24 AIR AND HYDRONIC SYSTEMS BALANCING

- A. General Requirements
 - 1. The Contractor shall select AABC MN-1, NEBB-01, SMACNA-07 or ASHRAE 111 as the standard for providing testing, adjusting and balancing (TAB) of air and hydronic systems. The selected standard shall be used throughout the project. Testing, adjusting, and balancing shall be accomplished by a firm certified for testing and balancing by Associated Air Balance Council (AABC), Testing, Adjusting, and Balancing Bureau (TABBB), National Environmental Balancing Bureau (NEBB), or National Balancing Council (NBC).
- B. Prior to testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Approved detail drawings and all other data required for each system and/or component to be tested shall be attached to system flow diagram documentation.
- C. The Contractor shall verify that all balancing devices required during the field coordination phase and confirm during the construction phase that they are properly installed to permit testing, adjusting and balancing and that all duct leakage tests have been completed prior to testing, adjusting and balancing. The dampers used for balancing shall be remote from the diffusers and registers, unless the registers are directly attached to the mains. The Owner's Representative shall be notified in writing of all equipment, components, or balancing devices, that are damaged, incorrectly installed, or missing, as well as any design deficiencies that will prevent proper testing, adjusting, and balancing. Testing, adjusting, and balancing shall not commence until approved by the Owner's Representative. Instrumentation accuracy shall be in accordance with the standard selected in this paragraph.
 - 1. The HVAC Subcontractor as a part of his contract shall provide all materials, labor and service of all Subcontractors for fulfillment of air and water balancing of all systems. The TAB Sub Subcontractor shall inform the HVAC Subcontractor of all requirements ahead of time.
 - 2. Provide additional sheaves and belts required to reach design CFM levels.

3. In addition to the procedures outlined in this specification section, the procedures used for air, hydronic and temperature balancing shall also be in conformance with the "Procedural Standards for Testing, Adjusting, Balancing of Environmental System", seventh (2005) edition published by the National Environmental Balancing Bureau, the "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", fifth edition published by the Associated Air Balance Council or the Practical Standards and Procedures published by Testing, Adjusting, and Balancing Bureau or the National Balancing Institute.
4. A copy of the standards must be maintained on site by the Balancing Subcontractor at all times. The test report forms shall comply with the formats listed in these standards.

D. Recording of Existing Airflows

1. Prior to demolition, where shown on the drawings, take and submit flow readings and record existing volume damper positions for all existing air inlets and outlets, volume boxes, and air handlers along with static pressure readings with the systems set to full design airflow per this balancing spec. Include filter pressure drop and fan speed data. After new work is completed and balanced, rebalance all existing and new air inlets and outlets to their new or original airflows (as shown). Adjust existing volume boxes and air handlers as necessary to accommodate new and existing layouts.

E. Instrument Accuracy Requirements

1. All instrumentation shall be checked for accuracy before beginning testing, adjusting and balancing procedures. Instrument accuracy shall be in accordance with the standard selected in Paragraph A. General Requirements, immediately above. Checks may be carried out against similar equipment maintained specifically for checking purposes or by the manufacturer or a recognized testing facility. All instrumentation used for testing shall be calibrated within six (6) months of use. Pitot tubes and U-tube manometers do not require checking. In no case shall the instrumentation accuracy be less than specified by the instrument manufacturer. Any instrument falling out of calibration during the process of balancing and testing shall be recalibrated or removed from the site and replaced by a properly calibrated instrument. No instruments shall be allowed to remain on-site that are not in calibration.

F. Integral with the TAB standard followed, the TAB Contractor shall submit in the submittal phase the following documents:

1. Qualification data shall be submitted, sixty (60) days prior to testing and balancing operations. The test and balance firm shall be certified by the Associated Air Balance Council (AABC), the National Environmental Balancing Bureau (NEBB), Testing, Adjusting, and Balancing Bureau (TABB), or the National Balancing Council (NBC). The lead balancing technician shall be qualified by AABC, NEBB or NBC and his qualification data shall include past experience on at least five (5) similar projects. Provide proof of certification
2. TAB Plan and preliminary timeline.
3. Individual system one-line flow diagrams with pertinent data (i.e., static pressure, velocities, CFM, GPM, etc.) indicated on the applicable flow diagram for all components. Diagrams shall be made for each individual air and hydronic system.
4. Six (6) copies of a preliminary TAB report, thirty (30) days before balancing commences. The report shall be organized by specific systems and shall clearly

- identify each item of equipment to be tested, adjusted, and balanced. The appropriate test procedures and measurements to be taken for each item of equipment shall be listed. Instrument calibration records shall be provided on forms shown in AABC MN-1 or SMACNA-07. Manufacturer's specified accuracy shall be shown. The report shall include floor plan drawings showing all dimensions of ductwork, piping and their related measurement locations and types of measurements to be made. All related data necessary for testing, balancing, and adjusting, including fan and pump curves, actual and nameplate speeds, voltage and amp draw (each leg) shall be included. A system readiness checklist, similar to that shown in SMACNA-07, shall be included. The report shall contain a listing of the deficiencies of all systems to be tested, adjusted and balanced and the corrective action taken. The report shall contain a schedule for the final testing and balancing.
5. Six (6) copies of the final TAB report on forms shown in AABC MN-1, SMACNA-07, or equivalent forms from NEBB or NBC, within 2 weeks after completion of the test and balance operation. Data shall be in a hard bound cover identifying the project name, location, date of submittal, name of Contractor, and a general title indicating the specific area and type of work, and shall be signed by a registered professional engineer, employed by the test and balance firm, who has a minimum of two (2) years' experience in testing, adjusting and balancing work. The final report shall include a summary of the preliminary report describing test methods, test results, and major corrective actions taken. The report shall include as-tested floor plans showing all measurement locations and types of measurements made. The air handling unit data shall include a static pressure profile diagram, and pitot tube traverses where possible. The VAV terminal data shall include maximum and minimum air flows, for design and actual conditions, and shall be supported with summaries which show the air outlet totals for each VAV terminal and the VAV terminal totals for each air handling unit. Air distribution data shall include coded drawings which show the exact location of each air outlet. Pump data shall include pump efficiency. Data for chillers, heating and cooling coils, and heat exchangers, shall include heat balance calculations.
 6. All instruments that are recalibrated and brought back onto the jobsite after being found to be out of calibration shall have recalibration records submitted on forms shown in AABC MN-1 or SMACNA-07.
- G. The facility shall be essentially complete with final ceiling, walls, windows, doors and partitions in place. Doors and windows surrounding each area to be balanced shall be closed during testing and balancing operations. Air systems shall be complete and operable with balancing dampers, ducting, diffusers, returns, flow control boxes and control components in place. Exhaust fans and any hoods shall be operational. Hydronic systems shall be complete and operable with balancing valves, flow meters, coils, pumps, piping and control components in place. All measurements and adjustments shall be made using procedures described in standard selected in paragraph GENERAL REQUIREMENTS. Air motion and distribution from air terminals shall be as shown. All data including deficiencies encountered and corrective action taken shall be recorded. If a system cannot be adjusted to meet the design requirements, the Contractor shall promptly notify the Owner's Representative in writing.
- H. Air Systems: Each system shall be adjusted until all flow quantities (supply, return, exhaust/relief, and outdoor air) are within plus 10% and minus 5%. Dampers shall be checked for tight shutoff. Any air leakage around dampers shall be rectified. [Face and bypass dampers shall be set for air flow through coils.] [Multizone dampers shall be set for air flow through cooling coils.] Fire and smoke dampers shall be open. Fans shall be

checked for correct direction of rotation and proper speed shall be verified. Fire and smoke dampers shall be tested at system design air flow to ensure proper closure in accordance with NFPA 90A and manufacturer's instructions prior to building occupancy.

1. Filters: Clean filters shall be installed at the beginning of the testing, adjusting, and balancing effort. For constant volume air handling units (no VFD), simulate the filters as $\frac{1}{2}$ dirty by adding pressure drop (by temporarily adding cheese cloth or by other means). If the added P.D. is not listed in the schedules, confirm what to use with the engineer. For variable volume air handling units, simulate the filters as dirty (by temporarily adding cheese cloth or by other means). If the dirty P.D. is not listed in the schedules, confirm what to use with the engineer.
 2. General Balancing Methods: In addition to the requirements for specific systems, flows in supply, exhaust and return air systems shall be balanced using the methods in standard selected in paragraph GENERAL REQUIREMENTS. Throttling losses shall be limited. Air flow adjustments shall be made by first adjusting the fan speed to meet the design flow conditions. Fan speed adjustment may not be required for fan motors which are less than 746 W, (one horsepower,) or if throttling results in no greater than an additional 5% of the kw draw above that required if the fan speed were adjusted. If the excess draw causes the motor to enter its service factor, fan speed shall be reduced accordingly. Flows and pressures shall be checked in all main risers and supply ducts at all supply, exhaust and return fan discharges. All flows shall be recorded before and after each adjustment.
 3. Specific Systems All special or additional procedures for testing and balancing shall be in accordance with the applicable requirements of the standard selected in paragraph GENERAL REQUIREMENTS.
 - a. If a system has diversity (variable flow), only the required quantity of balanced terminals shall be opened to meet the design air flow. For terminal boxes/valves, readings shall include minimum, maximum, and heating primary air flows. Fan powered terminal units shall include the previously listed primary air flows and the fan air flow.
 - b. Balancing of differential airflow: For areas such as kitchens, laboratories, hospitals and cleanrooms, in addition to balancing the individual supply, return and exhaust airflows, the differential (supply CFM less return CFM) and where indicated the pressurization air (positive or negative differential pressures between rooms) MUST be maintained as shown on drawings for each room, tested with doors closed, and submitted. Where room differential pressure is called for, if the room's construction requires excessive airflow differential (beyond 10% for both supply and exhaust), the room will need to be sealed/weather-stripped by the GC or CM and the balancing repeated until all rooms are tight enough for work with the 10% tolerance.
- I. Hydronic Systems: All valves and control components shall be open or set as required for maximum system flow. Each system shall be adjusted until all flow quantities are within plus/minus 10%. Pumps shall be checked for proper speed. Pump activation signal and deactivation signal valves shall be verified. Pump motor current shall be checked at maximum design flow. Variable speed pumping systems shall be tested at a minimum of four (4) separate flow conditions to simulate design diversity.
1. General Balancing Methods: In addition to the requirements for specific systems, flows in piping, coils and other hydronic system components shall be balanced using the flow meter, balancing valve, equipment or pump curve methods in accordance with the applicable provisions of the standard selected in paragraph GENERAL REQUIREMENTS. Flows shall be balanced in all flow bypasses,

coils, heat exchangers, boilers, chillers, pump discharges and any locations where flow rate is indicated on drawings. Pressure taps on all pumps shall be made at factory suction and discharge tappings where available. All flows shall be recorded before and after each adjustment. Balancing is simplified where self-adjusting Pressure Independent Automatic Control Valves (PIACV) or flow limiting valves (Griswold type) are used, as the balancer only needs to set ("dial in") the flow and verify the valve flow setting on the device matches and is adjusted to the design equipment flow. If the PIACV or Griswold type device flow is not set to the equipment's design flow, obtain directions for setting the flow with the BAS contractor (for PIACV's) or mechanical contractor (for Griswold type devices) to make the adjustments required or, if the device can't be set properly to have the device replaced with the a device that will give the required flow. Once the device has been set to the correct flow, verify that the valve pressure drop is within the valve's control range per the manufacturer's procedures. Where PIACV's serve multiple coils, proportionally balance each coil to its percentage flow.

2. Specific Systems: Where specific systems require special or additional procedures for testing and balancing, such procedures shall be in accordance with the standard selected in paragraph GENERAL REQUIREMENTS. If a system has diversity, only the required quantity of wide-open terminals shall be used to meet the design water flow.
 - a. Primary-Secondary: Primary-secondary systems shall be treated as separate systems. Primary systems shall be balanced first with the secondary systems running. Secondary systems shall then be balanced.
 - b. Summer-Winter: Summer-winter systems shall be balanced in the summer mode of operation. Following completion of the summer-mode balancing, equipment used for winter operation shall be balanced.
 - c. Four-Pipe Systems: Four-pipe systems shall be considered as two (2) two-pipe systems, and balanced separately.
 - d. If a system has diversity (variable flow), only the required quantity of balanced coil control valves shall be opened to meet the design pump flow.

- J. Steam Coils and Heat Exchanger Balancing: Where multiple coils or HX are served by common steam control valves, adjust the globe balancing valves for equal flow to each coil/HX. For coils, verify this by equalizing the temperature profile of the leaving air so that the maximum variation is more than $\pm 10^{\circ}\text{F}$ from average over the coil's face area. Measure a minimum of one (1) temperature point per square foot of coil.

- K. Marking of Setting: Following final acceptance of certified reports by the Owner's Representative, the setting of all HVAC adjustment devices including valves, splitters, and dampers shall be permanently marked by the testing and balancing engineer so that adjustment can be restored if disturbed at any time.

- L. Marking of Test Ports: The testing and balancing engineer shall permanently and legibly mark and identify the location points of the duct test ports. If the ductwork has exterior insulation, these markings shall be made on the exterior side of the ductwork insulation. All penetrations through ductwork and ductwork insulation shall be properly sealed to prevent air leakage or loss of vapor barrier.

- M. Control Systems: Testing, adjusting, and balancing of the systems shall be coordinated with the control system installation. Work with the BAS Contractor for all balancing items shown on the control sequences such as airflow at air monitoring stations, outdoor airflow, and optimized set points for remote differential pressure sensors/transmitters

(DPT) used for control of VFD's. Set point for DPT's shall be optimized to the lowest pressure required to provide design flow to all downstream terminal units with at least one (1) unit's balancing device between 95% - 100% open on any of the terminal units on the pumping system. Where Pressure Independent Automatic Control Valves (PIACV) or self-adjusting flow limiting valves (Griswold type) are used, optimize DPT set points such that the valve's pressure drop is no more than 50% above the lowest pressure in the valve's control range (typically 5 to 6 PSID for PIACVs or 2 PSID for flow limiting valves). All control components shall be verified to be properly installed and operating as specified before proceeding with testing, adjusting, and balancing. Verification shall be in accordance with AABC MN-1.

1. Adjustment of the temperature controls shall be coordinated by the person in charge of the balancing and adjusting and shall be performed coincidental therewith. In conjunction with the Controls Contractor simulate a complete cycle of operation for each system.

3.25 INSTALLATION OF VARIABLE SPEED HEAT PUMP OUTDOOR UNITS

- A. Install condensing units on a flat surface level within 1/8 inch, and elevated a minimum of 18" from ground or roof surface. Provide intermediate supports as recommended by the equipment manufacturer.
- B. Provide all necessary control wiring as recommended by the manufacturer.
- C. High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.
- D. Contact local manufacturer's representative prior to installation to review and confirm piping layout and lengths.
- E. Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.
- F. Pressure test ALL systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.

3.26 INSTALLATION OF AIR HANDLING UNITS

- A. Examination
 1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 2. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
 3. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
 4. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Installation

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1. The mechanical contractor is responsible for submitting a plan and coordination drawings prior to beginning work in the mechanical rooms. Manufacturer shall review plan and approve.
2. Manufacturer shall coordinate with controls contractor to ensure the controls contractor is able to integrate the manufacturer's controls into the Owner's control system.

C. Startup Service

1. Factory-authorized service representative to perform startup service.
 - a. Complete installation and startup checks according to manufacturer's written instructions.
 - b. Verify that shipping, blocking, and bracing are removed.
 - c. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - d. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - e. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - f. Vibration Testing: Each fan shall be energized after field assembly and successful completion of dynamic assembly balancing for a thorough vibration analysis. Three (3) vibration readings shall be taken for each bearing in the horizontal, vertical, and axial directions. These vibration signatures shall be recorded and consist of vibration amplitude verses frequency. The maximum allowable fan vibration shall be 0.10 in/sec peak velocity (filter-in). Fan bearing measurement points shall be marked/scribed on bearings for permanent record and future use by Owner.
 - g. Perform a routine commercial test to demonstrate that the motors are free from mechanical and electrical defects. Routine tests shall be as listed in NEMA MG1 and shall be made in accordance with IEEE 112 and 114.
 - h. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - i. Comb coil fins for parallel orientation.
 - j. Install new, clean filters.
 - k. Verify that manual and automatic volume control and any fire and/or smoke dampers in connected duct systems are in fully open position.

D. Adjusting

1. Adjust damper linkages for proper damper operation.

E. Commissioning

1. Provide all test report and field inspection reports to commissioning agent.
2. Allow for two (2) full days of commissioning per air handling unit. Manufacturer's representative shall be required while unit is being commissioned.

3.27 BASES AND SUPPORTS

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- A. In addition to supports and hangers as mentioned in the MISCELLANEOUS METALS section, provide all bases and supports not part of the building structure, of required size, type, and strength, as approved by the Architect, for all equipment and materials furnished by him. All equipment, bases and supports shall be adequately anchored to the building structure to prevent shifting of position under operating conditions.
- B. All concrete foundations and all concrete supports will be provided by the General Contractor. The HVAC Subcontractor shall furnish shop drawings and templates for all concrete foundations and supports for setting all required hanger and foundation bolts and other appurtenances necessary for the proper installation of his equipment. All concrete work shall be shown in detail on the shop drawings prepared by the HVAC Subcontractor, and be submitted to the Architect, showing the complete details of all foundations, including the necessary concrete and steel work and vibration isolation devices.
- C. All floor-mounted equipment shall be erected on concrete pads over the complete floor area of the equipment, unless specified to the contrary herein.

3.28 WATERPROOFING

- A. Pipes passing through slabs shall have the sleeve extended $\frac{1}{4}$ inch above floors of finished spaces and two (2) inches above floors of mechanical equipment rooms. The space between the pipe and sleeve shall be sealed with interlinking seals equal to Link-Seal.
- B. Ducts through slabs shall have the sleeve extended $\frac{1}{4}$ inch above floors of finished spaces and two (2) inches above floors of mechanical equipment rooms. The space between the pipe and sleeve shall be caulked with lead wool. The top shall be sealed with lead and the bottom shall be sealed with monolastic caulking compound.

3.29 MISCELLANEOUS IRON AND STEEL

- A. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and firmly constructed.
- B. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be by experienced metal working mechanics. Members shall be straight and true and accurately fitted. Scale, rust, and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other trades as directed by them.
- C. Members shall be generally welded, except that bolting may be used for field assembly where welding would be impractical.
- D. All shop fabricated iron and steel work shall be cleaned and dried and given a shop coat of paint on all surfaces and in all openings and crevices.

3.30 PLACING IN SERVICE

- A. At the completion of performance tests and following approval of test result, recheck all equipment to see that each item is adequately lubricated and functioning correctly.
- B. Furnish upon completion of all work, certificates of inspections from the manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating conditions.

3.31 CLEANING AND ADJUSTING

- A. During the progress of the work, clean up and remove all oil, grease, and other debris caused by the work performed under this section.
- B. At the conclusion of the project, clean and repair all areas and finishes as installed or affected by this installation of work under this section.
- C. Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.
- D. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.
- E. Variable frequency drives (VFD) shall be adjusted and set-up to lock out any frequencies that cause a resonance or vibration. To test for this, slowly increase and decrease the speed between minimum and maximum while noting all frequencies that cause problems.

3.32 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. All operating equipment installed under this section shall be placed in operation and shall function continuously in an operating test for a period of one (1) week without shutdown due to mechanical failure or necessity of adjustment. Prior to scheduling the Project Final Inspection and after completion of all installation and running adjustments, the HVAC Subcontractor shall perform all work required to place the equipment in complete operating condition to meet all requirements under this specification.
- B. During this running test period, the HVAC Subcontractor shall deliver to the designated representative of the Owner, through the Architect, six (6) complete sets of operating, service and replacement data for all equipment which will require operating maintenance or replacement and one (1) copy of this literature shall be available during the instruction of the operating personnel while the other is checked for completeness by the Architect.

3.33 COMMISSIONING

- A. The contractor shall submit commissioning and commissioning plans including preliminary commissioning reports developed by a registered design professional or an approved agency in accordance with section C408.2 of the adopted edition of the International Energy Conservation Code. The same registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion to the professional engineer stamping the HVAC drawings in accordance with the provisions of the code sections.

3.34 TRAINING

- A. Conduct a training course for the maintenance and operating staff. The training shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the operating and maintenance instructions as well as demonstrations of routine maintenance operations. The Owner's Representative shall be given at least two (2) weeks advance notice of such training.
- B. During all working hours of the one (1) week operating test, the HVAC Subcontractor's instruction personnel shall be available for and provide thorough and detailed training to the Owner's operating and maintenance personnel in operation, maintenance and adjustment of all equipment installed. The instructions shall be videotaped by the Subcontractor. The master tape and one (1) copy shall be turned over to the Owner not more than ten (10) days following the completion of the training.
- C. Give sufficient notice to the designated operating personnel of the Owner in advance of this period. Upon completion of instruction, obtain from such representatives written verification on that which the above mentioned instruction has been performed, such verification to be forwarded to the Architect.
- D. Provide instruction time of forty (40) hours for systems and an additional forty (40) hours for ATC.

END OF SECTION 23 00 00

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SECTION 23 09 23

BUILDING AUTOMATION SYSTEM

(FILED TRADE SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General, Supplementary, and Special Conditions, Division 01 - General Requirements, Section 23 00 00 HVAC, and Division 26-Electrical, apply to work specified in this section. This Subcontractor is bound by the provisions of these Divisions and Sections and must familiarize himself with the terms of the above documents.
- B. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the Work of this Section.
- C. Time, Manner and Requirements for Submitting Trade Sub-Bids:
 - 1. Trade sub-bids shall be for the complete work under this Section and shall be filed in a sealed envelope and delivered to the Awarding Authority. At the designated time, trade bids will be immediately opened and read publicly. The following should appear on the upper left-hand corner of the envelope:
[JOB TITLE]
[NAME OF TRADE SUB-BIDDER]
SUB-BID FOR SECTION 23 00 00, HEATING, VENTILATING AND AIR CONDITIONING
 - 2. Trade sub-bids shall be accompanied by a bid bond, or cash, or certified check on, or a treasurer's or cashier's check issued to the trade bidder by a responsible bank or trust company, made payable to the Awarding Authority in the amount specified in NOTICE TO CONTRACTORS. A trade bid accompanied by any other form of bid deposit than those specified will be rejected.
 - 3. Each trade sub-bidder shall list in the "Form for Trade Bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which (the Section of the Specifications for that trade bid) requires such listing; provided that, in the absence of a contrary provision in the Specifications, any trade sub-bidder may, without listing any bid price, list his own name in said form for any such class of work or part thereof and perform that work with persons on his own payroll; if such trade sub-bidder, after trade bid openings, shows to the satisfaction of the awarding authority that he does customarily perform such class of work or the part thereof with persons on his own payroll and is qualified to do so.
- D. Trade Sub-Trade Requirements:

1. For the class of work listed below, the Trade Sub-Contractor's attention is directed to Massachusetts G.L. 149 Section 8(g)(6) and the Trade Contractor's Bid Form as amended, which provides in part as follows:
2. The names of all persons, firms and corporations furnishing to the undersigned labor or labor and materials for the class or part thereof of work for which the provisions of the section of the Specifications for this sub-trade require listing in this paragraph, including the undersigned if customarily furnished by persons on his own payroll, and in the absence of a customary provision in the Specifications, the name of each class of work or part thereof and the bid price for such class of work or part thereof is:

<u>Class of Work</u>	<u>Reference Specification</u>	<u>Paragraphs</u>
Automatic Temperature Controls	23 00 00	

E. Reference Drawings: The Work of this Trade Sub-Bid is shown on the following Contract Drawings:

1.	M-0.0	MECHANICAL LEGENDS NOTES, AND ABBREVIATIONS
2.	M-0.1	MECHANICAL NOTES
3.	MD-2.1	MECHANICAL GROUND FLOOR DEMO PLAN
4.	MD-2.2	MECHANICAL FIRST FLOOR DEMO PLAN
5.	MD-2.3	MECHANICAL SECOND FLOOR DEMO PLAN
6.	MD-2.4	MECHANICAL ROOF DEMO PLAN
7.	M-2.1	MECHANICAL GROUND FLOOR NEW WORK PLAN
8.	M-2.2	MECHANICAL FIRST FLOOR NEW WORK PLAN
9.	M-2.3	MECHANICAL SECOND FLOOR NEW WORK PLAN
10.	M-2.4	MECHANICAL ROOF NEW WORK PLAN
11.	M-6.0	MECHANICAL CONTROLS
12.	M-6.1	MECHANICAL CONTROLS
13.	M-6.2	MECHANICAL CONTROLS
14.	M-6.3	MECHANICAL CONTROLS
15.	M-7.0	MECHANICAL DETAILS
16.	M-7.1	MECHANICAL DETAILS
17.	M-8.0	MECHANICAL SCHEDULES
18.	M-8.1	MECHANICAL SCHEDULES
19.	M-8.2	MECHANICAL SCHEDULES

1.2 QUALIFICATIONS OF BIDDER

- A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 3 years.
- B. Bidder must have an office within 50 miles of the job site staffed with factory-trained engineers capable of trouble shooting and maintaining all systems for the project.
- C. All bidders must be authorized distributors or branch offices of the manufacturers specified.
- D. All bidders must have a trained staff of application engineers, who have been certified by the manufacturer in the configuration, programming and service of the automation system. The Installer shall have successfully completed the Control Systems Manufacturer's classes on the control system he is to install. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request. All systems design and programming shall be done by the bidder's staff and not subcontracted to a third party.

- E. Acceptable Vendors: The below listed vendors are acceptable providing they meet the requirements of these specifications. Any proposed deviations from these specifications or drawings shall be highlighted in the bid form or attached proposal and agreed to in writing by the Owner and Engineer prior to acceptance of the bid. No deviations will be allowed after that time. The BAS shall be by:
1. Alerton (BACtalk)
 2. Schneider Electric, Buildings Business (Andover, MA)
 3. Automated Logic
 4. Carrier (UT)
 5. Control Technologies, Inc.
 6. Delta Controls (GxP Automation)
 7. Honeywell International
 8. Invensys
 9. Johnson Controls
 10. Siemens
 11. Staefa (Talon)
 12. TAC Vista (FMC Technologies)
 13. Trane (Tracer Summit)
- F. The above list of manufacturers applies to operator workstation software, controller software, custom application programming language, Building Network Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.3 SCOPE OF WORK

- A. Except as otherwise noted, the control system shall consist of all Building Network Controllers, Custom Application Controllers, Application Specific Controllers, workstations, routers, software, sensors, transducers, relays, control valves, control dampers, valve and damper operators, control panels, and other accessory equipment to fully provide all required control functions. Provide a complete system of electrical interlock wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- B. The BAS contractor shall review and study all HVAC drawings and all mechanical and electrical specifications to familiarize him with all equipment and sequences. BAS contractor shall provide all the required quantities and types of devices necessary to completely perform all sequences, whether or not such devices are explicitly shown on

the drawings or specified. If any devices are not specified they shall be of the same high quality of specified components.

- C. The BAS contractor shall hire licensed electricians and shall provide all required interlock wiring and wiring of all control devices including sensors, control valves and damper actuators (including fire smoke dampers furnished and installed by the Section 23 30 00 Air Distribution Systems subcontractor), control panels, etc.). Scope of wiring includes the provision of additional required power wiring beyond what is shown on the electrical drawings. Any additional wiring required from electric panels shall be coordinated with the Division 26 electrical contractor and paid for by the BAS contractor. All wiring shall comply with the requirements of the electrical section of these specifications.
- D. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system and train the Owner's personnel. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications. The BAS contractor shall carry 40 [80] hours of additional on-site programming to allow for field modifications that may be needed to optimize the various systems to fully conform to the requirements of these specifications and work with the actual operating conditions as installed.
- E. The building is a LEED [WELL] design and contractor shall provide materials, equipment and required documentation to attain the points for this section of the specifications.
- F. The building is to be commissioned and contractor shall provide all labor required to fully test and demonstrate to the commissioning agent that all systems operate as designed.
- G. The Contractor shall furnish and install a complete building automation system including all necessary hardware, all BAS network wiring and component for a standalone operation without using the owner's network, and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. BAS network may be connected to owner's network (if allowed) for access to the Internet, but shall use the BAS network for all BAS operation so as not to slow down the owner's network. At a minimum, provide controls for the following:
 - 1. Graphics, reports, trending, alarms and occupancy (occupied, unoccupied and warm-up/cool-down) schedules as appropriate for all equipment.
 - 2. Interface with controls provided by equipment manufacturers.
 - 3. Supply, make-up air, and exhaust air handling units.
 - 4. Supply, exhaust and return air fans.
 - 5. Condensing units and condensers.
 - 6. Air-conditioning units.
 - 7. Heating and ventilating units.
 - 8. Heat pumps.
 - 9. Pumps.
 - 10. Boilers.
 - 11. Heat exchangers.
 - 12. Heat recovery systems.
 - 13. Hot water heating systems.
 - 14. Finned tube radiation and convectors.
 - 15. Variable volume and constant volume boxes/valves (including fan powered boxes) including heating coils.
 - 16. Cabinet and unit heaters.
 - 17. Carbon dioxide, carbon monoxide, and refrigerant detection.
 - 18. Filters.

19. Monitoring points for packaged equipment such as computer room units (via BACnet, Modbus or LonWorks), condensate/feed pumps, fuel oil pumps and tanks, chemical feed equipment, glycol feed pumps, fume hood monitors/alarms, etc.
 20. Interface with plumbing equipment for water heater combustion air damper interlocks and failure alarms such as water booster pumps, ejector pumps, etc.
 21. Monitoring points for fire alarm system signals, FOP (Firefighter's Override Panel) switches and pilot lights, etc.
 22. Monitoring points for building services such as steam pressure, generator status, electric usage and demand, gas meter, etc.
 23. Power and control wiring to all DDC devices, equipment interlocks, control valves and dampers, BAS panels, etc.
 24. All other equipment scheduled or shown on drawings
 25. Proposed acceptance testing plan, test forms, reports and narratives.
 26. All completed acceptance testing documentation. This is a separate submission prior to job completion.
 27. Subcontractor Project Completion Certificate for the control system. See Section 23 00 00 "Project Closeout" for requirements. This is a separate submission prior to job completion.
- H. Provide services and manpower necessary for testing of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative and in accordance with the acceptance testing plan and functional performance test narratives.
- I. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.4 SYSTEM DESCRIPTION

- A. The Building Automation System (BAS) shall consist of PC-based workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions. The intent is for the BAS to seamlessly connect devices throughout the building, regardless of sub-system type. Gateways shall not be used unless there is no other solution for systems integration.
- B. For this project the system shall consist of the following components:
1. Operator Workstation(s): The BAS Contractor shall furnish Operator Workstation Computers and printers as described in Part 2 of the specification. System monitoring and supervisory control shall be through the installation of graphical user interface (GUI) software applications through a fast interface/graphics sub-system. GUI workstations shall provide complete access to any point in the system at any time. Remote operator interfaces and configuration tools shall be supported in a client server fashion.
 2. Ethernet-based Building Network Control Units (BNCU): The BAS Contractor shall furnish Ethernet-based Building Network Controllers as described in Part 2 of the specifications. These controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to all Custom Application

- Controllers, Application Specific Controllers, Input/Output Modules, and serve as a communication link to equipment furnished by others (if applicable).
3. Custom Application Controllers (CAC):
 - a. Provide the necessary quantity and types of Custom Application Controllers to meet the requirements of the project for control of the designated mechanical equipment. All controllers shall be seamlessly integrated utilizing the same network and the same programming language.
 - b. Each controller shall be completely programmable and provide functionality based on I/O configuration rather than application. For example, the Custom Application Controllers shall have the ability to provide local lighting control.
 - c. Each CAC shall operate completely standalone, containing all of the I/O (including 15% spare points of each type) and programs to control its associated equipment.
 4. Application Specific Controllers (ASC):
 - a. Provide the necessary quantity and types of Application Specific Controllers to meet the requirements of the project for control of the designated equipment. All controllers shall be seamlessly integrated utilizing the same network and the same programming language.
 - b. Each ASC shall be capable of executing the required sequences of operation and provide the I/O point capacity and types as indicated on the drawings.
 - c. Each ASC shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
 5. Portable Computer and Service Tool: Provide one portable computer and one portable service tool for monitoring and testing of the BNCUs, CACs, and ASCs. The portable service tool will be for use by the balancing contractor. The Owner, upon completion of the project, shall retain the portable computer and service tool. If the BNCUs and CACs have integrated touch screen displays that allow the user to perform basic daily operations tasks, the service tool shall be returned to the BAS subcontractor upon completion of the project.
 6. WEB Server: The BAS shall function as a WEB server to allow an operator to view and/or modify any point in the system via the Internet and/or the Owner's Intranet (coordinate this with the Owner). HTML pages shall be capable of being accessed via any computer connected to the Internet and/or company Ethernet backbone via standard Internet browser software after confirmation of authorized user name and password. Provide a firewall for the BAS network. Systems requiring any version of the workstation software loaded on the accessing computer shall not be acceptable.
 7. Modem: Modems shall be furnished for remote interrogation of the system after confirmation of authorized user name and password. Modems shall operate at a minimum of 56.6 Kbaud and allow for access to the entire network of controllers.

1.5 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

- B. The BAS Contractor shall furnish all control dampers (not furnished by equipment manufacturers), control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor. These, as well as all actuators furnished with package equipment, all combination smoke/fire dampers furnished and mounted by Section 23 30 00 (Air Distribution Systems), all BAS panels and controls, shall be wired by the BAS Contractor.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - 1. Control dampers and valves.
 - 2. Blank-off plates for dampers that are smaller than duct size.
 - 3. Air and water flow monitoring stations.
 - 4. Sheet metal baffle plates to eliminate stratification.
 - 5. Location of all sensor wells and tapings in all piping and duct systems.
- D. The Electrical Contractor shall provide:
 - 1. All power wiring to HVAC equipment and motors, heat trace, and to junction boxes (for control power) in mechanical rooms as well as above the ceilings where control wiring is needed for terminal units at a spacing of every 100 sq. ft., and where showed on the electrical drawings. Where available, all control power shall be on the standby generator.
 - 2. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS contractor to hardwire to fan shut down and BAS alarm.
 - 3. Contact(s) from fire alarm system for opening of elevator shaft vent damper(s) for wiring by BAS contractor.
 - 4. Firefighter's Override Panel (FOP) with switches and pilot lights for wiring by BAS contractor to provide On-Off-Auto control of smoke control system(s) and air handling unit(s) including opening/closing the appropriate dampers and providing status through the pilot lights.
 - 5. Contact(s) from standby generator(s) for status of power (normal verses standby), day tank(s) and fuel oil pump set(s) for wiring to the control system by the BAS contractor.
 - 6. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWh and kW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.

1.6 CODE COMPLIANCE

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or wiring used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code and the Division 26 specifications – whichever is more stringent.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

- F. Comply with FCC, Part 68 rules for telephone modems and data sets.
- G. Components used for both HVAC and Smoke Management Systems shall be UL-864 listed and labeled. Components used for smoke control shall be supervised and listed for fire alarm service per NFPA. All such control panels shall be located in building life safety electric rooms, coordinate exact locations with the electrical contractor.

1.7 SUBMITTALS

- A. All shop drawings shall be submitted in electronic searchable PDF files. See Section 23 00 00 HVAC submittals paragraph for additional requirements. Upon request, NV5 will provide via email the floor plan drawings files for use by the BAS contractor. The drawings are diagrammatic and final floor plans and equipment locations are the responsibility of the BAS contractor.
- B. Shop drawings shall include a riser diagram and floor plans depicting locations of all controllers, routers, hubs, workstations, etc. with associated network architecture and wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. "Typicals" will be allowed where appropriate. Wiring diagrams detailing interconnecting devices such as fan and pump starters, freezestats, smoke detectors, relays, etc., shall be provided for each system. Written narratives for all sequences shall be included. Any deviations from the original design shall be highlighted. A "Bill of Materials" list shall be provided for each system indicating part numbers, descriptions, manufacturer, and quantities of each component utilized.
- C. Submittal data shall contain manufacturer's data sheets on all hardware and software products required by the specification and sequences. Valve, damper, and airflow station schedules shall indicate size, type, configuration, capacity, maximum pressure rating, pressure drop, maximum differential pressure shut-off capabilities, and name and location of all equipment served.
- D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, trends, alarms and configuration to be furnished with the workstation software. Provide complete information on user programming (commands, sequences, etc.). Information shall be bound or in a three ring binder with an index and tabs.
- E. Specifications, Sequences, and Schedule Compliance Statement
 1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph and with each sequence and any control components schedules shown on the drawings.
 2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in Part 2 and applicable Part 3 of the specification and all sequence items based on the sequences issued with the design drawings for which the submitted product complies, deviates, or does not meet.
 3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.
 4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
 5. If any associated schedules or sizing data on the drawings apply to these products, verify each field. Where the submitted material does not "comply"

- provide the value the submitted equipment will achieve based upon the specified conditions.
6. Submissions which do not include a point by point statement of compliance as specified shall be **disapproved**.
- F. Submit electronic searchable PDF files containing submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor shall check all documents for accuracy prior to submitting.
- G. The Engineer will make corrections, if required, and return submittal with any applicable comments to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- H. No work may begin on any segment of the project until submittals have been successfully reviewed for conformity with the design intent of the project.
- I. CAD layering standards for field coordination drawings (Division 23 & 26 requirement)
- J. Identification labels and tags, including database for equipment, valves, panels, and devices (Division 23 & 26).
- K. Proposed O&M table of contents.
- L. O&M Manuals.
- M. Startup and acceptance plan, narratives, test forms, and report containing all completed forms, and report of the required successful completion of the 30 day performance test.
- N. Training plan, documents, handouts, etc.

1.8 SYSTEM STARTUP AND ACCEPTANCE TESTING

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted (with copy to Owner's Representative) indicating that the installed system functions in accordance with the plans and specifications.
- B. The BAS contractor shall submit their acceptance testing plan, pre-functional performance test forms and narratives, and functional performance test forms and narratives. Unless a commissioning agent has been contracted the responsibility to facilitate the commissioning process, the BAS contractor shall be responsible for coordinating the attendees needed to demonstrate the sequence of operation performance to the Owner. The controls system will not be accepted without the prior acceptance of the submitted documents noted herein.
- C. The BAS contractor shall test and set in operating condition all equipment and systems. For major equipment such as chillers, boilers, and air handling units, this shall be done in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. Coordinate with all required attendees.

- D. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.9 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel using the BAS acceptance testing documents.
- B. On-site training shall also include a minimum of 40 hours of hands-on instruction geared toward the operation and maintenance of the systems. Prior to training, the necessary lesson plans, training documents, handouts, etc. shall be provided with the curriculum outline, which shall include as a minimum:
 - 1. System Overview.
 - 2. System Software and Operation.
 - 3. System Access.
 - 4. Software features overview.
 - 5. Changing set points and other attributes.
 - 6. Scheduling.
 - 7. Editing programmed variables.
 - 8. Displaying and editing color graphics.
 - 9. Running reports and trending.
 - 10. Workstation maintenance.
 - 11. Application programming.
 - 12. Operational sequences including start-up, shutdown, adjusting and balancing.
 - 13. Equipment maintenance.
- C. Classroom training will include a minimum of (2) training slots (for different weeks) for factory course material covering workstation operation and controller programming.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead time and expected frequency of use of each part clearly identified. These manuals shall be delivered to the Owner's representative within 3 months of the final approved submittals.
- B. Submit O&M table of contents in the submittal phase. O&M manuals shall be built as submittals are accepted and shall include the individual equipment manufacturer's data retrieval sheet, as per Attachment A in Part IV for input into the Owner's Maintenance Management System. Form shall be provided and completed electronically.
- C. Each O&M document shall include the manufacturer's web site-specific O&M address for Internet access by the facility operator.

- D. The manual shall consist of (3) sets of manuals and include (3) sets of searchable CDs or DVDs, which shall contain the scanned content of the entire manual. The manual shall be submitted for review prior to creation of the CDs or DVDs. The manual shall include manufacturer's Internet addresses for all equipment.
- E. The preventative maintenance shall include all tasking, frequency, and special instructions required for a proactive preventative maintenance action plan.
- F. Following project completion and testing, the BAS contractor shall submit "as-built" record drawings reflecting the exact installation of the system. The as-built documentation shall include a copy of all application software and graphics both in written form and on CDs or DVDs. Documentation shall also include all BAS controls and interfaces with equipment manufacturer's controls, including as-built manufacturer's controls and sequences of operation.

1.11 WARRANTY

- A. The BAS contractor shall warrant the entire system (parts and labor) for 18 [24] months after successful system acceptance testing is accepted by Owner's Representative. Beneficial use by the Owner may be an alternative method to begin the warrantee period (providing there is a minimum of 12 months left after successful system acceptance testing and system acceptance by Owner's Representative). Note that all control valves have longer warranties as indicated in the control valve specification paragraphs. During the warranty period, the BAS contractor shall be responsible for all software and hardware upgrades and revisions during normal workday schedule, and within 48 hours of notification if solution cannot be resolved via the remote or web-site connection, to provide and maintain complete and workable building control systems.
- B. Updates to the manufacturer's software shall be provided at no charge during the warranty period.

PART 2 - PRODUCTS

2.1 SYSTEM ARCHITECTURE

- A. General
 - 1. The Building Automation System (BAS) shall consist of Building Network Control Units (BNCU) and associated Input/Output Unit Modules (I/O, as applicable), Custom Application Controllers (CAC), Application Specific Controllers (ASC), and Operator Workstations (OW)/File Server. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN), if applicable, from a single ODBC-compliant database. The BAS shall have the capability to accommodate integration of and to other building sub-systems (fire alarm, security, card access, lighting, etc.) as indicated on the drawings and detailed in the specifications.
 - 2. Level 1 Network Description (BAS Network):
 - a. Level 1, the main backbone of the system, shall be an Ethernet (ISO/IEC 8802-3) LAN/WAN. Building Network Control Units and Operator Workstations/File Server shall connect directly to this network without the need for Gateway devices.
 - 3. Level 2 Network Description (Field Bus Level)

- a. Level 2 of the system shall consist of one or more field buses managed by the Building Network Control Units. The Level-2 field buses may consist of one or more of the following types:
 - 1) An RS-485 proprietary field bus (or “machine bus”) that supports up to 32 Input/Output Units (I/O) directly connected to a Building Network Control Unit. The I/O modules may be mounted within the BNCU or remotely mounted via a single twisted, shielded pair of wires.
 - 2) An RS-485 proprietary token-passing bus that supports a minimum 120 Custom Application Controllers or Application Specific Controllers.
 - 3) ANSI/ATA 878.1 Arcnet: Field bus utilizes RS-485 signaling. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).
 - 4) Master-Slave/Token Passing (ANSI/ASHRAE Standard 135-2001, BACnet): Field bus utilizes RS-485 signaling. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).
 - 5) EIA-709.1, LonTalk: Field bus utilizing LonTalk FTT-10a network protocol over twisted pair wiring. Both Custom Application Controllers and Application Specific Controllers may reside on this network bus (minimum of 60 devices).

- B. BAS Configuration
 1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single workstation/file server (10/100 megabits/sec Ethernet). This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.

- C. Standard Network Support
 1. All BNCUs and Workstations/File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the BNCU’s, Workstations/File Server shall be capable of using standard, commercially available, “off-the-shelf” Ethernet infrastructure components such as routers, switches and hubs. With this design the Owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems department as all devices shall utilize standard TCP/IP components.

- D. Remote Communications
 1. In addition to the above LAN/WAN architecture support, the same workstation software (front end) must be capable of managing remote systems via both the internet via WEB server capability and standard dial-up phone lines via modem as a standard component of the software.

- E. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. The BAS shall be expandable to interoperate with Lighting, Fire, Security and Access Control sub-systems at any time in the future utilizing "Open Protocol" standards such as ASHRAE/ANSI 135-2001 BACnet, EIA-709.1 LonTalk, or Modbus.
3. The system shall use the same application programming language or configuration software application for a given systems communications level controller (i.e. Operator Workstation, Building Network Control Units, Custom Application Controllers, and Application Specific Controllers).

F. Support For Open Systems Protocols

1. The BAS design shall include solutions for the integration of the following "open systems" protocols: ANSI/ASHRAE 135-2001 BACnet, EIA-709.1 LonTalk™, Modbus, OPC Client/Server, and digital data communication to third party microprocessors such as any equipment manufacturer's controllers and variable frequency drives (VFDs).
 - a. BACnet: The BAS shall, as a minimum, support the BACnet Interoperable Building Blocks (BIBBS) for Read (Initiate) and Write (Execute) Services as defined in the Data Sharing BIBBS as follows:

DS-RP-A, B
DS-RPM-A, B
DS-WP-A, B
DS-WPM-A, B
 - b. LonTalk: The BAS shall support LonTalk communications using FTT-10 transceivers. All communications shall follow LonMark standards utilizing approved Standard Network Variable Types (SNVTs) and Standard Configuration Parameter Types (SCPTs). LonMark components which do not have a standard applicable profile must comply with LonMark standards, and be provided with a XIF file for self-documentation.
2. The system shall also provide the ability to program custom ASCII communication drivers, residing in the BNCU, for communication to third party systems and devices. These drivers shall provide real time monitoring and control of the third party systems.

G. Controller Standby Power Requirements

1. For every controller, regardless of type, that controls any life safety or critical systems such as Smoke Control, Lighting Control, Security Control, and Telecom or that serves critical buildings such as Hospital, Labs, Police or Fire Stations, [and other], provide an uninterruptible power supply (UPS) system capable of operating the controller and all associated I/O modules, routers, repeaters, etc. for at least 20 minutes.
2. Wire all these devices with standby (not normal) power. Coordinate locations with electrical contractor.

2.2 BUILDING NETWORK CONTROL UNITS (BNCU)

- A. General: Provide Level 1 Building Network Control Units to provide the performance specified in Part 1 of this Section. Each of these panels shall meet the following requirements.
1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based BNCUs to manage the global strategies required by this project.
 2. The BNCUs shall have sufficient memory to support its operating system, database, a minimum of 3 days of buffer (for trending data), and programming requirements with 50% spare capacity.
 3. The BNCUs shall provide communications ports for connection of the Portable Computer and Portable Operators Terminal.
 4. The operating system of the BNCUs shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 5. All BNCUs shall have minimum 72 hour battery-backup for real time clocks.
 6. Data shall be shared between all BNCUs.
 7. Each BNCU shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Communications: Each Building Network Control Unit shall reside on the same Level 1 inter-network as the Workstations/File Servers. The network shall be on ISO 8802-3 (Ethernet) and support the Internet Protocol (IP). This network shall be provided by the BAS subcontractor and shall communicate with the Owner's network as defined by the Owner's IT department. Each BNCU shall also perform routing to a network of Level 2 Custom Application and Application Specific Controllers.
- C. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 2. Controllers used a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.
 3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- D. Serviceability: Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- E. Memory: The Controllers shall maintain all BIOS, memory, and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage. The Controllers shall contain surge protection and not require any external AC power signal conditioning.

2.3 CUSTOM APPLICATION CONTROLLERS (CAC)

- A. General: Provide Level 2 Custom Application Controllers to provide the performance specified in Part 1 of this Section. Each of these panels shall meet the following requirements.
1. The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based CACs to manage the local strategies required by this project.
 2. The CACs shall provide communications ports for connection of the Portable Computer and Portable Operators Terminal.
 3. The CACs shall have sufficient memory to support its operating system, database, a minimum of 3 days of buffer (for trending data), and programming requirements with 50% spare capacity.
 4. All CACs shall have at least 72 hour battery-backed real time clocks.
 5. The operating system of the CACs shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
 6. Each CAC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - a. Assume a predetermined failure mode.
 - b. Generate an alarm notification.
- B. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 2. Controllers used a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.
 3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- C. CAC Operator Display: A local operator display (similar to that specified for BNCUs) shall be provided on at least one CAC or BNCU at each control panel location. The operator display shall be provided for interrogating and editing data. A system security password shall be available to prevent unauthorized use of the keypad and display.
- D. Serviceability: Provide diagnostic LEDs for power, communications, and processor. All low voltage wiring connections shall be made such that the controller electronics can be removed and/or replaced without disconnection of field termination wiring.
- E. Memory: The Controller shall maintain all BIOS, memory, and programming information in the event of a power loss for at least 72 hours.
- F. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Controllers shall contain surge protection and not require any external AC power signal conditioning.

2.4 APPLICATION SPECIFIC CONTROLLERS (ASC)

- A. General: Provide Level 2 ASCs as required for this project. ASCs are microprocessor-based DDC controllers dedicated to control a specific piece of equipment. They shall be fully user programmable, initially set up to provide the specified sequences. Applications are limited to small HVAC equipment such as VAV and CV terminal units (including fan powered), Unit Ventilators, Heat Pumps, Fan Coil Units, etc.
1. Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - a. VAV and CV terminal unit controllers shall include damper actuators with minimum torque of 35 in-lb, with override for manual positioning during start-up and servicing. Velocity sensors shall have an accuracy of +/- 3% of full range.
 2. Each ASC shall contain sufficient I/O capacity (at least 1 spare point of each type), memory (at least 50% spare), and programming flexibility to control the target system and allow for future changes in programs remotely through the front end.
 3. The ASCs shall provide communications ports for connection of the Portable Computer and/or Portable Operators Terminal.
- B. Environment: The hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used indoors in a conditioned space (heated and cooled) shall be mounted in NEMA 1 type enclosures, and shall be rated for operation at 32 F to 104 F.
 2. Controllers used in a non-cooled interior space or outdoors shall be rated for operation at minus 20 F to plus 130 F, provide ventilation and/or heaters sized to meet these conditions.
 3. Controllers used outdoors and/or in wet locations shall be mounted within NEMA 4 type waterproof enclosures.
- C. Serviceability: Provide diagnostic LEDs for power and communications. All wiring connections shall be clearly labeled and made to be field removable.
- D. Memory: ASCs shall maintain all BIOS and programming information in the event of a power loss for at least 90 days.
- E. Immunity to Power and Noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%.
- F. Transformer: Power supply for the ASCs must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type with all wiring by the BAS subcontractor.

2.5 LIGHTING CONTROLLERS

- A. Lighting controllers shall provide direct control of 20 Amp, 277 VAC lighting circuits using mechanically held, latching relays. Controllers shall contain a minimum of 8 circuits per

enclosure. Each controller shall also contain inputs for direct connection to light switches and motion detectors.

- B. Each controller shall have the capability for time of day scheduling, occupancy mode control, after hour operation, alarming, and trending.

2.6 DISPLAY CONTROLLERS

- A. Display controllers are standalone, touch screen based operator interfaces. The controller shall be designed for flush mounting in a finished space, with a minimum display size of 9 x 9 inches.
- B. Software shall be user programmable allowing for custom graphical images that simulate floor plans, menus, equipment schematics along with associated real time point values coming from any BNCU on the network.
- C. The touch screen display shall contain a minimum of 64 possible touch cells that permit user interaction for changing screens, modifying set points or operating equipment.
- D. Systems that do not offer a display controller as specified shall provide a panel mounted computer with touch screen capability as an alternative.

2.7 COMMUNICATIONS

- A. This project shall comprise of an ethernet network for communications between Building Network Control Units and Workstations/File Servers.
- B. The BAS subcontractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the controls system inter-network.
- C. Communications services over the inter-network shall result in operator interface and value passing that is transparent to the inter-network architecture as follows:
 - 1. Connection of an operator interface device to any one controller on the inter-network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the inter-network.
 - 2. All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the inter-network. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform inter-network value passing.
- D. The time clocks in all controllers shall be automatically synchronized daily and automatically corrected for daylight savings time and leap years.

2.8 INPUT/OUTPUT INTERFACE (I/O)

- A. Hard-wired inputs and outputs may tie into the system through Building, Custom, or Application Specific Controllers.
- B. All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller. Provide a minimum of 15% spare I/O points of each type for BNCUs and CACs.
- C. Binary (digital) inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices.
- D. Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- E. Analog inputs shall allow the monitoring of low voltage (0-10 Vdc), current (4-20 ma), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- F. Binary (digital) outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on custom and building controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation. The position of the override switches shall be monitored and any point in override shall be highlighted as such in all graphics.
- G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom controllers shall have status lights, a 2-position (auto/manual) switch, and manually adjustable potentiometer for manual override. The position of the override switches shall be monitored and any point in override shall be highlighted as such in all graphics.

2.9 WEB SERVER FUNCTIONALITY

- A. The BAS system on the Ethernet TCP/IP Internet and/or the Owner's Intranet (coordinate availability with the Owner's IT group) shall be setup as a seamless WEB server. The Web server function shall be either built into the BAS hardware or be a separate fully integrated solid state WEB server hardware device. All user entered information (web pages, security, etc.) shall be stored in non-volatile memory. System operational information and clock functions shall be battery-backed or backed up automatically to another device for a minimum of 72 hours.
- B. The WEB server shall have the ability to automatically obtain an IP (Internet Protocol) address using DHCP. Use of static IP addressing shall also be supported. The WEB server shall have the ability to store HTML code and "serve" pages to a web browser. This provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS. No additional software shall have to be installed on the client PC for normal operation of the system.

An unlimited number of users shall be able to access the WEB server. A minimum of 15 users shall be able to utilize this device at the same time.

- C. Graphics (for all systems) and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.
- D. The WEB server interface shall be capable of password security, including validation of the requesting PC's IP address. All communication with the WEB server shall be encrypted using 128 bit Secure Socket Layer (SSL) technology. The WEB server interface shall allow the sharing of data or information between any controller, or process or network interface (BACnet, LonTalk and TCP/IP) that the BAS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.
- E. Operators with proper security shall be able to override set points, operation schedules, and equipment operation. These changes shall be made graphically within the web browser. A log of system alarms and events shall be able to be viewed from the web browser. Operators with proper security shall be able to acknowledge alarms. System trends shall be able to be selected and viewed. Trends shall be shown graphically with the proper axis scaling automatically selected. Operators with proper access shall be able to configure the web server using their web browser.
- F. To simplify graphic image space allocation, HTML graphic images, if desired, may be stored on any shared network device. The BAS WEB server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. Real-time values shall be updated automatically at least once every 30 seconds (with the option to switch to manual updates from the remote computer).

2.10 OPERATOR WORKSTATION

- A. General.
 - 1. The BAS workstation software shall be configurable as either a single workstation system (with a local database) or multi-workstation system where the database is located on a central file server. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network running at 10/100/1000 MBPS.
 - 2. All Workstations shall be Intel Multi-Core (minimum 6 cores/12 threads) processor based workstation computers operating under Microsoft Window 10 Pro 64, Windows Pro for Workstation, or newer operating system. Provide all computers with virus protect (latest version of McAfee or Norton Antivirus with 36-month subscription) and all required cables. Workstation computers shall include tower case, 5-year on-site next business day support warrantee on all components, and be as manufactured by Dell (Precision 5820 Tower), Lenovo (Enterprise ThinkCentre M720 Tower), or equal by Gateway, HP, or Compaq. The application software shall be capable of communication to all Network Control Units and Standalone Digital Control Units, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions. For multi-workstation systems, a minimum of 250 workstations shall be allowed on the Ethernet network along with the central file server. In this client/server configuration, any changes or additions made from

one workstation will automatically appear on all other workstations without the requirement for manual copying of files. Multi-workstation systems with no central database will not be acceptable. Multi-workstation systems with distributed/tiered file servers and a central (master) database will be acceptable.

3. Provide an uninterruptible power supply (UPS) system capable of operating the computer, monitor, printers, WEB server, and any other workstation components for at least 20 minutes. If power is not restored in 10 minutes, provide software to accomplish an orderly shutdown after saving all data in memory. The UPS shall also function as a surge suppressor and voltage regulator.

B. Workstation Requirements (Single workstation or multi-workstation configuration).

1. The workstations and file server shall consist of the following (as a minimum):
 - a. 6-core Intel processor, either:
 - 1) Xeon W-2135 3.7 GHz, 4.5 turbo GHz with 8.25 MB L3 cache, 6 cores/12 threads, HT, or
 - 2) 8th Generation Core i7-8700K 3.2 GHz, 4.6 turbo GHz with 12 MB L3 cache, 6 cores/12 threads, HT
 - b. Minimum 16 GB 2666 MHz RDIMM ECC
 - c. Energy-Star Tower Chassis with Power Supply
 - d. One serial port
 - e. Two Thunderbolt 3 type C ports
 - f. Two USB 3.1 ports (on front)
 - g. Smart Memory Card Reader port
 - h. Ethernet port
 - i. HDMI 2.0 port
 - j. 1 Gbit NIC card (PCIe-Intel) with wireless capability
 - k. 512 GB Solid State Drive, PCIe-NVME Opal or equal (boot drive)
 - l. 2 TB SATA 7200 RPM hard drive
 - m. DVD/+/-RW optical drive with Cyberlink Media Suite for DVD
 - n. 34" curved panel wide angle LED backlit LCD monitor with 3440 x 1440 at 60Hz Native Resolution with camera and speakers
 - o. Radeon Pro WX 7100, 8GB memory, 4DP (5820T) accelerated graphics card or equal.
 - p. Mouse
 - q. Full function keyboard
 - r. Integrated sound card
 - s. License agreements for all applicable software

- C. Printers: Provide an alarm printer and a separate report/graphics printer. The alarm printer shall be a tractor feed 24 pin Epson Model LQ-590II dot matrix impact printer with 25,000 POH hour MTBF rating, 400 million character print head life, 5 million character ribbon cartridge life, and 3-year warranty or equivalent by Okidata or IBM. The report printer shall be a color inkjet type, energy star certified, Brother (MFC-J6930dw) dual tray all-in-one, with automatic document feeder, duplex printing, copying and scanning using both 8.5" x 11" and 11" x 17" paper with 4800 by 1200 dpi resolution capability and minimum ISO print speeds of 22 ppm black and 20 ppm color, with 2-year warranty, or equivalent model by HP, Epson, or Lexmark. Supply three boxes of printer paper each with a minimum of 2000 sheets. One (1) box each shall be for 8.5" x 11" tractor feed paper, 8.5" x 11" inkjet paper, and 11' x 17' inkjet paper. Provide two (2) spare ribbons and/or cartridges (of each color) of the largest capacity available for each printer.

2.11 PORTABLE OPERATOR'S COMPUTER AND SERVICE TOOL

- A. Provide full screen, laptop operator's computer and a portable proprietary (or second laptop) service tool to communicate directly to all controllers. The laptop software shall enable users to monitor both instantaneous and historical point data, modify control parameters, and enable/disable any point or program in any controller on the network. The laptop shall be usable as a backup computer to the workstation/file server and shall include all workstation programs and capability (provide all required hardware/software for this). The service tool (or second laptop) shall be used by the balancing contractor and then turned over to the Owner.
- B. The laptop computers shall be Mobile Intel multi-core based laptop computers operating under the Microsoft Windows 10 Pro 64 bit, Windows 10 Pro for Workstations, or newer operating system (same operating system as for the Tower computer above). Provide all computers with virus protect (equal to the latest version of McAfee or Norton Antivirus with 36-month subscription), surge protectors (equal to Belkin Surgemaster Gold), and all required cables. Laptop computers shall include carrying case, 3-year on-site warranty, and be as manufactured by Dell (Latitude 7530) or equal by Lenovo, Compaq, Toshiba, or Samsung. The application software shall be capable of communication to all Network Control Units and Standalone Digital Control Units, feature high-resolution color graphics, alarming, reporting, and be user configurable for all data collection and data presentation functions.
- C. Laptop Computer Requirements
1. The laptops shall consist of the following (as a minimum):
 - a. 6-core Intel processor (same type used in the workstation above), either:
 - 1) Xeon E-2176 2.7 GHz, 4.4 turbo GHz with 12 MB cache, 6 cores/12 threads, HT, or
 - 2) 8th Generation Core i7-8850H 2.6 GHz, 4.3 turbo GHz with 9 MB cache, 6 cores/12 threads, HT
 - b. 16 GB DDR4-2666 SDRAM
 - c. 15.6" Ultra-Sharp anti-glare FHD IPS 1920 x 1080 72% color gamut display with camera and microphone
 - d. Accelerated graphics card equal to Nvidia Quadro P3200 with 6 GB GDDR5 memory
 - e. Internal or external with cable DVD-RW drive
 - f. 2 TB M.2 PCIe NVMe 1 TB Class 40 Solid State Drive
 - g. Two Thunderbolt 3 type C ports
 - h. Two USB 3.1 ports
 - i. Smart Memory Card Reader port
 - j. Ethernet port
 - k. HDMI 2.0 port
 - l. Dual Band Wireless AC 9560, 802.11ac, MU-MIMO Dual Band 2x2 + Bluetooth 5.0 wireless LAN Card
 - m. Internal sound card and speakers
 - n. Keyboard and slide panel mouse device
 - o. Charger/AC adapter
 - p. External wireless mouse
 - q. External wireless full function keyboard
 - r. 6 cell 90+ Whr fast charge capable lithium ion battery
 - s. Spare battery
 - t. Advanced Port Replicator or Docking Station with all required cables and adaptors.
 - u. License agreements for all applicable software

- D. The portable service tool shall be the standard by the control system manufacturer (if proprietary) or a second laptop.
- E. The laptop and service tool shall be able to connect to any Ethernet controller or standalone controller via a dedicated service port. From this single connection, the user shall be able to communicate with any other controller on the LAN.
- F. The laptop and service tool shall limit operator access by passwords. The service tool must support, at a minimum, the following password-protected user types: Administrator, Modify Parameters, View Only.
- G. The laptop and service tool software shall include built-in menus for viewing points by controller, enabling, disabling and viewing programs, configuring controllers, and communicating to other controllers on the network.

2.12 SYSTEM SOFTWARE

A. General Description

- 1. The software architecture must be object-oriented in design, a true 32-bit application suite utilizing Microsoft's OLE, COM, DCOM and ODBC technologies. These technologies make it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the BAS.
- 2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and set point adjustments.
- 3. Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information shall be available in graphic or text displays. Graphic displays shall feature visual effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

B. System Database

- 1. The files server database engine must be Microsoft SQL Server, or another ODBC-compliant, relational database program. This ODBC (Open Database Connectivity)-compliant database engine allows for an Owner to utilize "their" choice of database and due to its "open" architecture, allows an Owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.

C. User Interface

- 1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be

configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

D. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 250 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

E. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer™-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions. Object names shall not be required to be unique throughout the system. This allows consistency in point naming. For example, each ASC can have an input called Space Temperature and a set point called CFM Set point. The ASC name shall be unique such as VAV for LAB101. Systems requiring unique object names throughout the system will not be acceptable.
2. The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the BAS database. The types of template objects supported shall include all data point types (input, output, string variables, set points, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all "child" objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the BAS.

F. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change set points from a

graphic through the use of the mouse. Requirements of the color graphic subsystem include:

- a. Full High Definition (FHD), bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays. As a minimum graphics shall include: all mechanical equipment including each individual air handling unit, fan, chiller, pump, boiler, heat exchanger, etc.; systems of equipment including chilled water system (chillers, pumps, heat exchangers, control valves, etc.), condenser water system (towers, pumps, chillers, heat exchangers, control valves, etc.); hot water system (boilers, heat exchangers, pumps, control valves, etc.); air handling systems (AHUs, associated fans, control dampers, etc.); clean rooms (all controls); animal rooms (all controls), etc.; floor plans showing equipment locations and visual indication of any rooms in alarm, with point and click selection of any room's system.
 - b. A built-in library of objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". Objects shall be set up so that it is easy to visually see the state of the object (such as fan on or off). These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust set points, start or stop equipment, modify PID loop parameters, or change schedules.
 - c. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
 - d. Graphic panel objects shall be able to be configured with multiple "tabbed" pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.
 - e. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
- G. On-Line Help and Training
1. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. Provide an interactive tutorial CD, which will act as on-line training/help for the systems operator.
- H. Automatic Monitoring
1. The software shall allow for the automatic collection of data and reports from any controller through either a hardwired or webserver communication link. The frequency of data collection shall be completely user-configurable.
- I. Alarm Management
1. The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available

for operator acknowledgment, and have the option for displaying graphics, or reports.

a. Alarm management features shall include:

- 1) A minimum of 20 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.
 - 2) Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
 - 3) Automatic printing of the alarm information or alarm report to an alarm printer or report printer.
 - 4) Playing an audible beep or audio (wav) file on alarm initiation or return to normal.
 - 5) Sending an email, alphanumeric page, or phone call (by text to speech technology) to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email, phone and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI).
2. Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
 3. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
 4. The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
 5. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

J. Custom Report Generation

1. The software shall contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word™, WordPerfect™, MS Excel™, or Quattro Pro™.
2. Reports can be of any length and contain any point attributes from any controller on the network.
3. The report generator shall have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

4. It shall be possible to run other executable programs whenever a report is initiated.
5. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
6. Standard Reports: The following standard system reports shall be provided for this project. These reports shall be readily customized to the project by the owner.
 - a. Points in each controller.
 - b. Points in alarm
 - c. Disabled points
 - d. Overridden points
 - e. Operator activity report
 - f. Alarm history log.
 - g. Program listing by controller with status.
 - h. Network status of each controller
 - i. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand for each building meter. Provide an annual (12 month) summary report showing the monthly electrical consumption and peak demand for each meter.
 - j. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12 month) report that shows the monthly consumption for each meter.
 - k. Weather Data Report: Provide a monthly report showing the daily minimum, maximum and average outdoor air temperature and the number of heating and cooling degree days for each day. Provide an annual (12 month) report showing the minimum, maximum and average outdoor air temperature for the month and the number of heating and cooling degree days for the month.
- K. Spreadsheet-style reports: The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition the report shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.
- L. Dynamic Graphical Charting: The operator shall be able to select system values to be charted in real time. A minimum of three values at one time can be selected for each chart. The type of chart (bar, line, 3-D, etc.) shall be user selectable.
- M. HTML Reporting: The above reports shall be able to be run to an HTML template file. This feature will create an HTML "results" file in the directory of the HTML template. This directory can be shared with other computer users, which will allow those users with access to the directory to "point" their web browser at the file and view the report.
- N. Clock Synchronization: The real time clocks in all building control panels and workstations shall be synchronized on command of an operator. The system shall also be able to automatically synchronize all system clocks; daily from any operator designated device in the system. The system shall automatically adjust for daylight savings and standard time if applicable and for leap years.
- O. Scheduling
 1. It shall be possible to configure and download from the workstation schedules for any of the controllers on the network.

2. Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.
 3. Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
 4. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
- P. Programmer's Environment: The programmer's environment will include access to a superset of the same programming language supported in the controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition a wizard tool shall be available for loading programs from a library file in the program editor.
- Q. Saving/Reloading: The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.
- R. Data Logging (Trends and Histories): The workstation software shall have the capability to easily configure groups of data points with trend and history logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend and history log data shall be displayed through a simply menu selection. This data shall be able to be saved to file and/or printed. The operator shall be able to define a custom trend and history log for any data in the system. This definition shall include interval, start-time, and stop-time. As a minimum, any point may be recorded at user selected intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, once a month, or for change of value. Trend and history data shall be capable of being selected as either instantaneous at the time of recording or averaged between time intervals. All trends and histories shall start based on the hour. Each trend and history shall accommodate up to a minimum of 64 system objects. The system operator with proper password shall be able to determine how many samples are stored. Trend and history data shall be sampled and stored on the Building Controller and be archived on the hard disk monthly. BAS shall archive histories for a minimum of 18 months and shall prompt operator each January to archive each calendar year's data on a CD. Trend and history data shall be able to be viewed and printed from the operator interface software. Trends and histories shall be viewable in a text-based format and graphically. They shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages. BAS contractor shall provide setup of custom histories as required for the listed reports.
- S. Audit Trail: The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to

changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

- T. Custom Application Programming: Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:
1. The language shall be English language oriented and be based on the syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, the programming language can be graphically-based using function blocks as long as blocks are available that directly provide the functions listed below, and that custom or compound function blocks can be created.
 2. A full screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete code from the custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.
 3. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 4. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and to observe any intermediate values and or results. The debugger shall also provide error messages for syntax and execution errors.
 5. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 6. The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and xy. The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.
 7. The programming language shall have pre-defined variables that represent clock time, day of the week, and date. Variables that provide interval timing shall also be available. The language shall allow for computations using these values.
 8. The programming language shall have ability to pre-defined variables representing the status and results of the System Software, and shall be able to enable, disable, and change the values of objects in the system.
- U. Demand Limiting: The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter, or from a watt transducer or current transformer attached to the building feeder lines. The demand limiting program shall be based on a predictive sliding window algorithm. The sliding window duration and sampling interval shall be set equal to that of the local Electrical Utility. Control system shall be capable of demand limiting by resetting HVAC system set-points to reduce load while maintaining Indoor Air Quality (humidity, CO₂) and comfort control in the space. Input capability shall also be provided for an end-of-billing period indication.
- V. Maintenance Management: The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

- W. PID Control: A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-wind-up shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable with an option for auto-tuning. The set point shall optionally be chosen to be a reset schedule.
- X. Staggered Start: This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user-selectable.
- Y. System Calculations: Provide software to allow instantaneous power (e.g. KW), flow rates (e.g. GPM) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window KW demand value. Provide an algorithm that calculates energy usage and weather data (heating and cooling degree days). These items shall all be available for daily, previous day, monthly and the previous month.
- Z. Anti-Short Cycling: All binary (digital) output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- AA. Fault Tolerant File Server Operation
 - 1. The system shall provide fault tolerant operation in the event of the loss of the CPU, disk drives, or other hardware required to maintain the operational integrity of the system. Operational integrity includes all user interfaces, monitoring of alarm points and access points, and executing access control functions.
 - 2. The switchover mechanism provided shall be automatic. Should the failure be caused by hardware, then the system shall immediately switch to the Backup computer (which can be the portable computer). Should the system failure be caused by software (instruction or data), the system shall not pass the faulted code to the Backup computer, otherwise the Backup shall fail in the same manner of the Primary computer.
 - 3. Switchover to the Backup computer shall be initiated and effective (complete) in a manner and time frame that precludes the loss of event data, and shall be transparent to the system users, except for an advisory alarm message indicating that the switchover has occurred.
 - 4. When the system fails-over from the Primary to the Backup computer, no alarm or other event shall be lost, and the Backup computer shall take control of all system functions.
 - 5. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.
 - 6. The Back-up computer shall provide continual indication that the Primary computer is unavailable until such time that the fault has been purged.

2.13 DDC SENSORS AND POINT HARDWARE

- A. Temperature Sensors
 - 1. All temperature devices shall use precision thermistors or RTDs accurate to +/- 1 degree F over a range of minus 30 to 230 degrees F. Space temperature sensors shall be accurate to +/- 0.5 degrees F over a range of 40 to 100 degrees F. Outdoor air temperature sensors shall be accurate to +/- 0.7 [0.9] degrees F over a minimum range of minus 20 to 120 degrees F.

2. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box. Temperature sensor may be combined with humidity or carbon dioxide sensor in one housing providing it meets the specifications listed above.
3. Where manual overrides are required in the sequences for off-hours occupancy, space temperature sensor housings shall feature both an optional means for adjusting the space temperature set point, as well as a push button for selecting after hours operation.
4. Space sensors shall incorporate either an LED or LCD display for viewing the space temperature, set point and other operator selectable parameters. The sensors shall include built in buttons that allow local temperature set point adjustment. Displays shall be capable of being blanked out for no local readings where specifically requested by the Owner.
5. Duct temperature sensors shall incorporate a thermistor bead or RTD embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the AHU or duct area is less than twelve (12) SF. Tube shall be long enough so that the sensor is at least 1/3 of the way into the air stream.
6. Averaging sensors shall be employed in AHU's or ducts that are twelve (12) SF and larger. The averaging sensor tube must contain at least one thermistor or RTD for every three (3) SF of AHU or duct area. Sensors shall be accurate to +/- [0.5 or 0.9] degrees F over their normal operating temperature range +/- a 20 degree F margin. Example, for a heating/cooling air-handling unit that normally varies between 55 and 100 degrees F, the sensor shall have the stated accuracy over a range of 35 to 120 degrees F.
7. Immersion sensors employed for measurement of temperature in all chilled, condenser, glycol and hot water applications as well as steam and refrigerant applications shall incorporate a precision thermistor or RTD type sensor. "Smart" sensors (where called for) shall be RTD type and include either an LED or LCD display. Chilled water sensors shall be accurate to +/- 0.5 degrees F over their normal operating temperature range +/- a 20-degree margin. Condenser and hot water sensors shall be accurate to +/- [0.5 or 0.9] degrees F over their normal operating temperature range +/- a 20-degree margin. Example, for a hot water system that normally varies between 90 and 200 degrees F, the sensor shall have the stated accuracy over a range of 70 to 220 degrees F. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
8. Outside Air Temperature Sensors: Utilize precision thermistor or RTD-type units. Sensors shall be designed to withstand the environmental conditions to which they will be exposed. Sensor enclosure shall allow for adequate air flow over the sensing element. Housing shall be NEMA-3R construction as a minimum.

B. Electric Thermostats

1. Provide low temperature thermostats (freezestats) as indicated on drawings. Low reading freezestats shall register alarm and be wired to shut down the associated fan system when temperature along any 1' of element falls below set point. Manual reset shall be required. Provide 1' of element for every square foot of coil face area. Minimum adjustable range shall be 34 to 46 degrees F with an initial set point of 37 degrees F, unless listed otherwise on the drawings.
2. Provide low voltage thermostats for control of single zone heating or air conditioning equipment as specified in the sequence of operation. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the set point locally. Electric thermostats that control

both heating and cooling shall be 7-day programmable with a minimum 5-degree dead band between the heating and cooling set points.

C. Humidity Sensors

1. Humidity sensors shall be analog type with proportional output using thin film polymer accurate to +/- 3% [2%] RH at full scale for space, supply, return or exhaust duct applications. Outdoor air humidity sensors (all, whether located outdoors or in outdoor air ducts) shall be accurate to +/- 5% or [3%] RH over a minimum range of minus 20 to 120 degrees F. Suppliers shall be able to demonstrate that accuracy is NIST traceable. Acceptable manufacturers include Vaisala, E&E Elektronik, General Eastern or Staefa.
2. Provide a hand held field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

D. Pressure Sensors

1. Air pressure measurements in ranges up to 0 to 10" water column will be accurate to +/- 1% [0.4%] of range using a solid-state sensing element. Select the smallest range applicable to the use of the sensor. Sensors shall be bi-directional for room pressure monitoring. Acceptable manufacturers include Ashcroft Inc., Modus Instruments, Setra and Mamac.
2. Differential pressure measurements of liquids or steam shall be accurate to +/- 0.5% of range. Housings shall be NEMA 4 rated.
3. Provide wind baffles for outdoor pressure sensor locations and indoor locations where there can be turbulence.

E. Current and KW Devices

1. Current devices shall be used to monitor fans, pumps, motors and electrical loads. Current devices shall be available in solid and split core models, and offer either a digital (switch for on-off status of constant speed equipment) or an analog (sensor for status of VFD driven equipment) signal to the automation system. Current switches shall be capable of differentiating between free-wheeling (belt breakage) and normal motor load. Acceptable manufacturers are Veris, Siemens, or approved equal.
2. Measurement of three-phase power shall be accomplished with a kW/kWH transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWH). Provide Veris Model 6000 Power Transducer, the equivalent by Siemens or approved equal.

F. Water and System Flow Sensors

1. Provide where indicated insertion dual turbine flow meters for measurement of liquid flows in pipe sizes above 2" inches. Below 2 1/2" pipe, provide in-line type flow meters with isolation valves and manual bypass.
2. Install the insertion flow meters on isolation valves to permit removal without process shutdown.
3. Sensors shall be capable of reading velocities between 0.17 and 20 FPS with 2% accuracy above 0.4 FPS, have local readout, and 4 to 20 mA or 0-10 volt output to the control system. Sensors shall be as manufactured by ONICON or approved equal.
4. Contractor shall ensure proper straight lengths of upstream (minimum of 10 pipe diameters) and downstream (minimum 5 pipe diameters), or more if required per manufacturer's recommendations for the location chosen.

G. Airflow Measuring Stations

1. Outdoor Air

- a. Provide thermal dispersion velocity meters using bio-medical grade self-heated thermistor sensors with glass encapsulated thermistor temperature sensors capable of reading airflow between an airflow range of 50 (or lower) to 5,000 fpm with negligible airside pressure drop (no more than 0.12" at 2500 fpm velocity).
- b. Coordinate size and location of sensor with manufacturer, AHU/RTU manufacturer, and mechanical contractor to design for a velocity at maximum designed air-flow between 1000 – 1600 FPM to provide a minimum 20 to 1 turn-down (5% of design airflow). If the unit has both minimum and maximum outdoor air intakes, both shall have airflow monitors sized within the above listed velocity range.
- c. The electronic module shall be microprocessor-based with an alphanumeric LCD Display. Unit shall be rated for a minimum operating temperature range of minus 20 to 120 degrees F, provide any required if heaters required to meet this minimum operating range. The module shall operate on 24VAC, with an optional 120VAC. The output and input signals shall be field selectable and linear with field adjustable scales and shall include 0-5VDC, 0-10VDC, 4-20mA, BACnet, or LonTalk as required. Accuracy shall be at least +/- 2% (sensor only) to 3% (overall unit) of actual airflow.
- d. Furnish Ebtron GTD116-Pc or Ebtron Air-IQ/GTx-PC (integrated with TAMCO Damper), or equal by Ruskin, JCI, or Air Monitor.

2. Supply, Return and Exhaust Air

- a. Provide thermal dispersion velocity meters using intrinsically safe bio-medical grade self-heated glass encapsulated thermistor sensors with thermistor temperature sensors.
- b. Install units with proper upstream and downstream straight duct runs or, if these are too short flow straighteners shall be used on the inlet as recommended by the manufacturer.
- c. The flow stations shall operate over a minimum range of 50 (or lower) to 5000 feet/min with and overall accuracy of $\pm 2\%$ (sensor only) to 3% (overall unit) of reading.
- d. The output signal shall be field selectable and linear with field adjustable scales and shall include 0-5VDC, 0-10VDC, 4-20mA, BACnet, or LonTalk as required.
- e. Furnish Ebtron GTA116-Pc or equal by Ruskin, JCI, or Air Monitor.

H. Carbon Dioxide Sensors

1. Provide wall and duct mounted non-dispersive infrared type carbon dioxide sensors where indicated on drawings. Sensors shall have a field selectable 4 to 20 mA or 0 to 10 VDC linearized output signal over a 0-2000 ppm range (set point will normally be between 600 and 1200 ppm). Power requirement shall be 24 VAC or 24 VDC. Units shall operate in an environment of at least minus 20 to 120 degrees F temperature range and 0 to 95% RH. Accuracy shall be +/- 5% of reading or +/- 75 ppm, whichever is greater. Repeatability shall be +/- 20 ppm. Annual drift shall not exceed 75 ppm. Response time shall not exceed 2 minutes. Enclosure shall be an attractive high impact plastic case. Sensors, providing they meet these specifications, shall be as manufactured by R.E. Technologies, Vaisala, Vulcain, Engelhard, Texas Instruments, Enmet Canada Limited, ToxAlert, AirTest, MSA, or approved equal.

2.14 CONTROL VALVES AND ACTUATORS

- A. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve no more than the leakage listed in the HVAC valve specification section. Valves shall be pressure independent (PIACV), globe, butterfly (open-closed only), high performance butterfly (open-closed or modulating with Cv at 2/3 open), or characterized ball as listed for the system served and of construction listed in Section 23 20 00 HVAC Piping and Distribution Systems valve specification for the system's fluid and temperature/pressure limits and as listed herein. Valves shall be manufactured by one of the listed manufacturers (in the HVAC valve specification) or, providing they meet all specified requirements, Belimo, Bray, Delta P Valve, Griswold, Bell & Gossett, Fisher, Macon, Victaulic TA, Honeywell, Johnson, or Siemens/Staefa. All non-pressure independent control valves and actuators shall have a minimum 3 year warranty.
- B. The intent is for PIACVs to be used for all modulating 2-way control valves on all water systems (including glycol). Exceptions would be valves where the PIACV minimum pressure drop is higher than allowed (such as a cooling tower bypass which may have a 3 psi limit). PIACVs shall be used for these systems and where shown on the piping details. Each pressure independent (PI) automatic control valve (ACV) is a two-section valve referred to herein as a PIACV. These valves shall be self-balancing (pressure independent) over a minimum operating range across both sections of the valve assembly of 6 to 45 psid (or higher, to match the pump head, if the pump head is over 105 feet) with the mechanical PI section limiting the differential pressure over the ACV section to provide very stable and accurate control. All mechanical pressure independent automatic control valves and actuators shall have a minimum 5 year parts warranty with the first two years being unconditional.
- C. PIACV flow selection shall be adjustable on the valve assembly with a minimum range of +40% above the design flow. PIACVs whose flow rate can't be field selected (fixed flow) shall be selected within in the range of -5% to +10% of the design flow and be provided with replacement flow cartridges if required by the balancing Contractor or engineer. The use of up to 3 parallel PIACV's to achieve the rated flow shall be permitted providing each is installed with a union and the control of the parallel valves is sequential, either by software with a single output or by individual outputs per valve.
- D. Electronic pressure independent automatic control valves (PIACVs) and actuators using flow meters are only allowed when submitted with a minimum 7-year parts warranty with the first two years being unconditional. In addition, these valves require a full 10 year parts and labor warranty if they experience close-off failure due to wire-draw of the seat. This is due to the fact that with flowmeter control versus mechanical pressure absorption requires the ACV section to absorb the entire pressure drop (up the maximum full rated differential pressure), and, at low flow, this can cause erosion (wire-draw) of the valve seat.
1. The flowmeter shall be integrated with an ultrasonic flow sensor (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psig. Contractor shall insure the required six (6) straight inlet pipe diameters are provide for the flowmeter.
 2. The control valve assembly shall incorporate an algorithm to automatically compensate for the glycol concentration and be readable by a local device.

E. [Electronic PIACVs used for energy monitoring shall also include:

1. Temperature Sensors: Provide two temperature sensors, matched for a maximum differential temperature of 0.25 degrees F to monitor and provide feedback of supply and return water temperatures.
2. Coil Optimization: Provide software to control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Real-time data and configuration of valve operating parameters shall be available by BTL listed BACnet MS/TP, BACnet/IP, MODBUS or HTTP. Monitored points shall include inlet and outlet water temperatures, absolute flow, absolute valve position, absolute coil power and total heating/cooling energy in BTU/hr. Configuration points shall include valve, flow and power settings. Historical trend data shall be stored for up to 13 months and be retrievable in a standard time-stamped format.]

F. Control valves shall meet the heating and cooling loads specified, operate against the normal expected differential pressure without any shortening of life, and close-off against the maximum differential pressure condition for the application (typically pump shut-off head) with a 25% safety factor. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Two-position (open/close) valves shall be full line sized. Unless specified elsewhere, the maximum pressure drop for modulating water/glycol systems control valves shall be 6 psi for mechanical PIACVs (including both sections) or 4 psi (minimum pressure drop shall be 1 psi) for electronic PIACVs or non-PIACVs (as these will have a separate balancing valve pressure drop). Unless specified elsewhere, the maximum pressure drop for modulating steam control valves shall be 50% of the inlet pressure (7.5 psi for a 15 psig steam system) providing the required equipment inlet pressure is met.

G. Trim material shall be stainless steel for all steam control valves, electronic PIACVs, and high differential pressure control valves (over 12 psid applications).

H. Valve actuators shall be electronic direct coupled over the shaft, enabling it to be mounted directly to the valve shaft without the need for connecting linkage. Actuators shall have electronic overload circuitry to prevent damage. Actuators shall have visual position indicators. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Spring shall be capable of easy field change from normally open to normally closed. Actuators shall have an external manual gear release (above 60 in-lb torque, provide manual crank) to allow manual positioning of the valve when the actuator is not powered. Modulating actuators shall be positive positioning and respond to a 2 to 10 VDC or 4 to 20 mA operating range. Actuators on all valves 3" and larger shall provide a position feedback signal indicating valve position wired to the BAS and indicated on the graphics. Outdoor mounted actuators shall have NEMA 4/4X enclosure and shall have same voltage heaters to prevent condensation. Indoor actuators near (within 4 feet) of outdoor air streams shall have NEMA 2 enclosures. Actuators shall be sized for the maximum flow and differential pressure available (such as shut-off head of the associated pump or maximum steam pressure) plus a minimum 25% safety factor. Submit sizing calculations with the shop drawings. Actuators shall be as manufactured by Belimo, Bray, Johnson, Siemens, or approved equal.

2.15 CONTROL AND SMOKE DAMPERS AND ACTUATORS

A. Automatic dampers, furnished by the Building Automation Contractor shall be low leakage and include all required linkages, supports, actuators, switches, etc. Dampers

are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor. Control dampers shall be designed for operation in a temperature range of minus 25 and 180 degrees F. Smoke dampers shall be UL 555S rated.

- B. Damper blade width shall not exceed six (6) inches (eight (8) inches for high pressure dampers), unless otherwise noted on drawings. Blade and frame seals shall be replaceable extruded silicone, EDPM, or PVC coated polyester (for low velocity dampers only) on blade edges, TPE or stainless steel compression at jambs. Seals and linkages shall provide tight closing, ultra low leakage dampers.
- C. Dampers installed on fan discharges shall be oriented such the blades are perpendicular to the fan shaft, this will minimize pressure drop due to uneven airflow from the fan. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control. Dampers, providing they meet the requirements of these specifications, shall be as manufactured by Ruskin, Arrow, TAMCO (T. A. Morrison), American Warming and Ventilating (AWV), Vent Products, Greenheck, or Johnson Controls. Note that not all manufacturers may make all types of dampers. Model numbers shown are used to indicate the minimum acceptable quality for each type of damper.
- D. Dampers used within four (4) feet of outdoor wall louvers, all penthouse/gooseneck intakes or reliefs, and in aluminum duct systems, shall be aluminum. Other dampers used in galvanized steel duct systems shall be either galvanized steel, or aluminum. Dampers for use in stainless steel duct systems shall be either stainless steel or baked herisite coated aluminum (with no steel or galvanized steel parts).
- E. Provide insulated aluminum dampers for all unducted outdoor air louvers (such as mechanical and generator room ventilation, space reliefs, etc.) and on the generator exhaust louvers. Insulated dampers shall be equal to Arrow model AFDTI-25LT, Tamco Series 9000BF, Greenheck model ICD-45, AWV model CR58, or Johnson VD-1252 with thermally broken frame and with blades foam insulated and thermally broken to provide a minimum overall R-value of 1.2. Maximum leakage shall not exceed Class 1A (3.0 cfm/sf at 1 (one) inch w.g. static pressure differential) for all sizes.
- F. Low pressure and smoke control dampers (on up to two (2) inch pressure class ductwork) shall be flat blade or airfoil type designed for a minimum of 2.5 inch differential pressure (all sizes) and up to 2,000 fpm face velocity. These are designated as low pressure dampers. Maximum size of modules for large dampers shall be 4 feet x 4 feet (size could be pressure limited) with an AMCA certified leakage rate not exceeding 3.0 (4.0 for smoke dampers) CFM/sf at one (1) inch w.g. static pressure differential for all sizes. Where larger dampers are needed (either dimension), incorporate mullion supports (same material as damper frame) designed to prevent failure or deformation of the damper assembly up to a differential pressure of four (4) inch w.g. Maximum pressure drop of a fully open 2 foot x 2 foot damper at 1,500 fpm shall not exceed 0.08 inch w.g..
- G. All medium and high pressure control and smoke dampers (on between two (2) inch and four (6) inch pressure class ductwork) shall be airfoil blade type designed for a minimum of the full pressure class rating: four (4) inches for classes 3 and 4 or six (6) inches for class 6 differential pressure (all sizes) and up to 4,000 (2,000 for smoke dampers) fpm face velocity. Maximum size of modules for large dampers shall be 4' x 4' (size could be pressure limited) with an AMCA (UL 555S for smoke dampers). Control dampers shall have Class 1A certified leakage rate not exceeding 3 CFM/sf at one (1) inch w.g. and 8

CFM/sf at four (4) inch w.g. static pressure differential. Smoke dampers shall have Class 1 certified leakage rate not exceeding 8 CFM/sf at four (4) inch w.g. static pressure differential. Where larger dampers are needed (either dimension), incorporate mullion supports (same material as damper frame) designed to prevent failure or deformation of the damper assembly up to a differential pressure of six (6) inch w.g. Maximum pressure drop of a fully open 4' x 4' damper at 2,500 fpm shall not exceed 0.18 inch w.g.

H. Aluminum Dampers:

1. Low Pressure Dampers: Frames and single thickness or airfoil blades shall be constructed of not less than 0.080" thick extruded aluminum, type 6063-T5 with minimum four (4) inches deep frame. Linkage hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Aluminum low pressure control dampers shall be equal to Greenheck model VCD-40 or 43 or Ruskin Type CD50. Aluminum low pressure smoke dampers shall be equal to Greenheck model SMD-401M or Ruskin type SD50M.
2. Medium Pressure Dampers: Frames and airfoil blades shall be constructed of not less than 0.080" thick extruded aluminum, type 6063-T5 with minimum four (4) inch deep frame. Linkage hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Aluminum medium pressure control dampers shall be equal to Ruskin Type CD50. Aluminum medium pressure smoke dampers shall be equal to Ruskin Type SD50M.

I. Steel Dampers:

1. Low Pressure Dampers: Frames shall be a minimum of five (5) inches deep with one (1) inch high minimum 13 gauge galvanized steel hat channel (stainless steel for use in stainless steel duct systems) or 16 gauge with corner reinforcements to equal 13 gauge strength. Single thickness or airfoil blades shall be a minimum of 16 gauge galvanized steel (stainless steel for use in stainless steel duct systems). Linkage hardware shall be installed in frame side and be constructed of corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Steel low pressure control dampers shall be equal to Ruskin Type CD60. Steel low pressure smoke dampers shall be equal to Greenheck model SMD-201 or Ruskin type SD37 (2-position) or Greenheck model SMD-301M or Ruskin type SD60M (where modulation is needed per sequences).
2. Medium Pressure Dampers: Frames shall be a minimum of five (5) inches deep with one (1) inch high 11 gauge galvanized steel hat channel (stainless steel for use in stainless steel duct systems) or 16 gauge with corner reinforcements to equal 11 gauge strength. Airfoil blades shall be a minimum of 14 gauge equivalent thickness galvanized steel (stainless steel for use in stainless steel duct systems). Linkage hardware shall be installed in frame side and be constructed of corrosion resistant, zinc & nickel-plated steel (stainless steel for use in stainless steel duct systems). Coordinate with manufacturers for inclusion of thrust collars and other special requirements where vertical blades are required (such as fan discharges). Steel medium pressure control dampers shall

be equal to Ruskin Type CD60. Steel medium pressure smoke dampers shall be equal to Ruskin Type SD60M.

- J. Damper actuators shall be electronic direct coupled over the shaft, enabling it to be mounted directly to the damper shaft with a "V" shaped toothed cradle (to minimize slippage) without the need for connecting linkage. Actuators shall have electronic overload circuitry to prevent damage. Actuators shall have position indicator. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Spring shall be capable of easy field change from normally open to normally closed. Actuators shall have an external manual gear release (above 60 in-lb torque, provide manual crank) to allow manual positioning of the damper when the actuator is not powered. Modulating actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range. All actuators on dampers two (2) square feet or larger shall provide a position feedback signal (such as 2 to 10 VDC) indicating damper position, wired to the BAS and indicated on the graphics.
- K. Outdoor mounted actuators shall have NEMA 4/4X enclosure and shall have same voltage heaters to prevent condensation. Indoor actuators near (within 4 feet) of outdoor air streams shall have NEMA 2 enclosures. Actuators for dampers mounted in up to two (2) inch pressure class shall be sized for a minimum 2,500 fpm velocity and two (2) inch differential pressure with a minimum 15% safety factor. Actuator for dampers mounted in higher pressure class ductwork shall be sized for 4,000 fpm velocity and a differential pressure equal to the duct design pressure with a minimum 15% safety factor. Show actuator sizing calculations on submittals. Actuators shall be as manufactured by Belimo, Johnson, Siemens, or approved equal. Actuators for smoke dampers shall meet UL 555S requirements.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

- A. General
 - 1. Installation of the building automation system shall be performed by this Contractor or his subcontractor(s). However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.
- B. Access to Site
 - 1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.
- C. Code Compliance
 - 1. All wiring shall be installed in accordance with the more stringent of all applicable electrical codes, equipment manufacturer's recommendations, and wiring specifications in Division 26.
- D. Cleanup

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

3.2 WIRING, CONDUIT AND CABLE

- A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

- B. Class Two and Three wiring and communications wiring may be run in the same conduit.
- C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
- D. Where wiring is required to be installed in conduit, galvanized EMT shall be used indoors unless indicated otherwise on the Drawings or as required by Division 26 specifications. Conduit shall be minimum 1/2 inch. Set screw fittings are acceptable for dry interior locations. EMT with compression fittings shall be used for interior damp locations. All exterior conduit shall be GRSC with threaded fittings. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- E. Flexible metallic conduit (max. three (3) feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
- G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management or smoke control systems shall be in conduit.
- H. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
- I. Ethernet 10/100 Base –T network wiring shall be equivalent to Owner’s premise wiring or, as a minimum, Category 5e or 6 cabling up to 300’ maximum run.
- J. Fiber optic cable shall be used for runs over 300’ and shall be the following size: 50/125.
- K. Only glass fiber is acceptable, no plastic.

- L. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents. Provide all fiber optic transceivers for all fiber cabling runs. Provide all power required at each fiber optic transceiver.
- M. Provide all networking electronics required for separate IP based BAS system network.

3.3 HARDWARE INSTALLATION

A. Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run shall include a separate hot, neutral and ground wire. The ground wire shall terminate at the breaker panel ground. This circuit shall not feed any other circuit or device.
3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires shall be attached to the building proper at regular intervals such that wiring does not droop. Wires shall not to be affixed to or supported by pipes, conduit, ducts, etc.
5. Conduit in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
6. Conduit, in non-finished areas where possible, shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
7. Wires shall be kept a minimum of three (3) inches from all piping.
8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
9. Wire shall not be allowed to run across telephone equipment areas.

B. Installation Practices for Field Devices

1. Well-mounted sensors shall include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building with a shield to prevent distortion of reading due to wind.

C. Enclosures

1. For all I/O requiring field interface devices, these devices where practical shall be mounted in field interface panels (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. FIP enclosures shall be of steel construction with baked enamel finish, NEMA 1 rated with hinged doors and keyed locks. The enclosures shall be sized for twenty percent spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP shall be to labeled screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using words, letters, and/or numbers that can be exactly cross-referenced with as-built drawings.
2. All I/O field devices inside FIP's shall be clearly labeled.
3. Junction box covers shall be marked to indicate that they are a part of the BAS system.
4. All enclosures (including controllers), all I/O field devices (except space sensors), all control valves and actuators, all routers and other field devices that are not mounted within FIP's shall be identified with bakelite nameplates. The lettering shall be in white against a black or blue background, be keyed to the as built drawings, and indicate that the device is a control device.

E. Location

1. The location of sensors shall be per mechanical and architectural drawings. Coordinate with installing contractor to provide appropriate straight upstream and/or downstream runs for accurate readings of mixed temperatures or flows.
2. Space humidity, carbon dioxide or temperature sensors shall be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air temperature sensors shall be mounted on the north building face directly in the outside air. Install outdoor temperature and humidity sensors with solar radiation/precipitation shields to minimize the effects of heat radiated from the building or sunlight and from rain.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.
5. Control panels used for smoke control shall be located in building life safety electric rooms, coordinate exact locations with the electrical contractor.

3.4 SOFTWARE INSTALLATION

A. General

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
2. The Contractor shall cooperate with the balancing Contractor and set-up Global Override Commands as required to expedite balancing of air handling and

pumping systems. Overrides (to open VAV boxes to desired flow or to open valves) shall be set-up for each system by floor and/or wing so that the total amount of flow can easily be set to equal the desired flow of the central equipment.

- B. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by all systems and their respective sequence of operation.
- C. Color Graphics: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays for each system and floor plan. Due to limitations on monitor size, some systems may need to be divided into multiple graphics. Provide hot links to all associated graphics for easy switching. For each system or floor plan, the display shall contain the associated points identified in the sequence and submitted point list and allow for set point changes. Color shall be used to highlight conditions that are out of range or in alarm.
- D. Reports: The Contractor shall configure a report for each system as well as overall energy usage and demand reports. As built software documentation shall include the following as a minimum:
 - 1. Descriptive point lists.
 - 2. Application program listing.
 - 3. Application programs with comments.
 - 4. Printouts of all reports.
 - 5. Alarm list.
 - 6. Printouts of all graphics.

3.5 SYSTEM STARTUP AND ACCEPTANCE TESTING

- A. Cooperate and coordinate with all trade contractors in the start-up of all BAS controlled and monitored equipment, as well as during the testing, balancing, and acceptance of the systems. Work with the balancing contractor to verify readings from the BAS agree with field measurements (such as VAV box flows) and that final set points for items such as differential pressure sensors (for VFD control) are not too high or too low for all downstream components to reach design flow.
- B. Point to Point Checkout: Each I/O device (both field mounted and located in FIPs and FOPs) shall be inspected and verified for proper installation and functionality (such as fan status and valve positioning). A pre-functional performance test checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager and submitted (with copy to the Owner's Representative).
- C. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software (including automatic switching to back-up computer – where called for in specs). A pre-functional performance test checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted (with copy to the Owner's Representative) before the completion of the project.
- D. System Acceptance Testing
 - 1. All application software shall be verified and compared against the specified sequences of operation in both normal and failure modes. Control loops shall be exercised by inducing a set point shift of at least 10% and observing whether the

- system successfully returns the process variable to set point. Record all test results and attach to the Functional Performance Test Results Sheets and submit (with copy to Owner's Representative).
2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).
 3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, that the computer readings (flows, temperatures, etc.) match field readings, and that any special features work as intended. Submit Functional Performance Test Results Sheet (with copy to the Owner's Representative).
 4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information. Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).
 5. Perform an operational test of the web server and modem by testing all graphics and systems (including alarm acknowledgement) from remote locations. Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).
 6. After the above tests have been completed and the system has demonstrated to function as specified, a 30-day performance test period shall begin. If all systems perform as specified throughout the test period, requiring only routine maintenance, submit a Functional Performance Test Results Sheet for each system (with copy to the Owner's Representative) and the BAS system shall be accepted. If any system fails during the test, and cannot be fully corrected within 8-hours, the Owner may request that the performance test be repeated and delay acceptance until all systems pass.

3.6 SEQUENCES OF OPERATION

- A. Sequences of operation shall be as shown on drawings. If any items are not shown, include BAS manufacturer's standard sequences.

3.7 FINAL DOCUMENTATION

- A. Upon completion of work and prior to request for Certificate of Occupancy, Contractor shall issue a certificate stating that work has been installed generally consistent with construction documents and tested per the specifications. All submittals, test reports, as-builts and O&M manuals are to be provided for engineer's review, prior to request for engineer's completion certificates. In addition, and also prior to request for completion certificates, all punch list items must be completed to the satisfaction of the engineer. The contractor must verify that all sequences of operations and controls have been incorporated and all systems and equipment are working per the sequences of operations. A blank contractor's certificate form can be furnished by NV5 upon request.

END OF SECTION 23 09 23

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SECTION 26 00 00

ELECTRICAL

(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 FILED SUB BID

A. Bidding procedures shall be in accordance with latest edition of Massachusetts General Laws, Chapter 149, Section 44, including provisions for pre-qualification; and Chapter 30, Section 39M. Time and place for submission of sub-bids is given in Advertisement for Bids.

B. Sub-bids for work under this section shall be for complete work of this section and shall be filed in a sealed envelope with Awarding Authority, at time and place specified in Advertisement for Bids. The following shall appear on the face of the envelope:

[JOB TITLE]

[NAME OF BIDDER]

SUB-BID FOR SECTION 26 00 00, ELECTRICAL

C. Every sub-bid submitted for work under this section shall be on forms furnished by Awarding Authority, as required by Section 44 of Mass. General Laws, and specified in Advertisement for Bids.

D. Sub-bids filed with the Awarding Authority shall be accompanied by bid deposits in form of a bid bond, or cash, or a certified check on, or a treasurer's or cashier's check issued by, a responsible bank or trust company, payable to [.....] in compliance with Chapter 149, Section 44 B. Amount of bid deposit shall be 5% of value of bid.

E. Additional Requirements:

1. Sub-bidder's attention is directed to Massachusetts G.L. Chapter 149 §44H, as amended, which provides in part as follows:

a. Each sub-bidder shall list in Paragraph E of the "Form for Sub-bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the section of the Specifications for that sub trade requires such listing, provided that, in the absence of a contrary provision in the specifications, any sub-bidder may, without listing any bid price, list his own name or part thereof and perform that work with persons on his own payroll, if such sub-bidders, after sub-bid openings, shows to the satisfaction of the Awarding Authority that he does customarily perform such class of work with persons on his own payroll and is qualified to do so. This section of the specifications requires that the following classes of work shall be listed in Paragraph E under the conditions indicated herein.

<u>Classes of Work</u>	<u>Reference Specification</u>	<u>Paragraphs</u>
Telecommunications	27 00 00	
Security	28 00 00	
Audiovisual	27 80 00	

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- F. The work to be done under this section is generally shown on Drawings _____.

1.2 GENERAL PROVISIONS

- A. The GENERAL REQUIREMENTS, DIVISION 1, and BIDDING AND CONTRACT REQUIREMENTS, DIVISION 0, are hereby made a part of this Specification Section.
- B. Examine all drawings and all sections of the specifications and requirements and provisions affecting the work of this section.
- C. The work listed in the following sections shall be made part of this Specification Section:

26 30 12 Fire Alarm Modification

1.3 SCOPE OF WORK

- A. This project includes the upgrade of existing mechanical equipment. Selective demolition of existing systems shall be required.
- B. Refer to the specific requirements for this project included in the "Narrative Report for Compliance with the Fire Protection and Life Safety Systems Section of the Massachusetts State Building Code (780CMR) – Fire Protection Construction Documents", which shall be considered part of these specifications. Include all associated testing and certifications necessary for compliance and any required remedial actions and retest due to failure.
- C. The work under this section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:
1. Identification
 2. Raceways and Conduit

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3. Wire and Cable (600V)
4. Wiring Devices and Plates
5. Outlet Boxes
6. Junction Boxes, Pull Boxes and Wireways
7. Safety Disconnect Switches
8. Fuses
9. Light Fixtures
10. Lighting Controls
11. Motor Starters
12. Variable Frequency Drives
13. Sleeving
14. Fire Seal and Fireproof Sealant
15. Supervision and Approval
16. Electrical Connections to HVAC Equipment, provided under other sections or by Owner.
17. Relocation of existing electrical components that interfere with new construction and removal and disposal of obsolete components.
18. Testing
19. Operating and maintenance instructions and manuals
20. Shop drawings
21. Record (as-built) drawings

D. Work of this section is generally shown on the Electrical Drawings.

1.4 RELATED WORK

- A. Principal classes of Work related to the Work of this section are listed in the Specification Table of Contents, and are specified to be performed under the indicated sections of the specifications. Refer to the indicated sections for description of the extent and nature of the indicated Work, and for coordination with related trades. This listing may not include all related Work items. It is the responsibility of the Contractor to coordinate and schedule the Work of this section with that of all other trades.
- B. The following work is not included in this section and will be provided under other sections:
1. Furnishing and installation of motors.
 2. Structural supports necessary to distribute loading from equipment to roof or floor except as specified.
 3. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing. Refer to Division 1, General Conditions.
 4. Automatic Temperature Control and Direct Digital Communication wiring except as noted on drawings.
 5. Flashing of roof and wall penetrations.
 6. Painting, except as specified herein.

1.5 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

- A. Furnish the following items for installation under other sections and provide wiring and connections as required:

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1. Duct mounted smoke detectors for installation under Section 23 03 00. Lengths of sampling tubes shall be coordinated with Sheet Metal Contractor. Control wiring for fan shut-down shall be provided under Section 15900.
2. Access panels and doors for installation by the General Contractor.
 - a. Furnish access panels for installation in walls, ceiling and floors at locations to permit access for adjustment, removal, replacement and servicing of all concealed equipment, valves and materials installed under this section of the specifications.
 - b. Access panels will be installed under the section of the related trades of the finished surfaces in which they are located.
 - c. Access panels shall be located in closets, storage rooms and/or other non-public areas if possible, positioned so that the equipment can be easily reached, and the size shall be sufficient for this purpose (min. 16" x 16"). When access panels are required in corridors, lobby or other habitable areas, they will be located as directed by the Owner's Representative.
 - d. Access panels shall be prime painted, keyed alike and provided with cylinder lock and two (2) keys for each panel. Units shall be manufactured by Milcor, Inland Steel, Miami Carey or approved equal. Required fire resistance of walls and ceilings shall be maintained.

1.6 DEFINITIONS

- A. As used in this section, the following items are understood to have the following meaning:
1. "*Contractor or Subcontractor*", unless otherwise qualified, shall mean the installer of the work specified under this section.
 2. "*Furnish*" shall mean purchase and deliver to the project site, complete with every necessary appurtenance.
 3. "*Install*" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.
 4. "*Provide*" shall mean "Furnish" and "Install".
 5. "*Work*" shall mean all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.
 6. "*Concealed*" shall mean hidden from sight in chases, furred-in spaces, shafts, hung ceilings, embedded in construction or in a crawl space. Areas to be concealed as part of tenant alterations to the building shall also be considered in this definition.
 7. "*Exposed*" shall mean not installed underground or concealed as defined above.
 8. "*Furnished by Others*" shall mean materials or equipment purchased under other sections of the general contract and installed by this section of the specifications by this trade Contractor.
 9. "*Owners Representative*" shall be the party responsible to make decisions regarding all contractual obligations in reference to the Scope of Work for the Owner.
 10. "*Date of Substantial Completion*" shall indicate the date where the work has been formally accepted as evidenced by completed final punch list or where the work has reached the stage that the Owner obtains beneficial use and commences utilization of the installed systems for business or occupancy purposes. The

GENERAL REQUIREMENTS, DIVISION 1, shall supersede this definition where specifically defined.

1.7 CODES, REFERENCES AND PERMITS

- A. Materials, installation of systems and equipment provided under this section shall be done in strict accordance with the Department of Public Safety, Department of Environmental Protection, State Building Code and any other Codes and Regulations having jurisdiction including but not limited to:
1. All Applicable NFPA Standards
 2. National Electrical Code (NEC).
 3. Occupational Safety and Health Administration (OSHA)
 4. State and Local Building Codes
 5. Underwriters' Laboratories, Inc. (UL)
- B. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, except when more rigid requirements are specified or are required by applicable codes but not limited to:
1. American National Standards Institute (ANSI)
 2. American Society of Mechanical Engineers (ASME).
 3. American Society of Testing and Materials (ASTM)
 4. Illuminating Engineering Society (IES)
 5. Institute of Electrical and Electronics Engineers (IEEE)
 6. Insulated Cable Engineers Association (ICEA)
 7. National Electrical Contractors Association (NECA)
 8. National Electric Manufacturers Association (NEMA)
 9. Thermal Insulation Manufacturers Association (TIMA)
- C. Codes, laws and standards provide a basis for the minimum installation criteria acceptable. The drawings and specifications illustrate the scope required for this project, which may exceed minimum codes, laws and standards.
- D. Give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from authorities having jurisdiction. Deliver all certificates of inspection to the authorities having jurisdiction. No work shall be covered before examination and approval by the Owner's Representative, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work to conform to requirements, satisfactory to Owner's Representative, and without extra cost to the Owner. If work is covered before inspection and approval, this Contractor shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.8 GENERAL REQUIREMENTS

- A. Nameplates
1. Each major component of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the equipment.
- B. Equipment Guards

1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.9 MATERIAL AND EQUIPMENT STANDARDS

- A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Owner's Representative.
- B. Substitutions may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. The request for each substitution must be accompanied by complete specifications together with drawings or samples to properly appraise the materials, equipment or process. The Contractor shall highlight and list all applicable specification requirements which the substituted material deviates from.
- C. If a substitution of materials or equipment in whole or in part is made, this Contractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.
- D. All materials, equipment and accessories provided under this section shall be new and unused products of recognized manufacturers as approved.

1.10 SUBMITTALS

- A. Conform to the requirements of Division 1, General Conditions, for schedule and form of all submittals unless specifically noted otherwise in this section. Coordinate this submittal with submittals for all other finishes. Shop drawings and design layouts shall be prepared by licensed installing Contractor s and shall note the name(s), license number(s) and license expiration date(s) of the Contractor (s) installing electrical systems.
- B. Definitions:
 1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than indicated in the Contract Documents.
 2. Acceptable Manufacturers: The mechanical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications, certain Alternate Manufacturers are listed as being acceptable. In addition, the MATERIAL AND EQUIPMENT STANDARDS paragraph potentially allows for substitutions as being acceptable. These are acceptable only if, as a minimum, they:
 - a. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an emergency generator must deliver equal kW / KVA at equal or greater efficiency using equal or less fuel as the emergency generator listed in the schedules.
 - b. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings, and other equipment will be at least equal to those shown on the design drawings. The fact

that a manufacturer's name appears as acceptable shall not be taken to mean the Engineer has determined that the manufacturer's products will fit within the available space – this determination is solely the responsibility of the Contractor.

- c. For rooftop mounted equipment and equipment mounted in areas where structural matters are a concern, the products must have a weight no greater than the product listed in the schedules or specifications.
- d. Products must adhere to all architectural considerations including, but not limited to; being of the same color as the product scheduled or specified, fitting within the architectural enclosures and details, and for lighting – being the same size and of the same physical appearance as scheduled or specified products.

C. Submittal Procedures, Format and Requirements

- 1. Review submittal packages for compliance with Contract Documents and then submit to Owner's Representative for review. Submit enough sets of shop drawings such that, after review, two (2) sets will be kept by the reviewer, with only the remaining sets returned with reviewer's marks and comments.
- 2. Each Shop Drawing shall indicate in title block, and each Product Data package shall indicate on cover sheet, the following information:
 - a. Title
 - b. Equipment number
 - c. Name and location of project
 - d. Names of Owner, Engineer and Seller
 - e. Names of manufacturers, suppliers, vendors, etc.
 - f. Date of submittal
 - g. Whether original submittal or resubmitted
- 3. Shop Drawings showing manufacturer's product data shall contain detailed dimensional drawings (minimum ¼ inch – 1 foot scale) including plans and sections (where physical clearance could be an issue). Provide larger scale details as necessary.
- 4. Submit accurate and complete description of materials of construction, manufacturer's published performance characteristics, sizes, weights, capacity ratings (performance data, alone, is not acceptable), electrical requirements, starting characteristics, wiring diagrams, and acoustical performance for complete assemblies. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
- 5. Provide Shop Drawings showing details of piping connections to all equipment. If connection details are not submitted and connections are found to be installed incorrectly, this Contractor shall reinstall them within the original contract price.
- 6. Provide complete data for all auxiliary services and utilities required by submitted equipment. This shall include fuel, cooling and exhaust requirements and points of connections.
- 7. Provide a complete description of all controls and instrumentation required including electrical power connection drawing for all components and interconnection wiring to starters, detailed information on starters, control diagrams, termination diagrams, and all control interfaces with a central control system.
- 8. Provide installation and erection information including; lifting requirements, and any special rigging or installation requirements for all equipment.

9. The Owner's Representative shall approve all materials before commitment for materials is made.
- D. Specifications and Schedule Compliance Statement
1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph for those submittals listed in Paragraph E: Product Data that are noted with an asterisk (*).
 2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in Part 2 and applicable Part 3 of the specification for which the submitted product in the opinion of the manufacturer complies, deviates, or does not meet.
 3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.
 4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.
 5. Verify each field of the associated schedule where associated technical data is presented on the drawings. Where the submitted material does not "comply" provide the value the submitted equipment will achieve based upon the specified conditions.
 6. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and the product will be rejected.
 7. Submissions which do not include a point by point statement of compliance as specified shall be disapproved.
- E. Product Data: Submit complete manufacturer's product description and technical information including:
1. Identification
 2. Raceways and Conduit
 3. Wire and Cable (600V)
 4. Wiring Devices and Plates
 5. Outlet Boxes
 6. Junction Boxes, Pull Boxes and Wireways
 7. Safety Disconnect Switches
 8. Fuses
 9. Light Fixtures
 10. Lighting Controls
 11. Motor Starters
 12. Variable Frequency Drives
- F. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal.
1. Access panel shop drawings shall be submitted to the Construction Supervisor for approval.
 2. Do not submit multiple product information in a single bound manual.
 3. Three-ring binders shall not be accepted.
- G. Deviations:

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Owner's Representative.
 2. Without letters flagging the deviation to the Owner's Representative, it is possible that the Engineer may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Owner's Representative, the Seller shall hold the Engineers, his consultants and the Owner harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Engineer has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
 3. Approval of proposed deviations, if any, will be made at discretion of Engineer.
- H. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. This Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule. Allow at least ten (10) working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that twenty (20) working days, exclusive of transmittal time are required for the following:
1. Coordination drawings.
 2. If more than five (5) shop drawings of a single trade are received in one (1) calendar week.
- I. Responsibility
1. Intent of Submittal review is to check for capacity, rating, and certain construction features. The Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other sections. Work shall comply with approved submittals to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor the shop drawing errors or deviations from requirements of Contract Documents. The Engineer's noting of some errors while overlooking others will not excuse the Contractor from proceeding in error. Contract Documents requirements are not limited, waived nor superseded in any way by review.
 2. Inform Contractor, manufacturers, suppliers, etc. of scope and limited nature of review process and enforce compliance with contract documents.
- J. In the event that the Contractor fails to provide Shop Drawings for any of the products specified herein:
1. The Contractor shall furnish and install all materials and equipment herein specified in complete accordance with these specifications.
 2. If the Contractor furnishes and installs material and/or equipment that is not in complete accordance with these specifications, he shall be responsible for the removal of this material and/or equipment. He shall also be responsible for the replacement of this material and/or equipment with material and/or equipment that is in complete accordance with these specifications, at the direction of the Owner's Representative.

3. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall be done at no extra cost to the Owner.
 4. Removal and replacement of materials and/or equipment that is not in complete compliance with these specifications shall not be allowed as a basis for a claim of delay of completion of the Work.
- K. Mark dimensions and values in units to match those specified.
- L. Submit Material Safety Data Sheets (MSD) on each applicable product with submittal.

1.11 OPERATION AND MAINTENANCE DATA

- A. Commence preparation of the Operating and Maintenance (O&M) manuals immediately upon receipt of "Approved" or "Approved as Noted" shop drawings and submit each section within one (1) month. The final submission shall be no later than two (2) months prior to the projected date of Substantial Completion of the Project.
- B. Each O&M document shall include the manufacturer's web address for equipment specific O&M information for Internet access by the Owner.
- C. The manual shall consist of three (3) sets of manuals and include three (3) sets of CDs, which shall contain the scanned content of the entire manual. The manual shall highlight the actual equipment used and not be a master catalog of all similar products of the manufacturer. The manual shall be submitted for review prior to creation of the CDs.
- D. The Manual shall contain the following:
1. Operations Manual
 - a. Systems description including all relevant information needed for day-to-day operations and management including start-up and shut-down instructions.
 - b. Wiring diagrams, schematics, logic diagrams and sequence of operations that accurately depict the controls system.
 - c. Depiction of each interface screen where programmable logic and visual displays are provided. Descriptors shall be provided to define displayed data, alarms, etc.
 - d. A single sheet (for ease of removal) of all access codes and passwords necessary to access all levels of control and programming.
 - e. Trouble shooting guide defining common alarms/problems with possible cause and effect.
 2. Maintenance Manual
 - a. Define all maintenance activities required to ensure system operation within manufacturers specified parameters. Provide table of all required activities plotted vs. interval with adequate fill-in-space for "activity completion date" and "comments". Where multiple instrument readings are required, provide data sheet formatted to accommodate activity.
 - b. Define recommended spare parts inventory with part numbers and source defined for ordering by the Owner. Identify lead time on all parts, source location and cost.

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- c. Provide copy of all warranty information with associated date of substantial completion (commencement of warranty) and end date of coverage. Define all components/subsystems specifically included and excluded.
- 3. Provide O&M manuals for each of the following:
 - a. Motor Starters
 - b. Variable Frequency Drives

1.12 COORDINATION

- A. Refer to Division 1, General Conditions, for coordination requirements applicable to this section, unless specifically noted otherwise in this section.
- B. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.
- C. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other sections. Any conflicts shall be referred immediately to the Owner's Representative for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Owner's Representative's satisfaction at no expense to the Owner.
- D. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section may interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8" scale or larger working drawings and sections, clearly showing how the work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.
- E. Keep fully informed as to the shape, size and position of all openings required for all apparatus, conduit, cable, sleeves, etc., and give information in advance to allow construction of required openings. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the General Contractor for the proper setting of same.
- F. All distribution systems which require pitch or slope such as condensate drains and water piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, ducts, lights and apparatus and install work to avoid interferences.
- G. Make reasonable modifications in the work as required by structural interferences, or by interference with work of other trades, or for proper execution of the work without extra charge.

1.13 RECORD DRAWINGS

- A. Refer to DIVISION 1, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.
- B. Record Drawings (red-line drawings) will be updated by this Contractor daily for review with the monthly requisition. The record drawing shall be an accurate depiction of the systems as completed, including dimensions (vertical/horizontal) of concealed components off fixed building elements.

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- C. The Electrical Foreman shall maintain complete and separate set of prints of Contract Drawings at job site at all times and shall record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to the original design.
- D. At completion of work the Electrical Contractor shall prepare a complete set of record drawings on AutoCAD showing all systems as actually installed. The Architectural background AutoCAD files will be made available for the Contractor's copying, at his expense, to serve as backgrounds for the drawings. The Electrical Contractor shall transfer changes from field drawings onto AutoCAD drawings and submit copy of files and three sets of prints to Owner's Representative for comments as to compliance with this section. CADD layering as established by the A&E design team shall be maintained with any and all changes done by the Contractor.
- E. The Architect and Engineer are not granting to the Contractor any ownership or property interest in the CADD Drawings by the delivery of the CADD Disks to the Contractor. The Contractor's rights to use the CADD disks and the CADD Drawings are limited to use for the sole purpose of assisting in the Contractor's performance of its contractual obligations under its contract with respect to the Project. The Architect and Engineer are granting no further rights. Any reuse or other use by the Contractor will be at the Contractor's sole risk and without liability to the Architect and Engineer. The Contractor hereby waives and releases any losses, claims, damages, liabilities of any nature whatsoever, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor. The Contractor, to the maximum extent permitted by law, hereby agrees to indemnify, defend and hold the Architect and Engineer harmless from all losses, claims, damages, liabilities, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor.
- F. Record Drawings, shall show "as-built" condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and model numbers of final equipment installation.
- G. The Electrical Contractor shall submit the record set for approval by the engineer a minimum of four (4) weeks prior to seeking the permanent certificate of occupancy.

1.14 WARRANTIES

- A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this section. Such warranties shall be in addition to and not in lieu of all liabilities which the manufacturer and the Electrical Contractor may have by law or by provisions of the Contract Documents.
- B. All materials, equipment and work furnished under this section shall be guaranteed against all defects in materials and workmanship for a minimum period of one-year (1) commencing with the Date of Substantial Completion. Where individual equipment sections specify longer warranties, provide the longer warranty. Any failure due to defective material, equipment or workmanship which may develop, shall be corrected at no expense to the Owner including all damage to areas, materials and other systems resulting from such failures.
- C. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the drawings.
- D. Upon receipt of notice from the Owner of the failure of any part of the systems during the warranty period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.15 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. It is the intention of the specifications and drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the drawings, but mentioned in the specifications or vice-versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by this Contractor without additional expense to the Owner.
- B. The drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the project and shall have the approval of the Owner's Representative before being installed. This Contractor shall follow drawings, including his shop drawings, in laying out work and shall check the drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Owner's Representative before proceeding with the installation. This Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
- C. Any requests for information (RFI) for resolving an apparent conflict or unclarity, or a request for additional detail, shall include a sketch or equivalent description of Contractor's proposed solution.
- D. Size of conduits, cable trays, raceways and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge. All work shall be installed in an approved workmanlike manner.

1.16 INSPECTION OF SITE CONDITIONS

- A. Prior to submission of bid, visit the site and review the related construction documents to determine the conditions under which the Work has to be performed and send a report, in writing, to the Owner's Representative, noting any conditions which might adversely affect the Work of this section of the specifications.

1.17 SURVEY AND MEASUREMENTS

- A. Base all required measurements, horizontal and vertical, from referenced points established WITH the Owner's Representative. The Electrical Contractor shall be responsible for correctly laying out the Work required under this section of the specifications.
- B. In the event of discrepancy between actual measurements and those indicated, notify the Owner's Representative in writing and do not proceed with the related work until instructions have been issued.

1.18 DELIVERY, STORAGE AND HANDLING

- A. No materials shall be delivered or stored on site until corresponding Shop Drawings have been approved.
- B. All manufactured materials shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
- C. Protect materials against dampness. Store off floors, under cover and adequately protected from damage.
- D. Inspect all equipment and materials, upon receipt at the job site, for damage and conformance to approved shop drawings.

1.19 PROTECTION OF WORK AND PROPERTY

- A. This Contractor shall be responsible for the care and protection of all work included under this section until the completion and final acceptance of this Contract.
- B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.

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- C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this section and make good damage thus caused.
- D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.20 SUPERVISION

- A. Supply the service of a competent Supervisor with a minimum of five (5) years of experience in Electrical construction supervision who shall be in charge of the Electrical work at the site.

1.21 SAFETY PRECAUTIONS

- A. Life safety and accident prevention shall be a primary consideration. Comply with all of the safety requirements of the Owner and OSHA throughout the entire construction period of the project.
- B. Furnish, place and maintain proper guards and any other necessary construction required to secure safety of life and/or property.

1.22 SCHEDULE

- A. Construct work in sequence under provisions of Division 1 and as coordinated with the Owner's Representative.

1.23 HOISTING, SCAFFOLDING AND PLANKING

- A. The work to be done under this section of the specifications shall include the furnishing, set-up and maintenance of all derricks, hoisting machinery, cranes, helicopters, scaffolds, staging and planking as required for the work.

1.24 CUTTING AND PATCHING

- A. Include all coring, cutting, patching, and fireproofing necessary for the execution of the work of this section. Structural elements shall not be cut without written approval of the Architect. This Contractor shall be responsible for taking all precautions required to identify hidden piping, conduits, etc. before any core drilling and/or cutting of slabs commences, including X-raying the affected slabs. Provide fire stopping to maintain the fire rating of the fire resistance-rated assembly. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details and be listed by UL or FM.
- B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.
- C. Form all chases or openings for the installation of the work of this section of the specifications, or cut the same in existing work and see that all sleeves or forms are in

the work and properly set in ample time to prevent delays. Be responsible that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and consult with the Owner's Representative and all other trades concerned in reference to this work. Confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Owner's Representative.

- D. Fit around, close up, repair, patch, and point around the work specified herein to match the existing adjacent surfaces and to the satisfaction of the Owner's Representative.
- E. Fill and patch all openings or holes left in the existing structures by the removal of existing equipment which is part of this section of the specifications.
- F. All of this work shall be carefully done by workmen qualified to do such work and with the proper and smallest tools applicable.
- G. Any cost caused by defective or ill-timed work required by this section of the specifications shall be borne by this Contractor.
- H. When, in order to accommodate the work required under this section of the specifications, finished materials of other trades must be cut or fitted, furnish the necessary drawings and information to the trades whose materials must be cut or fitted.

1.25 SLEEVES, INSERTS AND ANCHOR BOLTS

- A. Coordinate with other trades the location of and maintaining in proper positions, sleeves, inserts and anchor bolts to be supplied and/or set in place under this section of the specifications. In the event of incorrectly located preset sleeves, inserts and anchor bolts, etc., all required cutting and patching of finished work shall be done under this section of the specifications.
- B. All pipes passing through floors, walls, ceilings or partitions shall be provided with fire stopping to maintain the fire rating of the structure. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details. Provide sleeves for all penetrations where required by the listed detail, for the penetration of all mechanical room floors and where specifically required on the drawings.
- C. Field drilling (core drilling), when required, shall be performed under this section of the specifications, after receipt of approval by the Owner's Representative.
 - 1. When coring cannot be avoided, provide ¼ inch pilot hole prior to coring. When coring through floor or slab, verify location of core on floor below and protect and piping, ductwork, wiring, furniture, personnel, etc., below the location of the core.

1.26 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

- A. Provide all supplementary steel, factory fabricated channels and supports required for the proper installation, mounting and support of all Electrical equipment, piping, etc., required by the specifications.

- B. Supplementary steel and factory fabricated channels shall be firmly connected to building construction in a manner approved by the Owner's Representative as shown on the drawings or herein specified.
- C. The type and size of the supporting channels and supplementary steel shall be determined by the Contractor and shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.
- E. All supplementary steel including factory fabricated channels, supports and fittings shall be galvanized steel, aluminum or stainless steel where exposed or subject to rust producing atmosphere. Factory fabricated channels shall be manufactured by Unistrut, H-strut, Powerstrut or approved equal.

1.27 HAZARDOUS MATERIALS

- A. Where it has been identified that asbestos-containing material exists within the scope limits, refer to the Asbestos Abatement specification section for requirements.

1.28 ACCESSIBILITY

- A. All work provided under this section of the specification shall be installed so that parts requiring periodic inspection, maintenance and repair are accessible. Work of this trade shall not infringe upon clearances required by equipment of other trades, especially code required clearances to electrical gear. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the Owner's Representative.

1.29 SEISMIC RESTRAINT REQUIREMENTS

- A. Submit working plans and calculations reviewed, signed and stamped by a professional engineer who is registered in the State where the project is located and has specific experience in seismic calculations, certifying that the plans meet all seismic requirements established by authorities having jurisdiction over the project.
- B. For each seismic restraint, provide certified calculations to verify adequacy to meet the following design requirements:
 - 1. Ability to accommodate relative seismic displacements of supported item between points of support.
 - 2. Ability to accommodate the required seismic forces.
- C. For each respective set of anchor bolts provide calculations to verify adequacy to meet combined seismic-induced shear and tension forces.

- D. For each weldment between structure and item subject to seismic force, provide calculations to verify adequacy.
- E. Restraints shall maintain the restrained item in a captive position without short circuiting the vibration isolation.

1.30 PROJECT CLOSEOUT

A. Certificates Of Approval

- 1. Upon completion of all work, provide certificates of inspections from the following equipment manufacturers stating that the authorized factory representatives have inspected and tested the operation of their respective equipment and found the equipment to be in satisfactory operating condition and installed per the manufacturers installation instructions and requirements.

- a. Variable Speed Drive

B. Construction Observations By The Engineer

- 1. The engineer shall make progress site visits during construction and one (1) substantial completion (punch list) site visit for determining substantial completion.
- 2. The Trade Contractors and the General Contractor are required to inspect their own work and make any corrections to the work to comply with the specifications and the contract documents. It is not the responsibility of the engineer to develop lists of incomplete work items.

- 3. Progress Site Visits

- a. The purpose of the progress site visit by the engineer is to observe if the work is proceeding in accordance with the contract documents.
 - b. The engineer will prepare a field report which will note in general the work completed since the last observation visit, work found not to be in accordance with the contract documents and work not corrected since the previous observation visit.

C. Substantial Completion

- 1. When the Contractor considers the Work under this section is substantially complete, the Contractor shall submit written notice, through the General Contractor, with a detailed list of items remaining to be completed or corrected and a schedule of when each remaining work item will be completed. Should the engineer determine the list of remaining work does not constitute substantial completion the engineer will notify the Architect and/or Owner and he will not make a substantial completion site visit.

- 2. The following items shall be completed prior to the written request for substantial completion site visit:

- a. Certification of successful operation of all systems.
 - b. Training of the Owner's personnel in the operation of the systems.
 - c. Record Drawings in accordance with the contract specifications.
 - d. Operation and Maintenance manuals.
 - e. Testing reports.
 - f. Manufacturer's certificates of approvals.
 - g. Emergency contact list for reporting of malfunctioning equipment during the warranty period.
 - h. Contractors Project Completion certificate.

3. Should the Engineer, during the substantial completion visit, observe that the Work is substantially complete, s/he will provide a written listing of the observed deficiencies referred herein as the Punch List. The Punch List will provide for a place for the Contractor and General Contractor to sign off and date each item individually indicating that the observed deficiency item has been corrected.
4. Should the Engineer, during the substantial completion site visit, observe that the Work is not substantially complete, s/he will provide, a written list of the major deficiencies and a reason for the work not being considered substantially complete.
5. If the work is found not to be substantially complete then the engineer shall be reimbursed for his time to reobserve the work. A reobservation fee shall be charged to the Contractor through the contractual agreement for any further observations by the engineer.
6. The Contractor shall remedy all deficiencies listed in the punch list within the time frame required by the contract.

D. Engineer's Construction Completion Certification

1. Where required by the applicable code, the Engineer's Construction Completion Certification will be issued by NV5 when all life safety and health related issues are complete, all required functional tests are complete and all reports are complete.

E. Final Completion

1. The following items shall be submitted prior to the written request for Final completion:
 - a. Revised Substantial Completion items to be resubmitted in accordance with the review process comments.
 - b. Warranties commencing the date of Substantial completion
 - c. Individual Signed and dated Punch List acknowledging completion of all punch list items
2. When the Contractor considers all of the punch list work items complete, the Contractor shall submit written notice through the General Contractor that all Punch List items are complete and resolved and the work is ready for final observation site visit. The signature lines for completion of each punch list item shall be signed by the Contractor indicating the work is complete and signed by the General Contractor indicating s/he has inspected the work and found it to be complete. Should the Engineer find the work to be finally complete and all Punch List items are complete the Engineer will make a recommendation to the Architect or Owner. If the Engineer has found the punch list work to be incomplete during final inspection a written listing of the observed deficiencies will be prepared by the Engineer.
3. If the work is not fully complete then the engineer shall be reimbursed for his time to reobserve the work. A reobservation fee shall be charged to the Contractor through the contractual agreement for any reobservations by the Engineer.

F. Re-observation Fees

1. The re-observation fee shall be \$1200.00 per visit.

G. Contractor's Project Completion Certificate

1. Upon completion of work and prior to request for Certificate of Occupancy, each Trade Contractor and the General Contractor shall issue a certificate stating that work has been installed generally consistent with construction documents and all

applicable codes. NV5 can furnish a blank Contractor's certificate form upon request. The certificate shall certify:

- a. Execution of all work has been in accordance with the approved construction documents.
 - b. Execution and control of all methods of construction was in a safe and satisfactory manner in accordance with all applicable local, state and federal statutes and regulations.
2. The certificate shall include the following information:
- a. Project.
 - b. Permit Number.
 - c. Location.
 - d. Construction Documents.
 - e. Date on Plans and specifications submitted for approval and issuance of the Building Permit.
 - f. Addendum(a) and Revision Dates.
3. The certificate shall be signed by the Contractor and include the following:
- a. Signature.
 - b. Date.
 - c. Company.
 - d. License Number.
 - e. License Expiration Date.

PART 2 - PRODUCTS

2.1 NOT USED

2.2 IDENTIFICATION

A. Nameplates

1. Nameplates shall be laminated black Bakelite with minimum ¼ inch high white recessed letters.
2. Nameplates shall be securely attached to the equipment. Utilize mechanical fasteners such as galvanized steel or brass screws for exterior applications. High strength adhesives or cements may be used for interior applications.

2.3 RACEWAYS AND CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit

1. RGS shall be zinc-coated steel that conforms to ANSI C80.1, UL Specification No. 6 and Federal Specification WW-C-581e by Allied Tube and Conduit, Republic Steel, Wheatland Tube or approved equal.
2. RGS fittings shall be threaded. Split couplings or non-threaded fittings shall not be used.
3. Nipples and Close Nipples shall be RGS, length as noted or as required to conform to field conditions.

B. Intermediate Metal Conduit (IMC)

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1. IMC shall be zinc-coated steel that conforms to ANSI C80.6, UL Standard No. 1242 and Federal Specification WW-C-581e by Allied Tube and Conduit, Wheatland Tube or approved equal.
 2. IMC fittings shall be threaded.
- C. Electrical Metallic Tubing (EMT)
1. EMT shall be zinc-coated steel that conforms to ANSI C80.3, UL Standard No. 797 and Federal Specification WW-C-563 a by Republic Steel, Allied Tube and Conduit or approved equal.
 2. EMT fittings shall be
 - a. zinc plated pressed steel gland and ring compression
 - b. zinc plated pressed steel gland and ring compression up to two (2) inches and zinc plated pressed steel double set screw from two (2) inches and up
 - c. zinc plated pressed steel set screw type that shall form a positive ground path.
- D. Miscellaneous Conduit Fittings
1. Elbows shall be standard radius unless noted otherwise. Where Large Radius elbows are specified, provide forty-eight (48) inch radius unless noted otherwise.
 2. Bushings shall be threaded pressed steel hot dipped galvanized with conduit end stop and integrally molded noncombustible phenolic insulated surface rated for 150°C.
 3. Bonding bushings shall be threaded pressed steel hot dipped galvanized with conduit end stop and integrally molded noncombustible phenolic insulated surface rated for 150°C with a lay-in tin plated copper grounding lug.
 4. Exposed conduit expansion fittings shall be hot-dipped galvanized malleable iron with external bonding jumper equal to O.Z./Gedney Type EX for RGS or Type TX for EMT (four (4) inch maximum expansion).
 5. Provide water-tight gland sealing assemblies with pressure bushings equal to OZ/Gedney Type WSK for new cast-in-place installations or Type CSCM for retrofit (core drilling of existing walls) as required for below grade wall and floor penetrations.
- E. Flexible Metallic Conduit
1. Liquidtight Metal Conduit shall be UL Listed fabricated from a spiral wound strip of heavy gauge, corrosion resistant, hot dipped galvanized steel equal to Electri-flex Company Type LA. The jacket shall be flame retardant, sunlight resistant PVC extruded over the spiral wrap. Sizes through 1 ¼ inch shall have an integral copper bonding strip.
 2. Liquidtight fittings shall be UL listed zinc plated insulated throat.
 3. Flexible metal conduit shall be UL Listed non-jacketed steel fabricated from a spiral wound strip of heavy gauge, corrosion resistant, hot dipped galvanized steel equal to Electri-flex Company Type BR.

- F. Wireways shall be minimum 16-gauge steel with all straight runs having hinged spring-latched covers. Finish shall be painted over a corrosion resistant phosphate pretreatment to protect against corrosion. Interior parts shall be smooth and free of sharp edges and burrs. Provide wireway as identified on the drawings for NEMA 1, 3R or 12 service. Wireways shall be equal to Square D and UL Listed.

2.4 WIRE AND CABLE (600V)

- A. Provide single-conductor, annealed copper wire and cable with insulation rated for 600 V, of sizes specified and scheduled on drawings, by General Electric, Southwire, Okonite or approved equal, for secondary service, feeders, branch and system wiring. Wire sizes shown and specified are American Wire Gauge for copper conductors.
- B. The use of aluminum conductors is not allowed.
- C. Wire #10 and larger shall be stranded; #12 and smaller shall be solid. Wire and cable shall have THWN-THHN or XHHW insulation for branch circuit and feeder conductors.
- D. Conductor Color-coding
 - 1. Service entrance, branch circuit and feeder conductors shall be color-coded. Conductors #12 and #10 shall be colored with a factory applied solid or striped compound coating (black, red, blue, brown, orange or yellow). Neutrals and equipment grounds shall have solid compound or solid color coating (white, gray and green), except that neutrals with colored stripe shall be used where required by code. Phase conductors #8 and larger with stripes, bands or hash marks shall have background color other than white, green and gray.
 - 2. Alternative field-applied color coding methods may be used for wire #8 or larger, with color code as specified in other sections of this specification. Coloring shall be applied by the use of flame-retardant vinyl tape, equal to 3M Scotch 35.
- E. Cable
 - 1. Flexible Metal Clad (MC) cable shall be UL Listed with THHN insulated conductors with an insulated grounding conductor within galvanized steel or aluminum interlocked armor. Connectors shall be provided with lock nut connection to the termination point enclosure.
 - 2. Flexible Metal Clad (MC) cable utilized for Fire Alarm service shall be identified with a factory applied tracer along the entire length.
- F. Splices and Terminations
 - 1. Ampacity and temperature rating of splices and connectors shall be equal to or greater than those of associated wires and cables.
 - 2. Make splices in branch circuit or feeder wiring from #12 to #10 with UL-listed, solderless screw on connectors rated 600 V.
 - 3. Make splices in branch circuit or feeder wiring above #10 with UL-listed 90°C, 600V, compression butt splice barrel equal to Burndy YS-L HYLINK.

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4. Conductor terminations shall be standard bolt-on lugs with hex screws listed for attachment of copper wire and cable to panelboards, switchboards, disconnect switches and other electrical equipment.
 5. Make terminations for stranded conductors on screw terminals with UL Listed 105°C, 600V PVC insulated barrel compression locking fork tongue terminal equal to Burndy TP-LF VINYLUG.
 6. Make bus terminations for conductors #6 and larger with UL-listed 90°C, 600V, compression standard barrel length lugs equal to Burndy YA-L for conductor sizes to #4/0. Connectors for cable 250 KCMil and larger shall be with UL-listed 90°C, 600V, compression long barrel length two hole lugs equal to Burndy YA-2N. Lugs shall be high conductivity seamless copper electro-tin plated for corrosion protection.
- G. Wire management shall be provided by self-extinguishing self-locking nylon ties with -65 to 350°F. range for bundling conductors.
- H. Cable pulling compounds shall be UL Listed and be suitable for use with the specified cable insulation system. The compound shall reduce the coefficient of friction, while not adding any long term issues to the installation such as premature aging of the insulation system, added flammability or drying in such a manner as to stick the cable in place in the raceway.

2.5 WIRING DEVICES AND PLATES

- A. Provide wiring devices by single manufacturer. Catalog designations of Cooper are specified, unless noted otherwise, to establish standards of quality for materials and performance. Colors of devices as specified below are White for standard applications. Refer to the drawings for color requirements that vary from White. Equal products by Leviton, Pass & Seymour or Hubbell will be accepted. Provide published manufacturers cross-reference sheet highlighted with the device specified and that being submitted with all device product data for approval.
- B. Wall switches shall be of the totally enclosed tumbler type. Wiring terminals shall be spring loaded terminal screws for back or side wiring. Switches shall be rated 20-ampere 277 V for use on alternating current only. The yoke shall have a grounding terminal with a green hex head screw. Pilot lights indicated shall consist of red lighted handle, illuminated when the switch is on.
- C. Toggle Switches shall be heavy duty, UL listed, specification grade as follows:
1. Single-pole shall be No. 2221W
- D. Receptacles:
1. Receptacles shall be nylon faced with rigid, glass reinforced nylon bodies. Wiring terminals shall be spring loaded terminal screws for back or side wiring. Receptacles shall be rated 20-ampere 125 volt. The yoke shall have a grounding terminal with a green hex head screw.
 2. Duplex receptacles shall be UL Federal Specification WC-596 Specification Grade Extra Hard Duty 125V, 20A, 2 P, 3 W as follows:
 - a. General Use shall be No. 5362W (White)
 - b. General Use single receptacle shall be No. 5361W (White)

- c. GFCI Interior shall be No. GF20W (White)
- d. GFCI Exterior shall be GF20BK (Black) UL listed Weather Resistant

E. Wiring Device Plates:

1. Provide high-impact smooth nylon device plates by the manufacturer of the wiring device for all flush mounted switches and receptacles installed in dry locations and where not subjected to physical abuse. Fastening screws shall be color matched to the plate, plate color and to the device. Ganged plates shall be of one piece construction to accommodate the required number of installed devices. Oversized plates to cover wall finish blemishes adjacent to the device box shall not be used.
2. Provide heavy-duty cast aluminum horizontally mounted weatherproof covers for GFCI receptacles where weatherproof devices are specified equal to Hubbell No. WP26MH. Cover shall be attached to FS box with four (4) screws and spring back to the closed position upon removal of the cord set. Fasteners chrome-plated brass.

2.6 OUTLET BOXES

- A. Outlet and switch boxes on concealed work shall be at least 4 inch square, galvanized pressed steel conforming to UL 514A. Where installed in plaster, boxes shall be fitted with galvanized steel plaster covers of required depth to finish flush with finished wall or ceiling. Outlet boxes shall be by Steel City Electric Company, Appleton Electric Company, or approved equal.
- B. Outlet boxes installed in masonry walls or in concrete decking shall be UL Listed for the application.
- C. Outlet boxes for interior surface mounted locations where RGS is specified where exposed to moisture, adjacent to water or steam connections, and where indicated as weatherproof on drawings shall be cast malleable iron with an aluminum polymer enamel coating equal to Appleton Type FD. Conduit entries shall be threaded cast hubs. Device covers shall be coated malleable iron with moisture sealing gasket and stainless steel fasteners.
- D. Outlet boxes for exterior surface mounting shall be cast aluminum alloy with an aluminum polymer enamel coating equal to Appleton Type FD. Conduit entries shall be threaded cast hubs. Device covers shall be cast aluminum alloy with moisture sealing gasket and stainless steel fasteners.
- E. All boxes shall have at least one (1) tapped and threaded grounding hole for connection of a 10-32 grounding screw.
- F. Box depth shall accommodate code required volume for the specified installation. Through wall boxes shall not be used.

- G. Outlet boxes for various systems including but not limited to fire alarm shall be sized as required by the manufacturer. Boxes shall be cast where exposed to physical damage or installed in an exposed exterior location.

2.7 JUNCTION AND PULL BOXES

- A. Provide galvanized steel junction and pull boxes where indicated and as necessary to facilitate installation. Steel shall be minimum 16 gauge. Junction and pull boxes shall be of code required dimensions. Cover shall be of the same type and thickness material as the box construction.
- B. Junction and pull boxes intended for dry interior locations shall be NEMA 1 enclosures with accessible, removable screw-on covers. Covers shall be secured with corrosion-resistant screws with keyhole slots to accommodate easy removal.
- C. Junction and pull boxes intended for wet or exterior locations shall be NEMA 3R enclosures with hinged gasketed covers. Interior and exterior shall be finished with a gray enamel powder coat over the galvanized metal. Hinge shall be galvanized steel with stainless steel pin. Covers shall be secured with corrosion-resistant zinc plated lockable pull catches.
- D. Custom fabricated medium to large junction and pull boxes shall have internal structural steel bracing welded to form a rigid assembly adequate to maintain alignment and shape in shipment and installation.

2.8 SAFETY DISCONNECT SWITCHES

- A. Switches shall be three-pole heavy-duty type rated for 600V in NEMA 1 (interior dry applications) and NEMA 3R (exterior applications) enclosures unless noted otherwise on the drawings. All switches shall be horsepower rated and suitable for service entrance use. Provide with solid neutral where four wire circuits are indicated and with 200% solid neutral where neutrals are sized for 200% full load ampacity.
 - 1. Operating mechanisms shall be quick-make/quick-break. Current-carrying parts shall be high-conductivity copper. Contacts shall be silver-tungsten or plated. Provide positive pressure fuse clips and switch operating mechanism suitable for continuous use at rated capacity without auxiliary springs in current path. Switches shall withstand available fault current or let-through current before operating, without damage or rating change.
 - 2. Terminations shall be suitable for copper or aluminum conductors 60°/75° C rated. Clear shielding shall prevent accidental contact with energized line terminals.
 - 3. The cover shall be mechanically interlocked to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three padlocks with the door open or closed.
 - 4. The enclosure shall be given a phosphatizing pretreatment. The paint finish shall be manufacturer's standard color and shall pass 600 hours of corrosion resistance testing per ASTM B 117.

- B. Fused switches shall have short circuit ratings no less than 100,000 amperes RMS, with capabilities to 200,000 amperes when used with Class J, L or R fuses at 480V from 400A to 1200A.
- C. Manual Motor Starters shall have quick make, quick break toggle mechanisms with allowance for up to 10% field adjustment in nominal overload heater values. Manual Motor Starters shall be NEMA 1 (interior dry applications) and NEMA 3R (exterior applications) enclosed unless noted otherwise on the drawings. Provide Cutler Hammer type MS manual starters for applications up to 1 HP at 240V single phase and type B100 for up to 1 HP at 277V single phase. Permanent provisions shall be included to allow locking the disconnect in the OFF position.

2.9 MOTOR STARTERS

- A. The Motor Starters shall be 600 V class NEMA rated suitable for operation on a three-phase, 60-Hz system. The system operating voltage shall be as indicated on the drawings.
- B. Combination Starters
 - 1. Combination starter units shall be full voltage non-reversing, unless shown otherwise, and shall utilize Motor Circuit Protectors. Minimum size shall be NEMA Size 1. Maximum across-the-line starter shall be NEMA size 2 unless noted otherwise on the drawings. Starter units shall have NEMA rated electronic overload relays. Hand reset shall be by insulated button on outside of starter unit enclosure.
 - 2. Each combination unit shall be rated 100,000 AIC symmetrical at 480V. The HMCP shall provide adjustable magnetic protection and be provided with pin insert to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors shall include transient override feature for motor inrush current.
 - 3. Line starters shall be electrically operated, electrically held, three-pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight NO or eight NC auxiliary contacts and shall include NO/NC contacts as scheduled on the drawings.
 - 4. Overload relays (equal to Eaton C440) shall be NEMA rated electronic with:
 - a. Field selectable trip Class
 - b. Phase loss trip
 - c. Selectable (on-off) phase imbalance and ground fault trip
 - d. Reset from outside enclosure by insulated button.
 - 5. Provide fused (two primary and one secondary) control power transformer, LED indicating lights (green power available/energized and red/running), Hand-Off-Automatic (HOA) selector switch and two normally open and two normally closed contacts for each starter, unless scheduled otherwise on drawings. Device panel mounted on the face of the starter shall accommodate a minimum of six (6) oil-tight pilot control devices.

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6. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one (1) to three padlocks with the door open or closed.
- C. Manual Motor Starters – Refer to Safety Disconnect Switches
 - D. Enclosure
 1. The type of enclosure shall be in accordance with NEMA Standards for Type 1A with gasketed doors.
1 General; 3R Weatherproof; 12 Oil Seepage; 4 Hosedown; 4X Corrosive
 2. The enclosure shall be given a phosphatizing pretreatment. The paint finish shall be manufacturer's standard color and shall pass 600 hours of corrosion resistance testing per ASTM B 117.
 - E. Motor Starters shall be as manufactured by Cutler-Hammer, General Electric, Siemens or Square D.

2.10 LIGHTING FIXTURES

- A. Provide lighting fixtures, equipment and components where shown on drawings, as listed in fixture schedules and as specified, wired and assembled. Provide approved aligned canopies, hangers and other appurtenances as required, for a complete and functional system.
- B. Refer to the lighting fixture schedule for specific requirement. In general:
 1. LED luminaires shall have a luminous efficacy of at least 90 lumens/watt, a color temperature of 3500 K (unless noted otherwise on the plans), a CRI of at least 80, an estimated life of at least 50,000 hours at 70% lumen maintenance, and shall include a minimum five (5) year warranty on the entire luminaire including drivers. The luminaire and LEDs shall have been tested in accordance with LM-79 and LM-80
- C. Verify ceiling constructions, and provide frames, rings and other accessories suitable for construction encountered.

2.11 VARIABLE FREQUENCY DRIVES

- A. General
 1. Provide solid state, pulse-wide modulated (PWM) Variable Frequency Drives (VFDs) as scheduled on the drawings for use with standard NEMA Design B induction motors in variable torque applications.
 2. The VFDs with all options shall comply with the latest applicable standards of UL 508C, IEEE 519, NEMA and the IBC. VFDs shall be UL Listed and Labeled.

3. The manufacturer shall warranty the equipment to be free from defects in material and workmanship for two (2) years from the date of certified startup.
4. Acceptable manufacturers provided they meet the full requirements of this specification shall be ABB, Allen Bradley, Eaton, GE, Square D, Siemens or Yaskawa.

B. Construction

1. Enclosures:

- a. The housing shall be UL Type 1, NEMA 12, suitable for plenum installation.
- b. Operating environment shall be 32-122 °F continuous, less than 95% humidity. All circuit boards shall have conformal coatings.
- c. Door interlocked, padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options. The enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before the enclosure (VFD or bypass if applicable) may be accessed.

2. User Interface

- a. A digital display and keypad shall provide access and monitoring of all VFD functions. The keypad shall include Hand-Off-Auto selections and Manual Speed Control/Override.
- b. The keypad shall contain a built-in time clock. The clock shall have a battery backup with ten (10) years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault.

3. Standard Features

- a. The VFD shall have a UL listed short circuit current rating of 65,000 amps.
- b. The input current rating of the VFD shall be no more than 3% greater than the output current rating. Efficiency shall exceed 97% at 100% and 90% at 50% speed and load. Line side displacement power factor shall exceed 0.96 regardless of speed and load.
- c. VFDs for motors in excess of 50 HP shall be 18 pulse with a phase shifting transformer unless the drive has ultra-low harmonic distortion capabilities (less than 3% THD at the VFD terminals).
- d. The VFD shall operate with a tolerance for input voltage deviation from +10% to -15% nominal.
- e. The overload rating of the drive shall be 110% of its normal duty current rating for one (1) minute every ten (10) minutes, 130% overload for two (2) seconds.
- f. The VFD shall have internal 3% minimum impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. Input rectifier shall be protected from line events by MOV surge suppression. Passive input filters shall be sized and provided as required by the VFD manufacturer to ensure THD limitations defined in the Submittal section of this specification are met.
- g. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted.

- h. Provide dv/dt filtering within the VFD for motor leads that exceed fifty (50) feet in length (may be required by manufacturer for lesser lengths). Line reactors shall be sized to minimize dv/dt and voltage overshoot at the motor terminals.
 - i. Carrier frequency shall be field adjustable to a minimum of six (6) different settings.
 - j. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
 - k. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
 - l. Class 10, 20 or 30 (programmable) electronic motor overload protection shall be included.
4. Control
- a. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus.
 - b. The VFD shall include multiple “two zone” PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for “two zone” control. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
 - c. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two (2) separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close.
 - d. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates.
 - e. The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman’s override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined

safety run interlocks, and force the motor to run in one of the two modes above.

5. Communications

- a. The VFD shall have an RS-422/EIA-485 port. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet).
- b. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

C. Bypass

1. A factory fabricated, wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, variable frequency drive, input contactor, output contactor, bypass contactor, all UL listed as an assembly shall be provided. Additional bypass accessories shall be as follows:
 - a. 120V control power transformer with dual primary and single secondary fused protection.
 - b. Drive/Bypass selector switch
 - c. Bypass Hand-Off-Automatic selector switch.
 - d. Push-to-test LED Red Running and Green Energized/Off pilot lights.
 - e. UL Listed Class 10, 20, or 30 (programmable) electronic motor overload protection.
2. The drive panel will include a drive input and output contactor and a drive bypass starter. The drive isolation contactor will allow for removal of line power to the drive while running the motor with line voltage. The contactors will be mechanically and electrically interlocked to prevent operating at the same time. A solid state reduce voltage starter will be supplied for starting the motor in bypass operation mode where the motor exceeds 50 HP.
3. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication.
4. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
5. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall be Siemens Building Technologies FLN (P1); and BACnet.
6. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a

contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

7. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
8. Smoke Control Override Mode – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
9. Fireman's Override Mode – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.

D. Submittals

1. The manufacturer shall provide copies of following documents to the Owner for review and evaluation in accordance with general requirements of Division 1 and Division 16:
 - a. Product Data on specified product to include:
 - 1) Outline dimensions
 - 2) Point to point power and control wiring diagrams
 - 3) Schematic wiring diagrams
 - b. Detailed component data on specified product including complete list of included options.
 - c. Certified trip curves for each overload, overcurrent and short circuit protective device
 - d. Certified copies of all Type (Design) and Verification Test Reports
 - e. Nameplate list
 - f. Short circuit and coordination study shall be submitted with the equipment shop drawings to ensure rating conformity to study conclusions. Submittals made without the study shall be rejected.
 - g. Compliance calculations illustrating voltage THD is less than 5% at any bus/common coupling point that has more than 100 HP or greater than 50% of the connected load as VFD powered motors. The calculations shall utilize the specific power system in the model/calculation.
 - h. Seismic certification to illustrate compliance with IBC criteria based upon three axis of motion by a certified test lab.

2. Submit operation and maintenance data based on factory and field-testing, operation and maintenance of specified product.
3. Submit test report confirming acceptance of the VFD installation based upon the Installation inspections and tests outlined in Part 3 of this specification.

PART 3 - EXECUTION

3.1 DEMOLITION

A. General

1. Refer to the drawings for demolition scope applicable to the project.

3.2 IDENTIFICATION

A. Nameplates

1. Provide nameplates on all equipment listed in other sections of this specification including but not limited to switchboards, substations, panelboards, transformers, junction and pull boxes, disconnect switches, motor starters and motor control centers, contactors, time clocks, remote control stations, fire alarm panels, smoke detector remote test/alarm stations and fire alarm annunciators.
2. Nameplates shall designate equipment tag number as defined on the drawings, system voltage where applicable, circuit number, device controlled and system function. Refer to typical nameplate detail on the drawings for additional requirements.
3. Submit a complete list of proposed nameplates prior to order to ensure conformance to design criteria. Submittal shall include nomenclature, size and layout of each tag.
4. Samples of stickers together with color schedules shall be submitted during the submittal phase of this project.

B. Equipment Identification

1. Equipment identification designations shall be taken from equipment schedules and coordinated with the Owner's facility group to assure designations match up with Owner's maintenance management system identification database.

3.3 RACEWAYS AND CONDUIT

A. General

1. Unless specified or shown on drawings otherwise, install raceways and conduits concealed. Raceways and conduits may be run exposed on unfinished walls and

basement ceilings with exposed structure, in mechanical rooms, electric rooms, attics and roof spaces.

2. Run concealed raceways and conduits in as direct lines as possible with minimum number of bends of longest possible radius. Install exposed raceways and conduits parallel to or at right angles to building lines.
3. Raceway and conduit runs shall be mechanically and electrically continuous from supply to outlet. Conduit shall enter and be secured to metallic enclosures with lock nut and bushing inside. Provide additional exterior lock nut for RGS connections. Bushings shall be the bonding type for conduit connections to metallic enclosures with concentric or eccentric knockouts. Lock nuts and bushings will not be required where conduits are screwed into threaded hubs.
4. Size raceways and conduits as required by NEC unless oversized raceways and conduits are shown on the drawings. Raceways and conduits shall be ¾ inch minimum.
5. Install conduit systems complete before installation of conductors. Blow through and swab after plaster is finished and dry, and before conductors are installed.
6. Raceways and conduits supports shall be rigidly attached to the building structure utilizing corrosion resistant components suitable for use with the selected raceway or conduit. Refer to the seismic restraint sections of this specification for any additional requirements.
7. Field bending, cutting and threading shall be executed with the proper tools, resulting in bends and shortened conduits and raceways that are equivalent to factory fabricated and purchased components.
8. Provide standoff clips for conduits on exterior and wet location walls.
9. Protect all vertical conduit runs from the entrance of foreign material before installation of conductors and the final closure of the raceway system. All spare conduits (vertical and horizontal runs) shall be sealed with a bushing and appropriate insert to prohibit entrance of debris or vermin. Affix a label that indicates "Spare Conduit to _____" at each seal. Label shall be in accordance with the labeling section of this specification.

B. Rigid Galvanized Steel (RGS) Conduit

1. RGS may be used for all raceway applications outlined for EMT and PVC. RGS shall be used in locations where subject to accidental damage or abuse and for all above grade exterior applications unless other wiring methods are specified on the drawings. All circuit conductors in excess of 600 V shall be installed in RGS.
2. RGS shall not be used in corrosive environments.
3. All RGS fittings shall be threaded. Utilize Erickson couplings where joining two (2) threaded conduits that cannot be rotated.

C. Intermediate Metal Conduit (IMC) may be used in any application, with same requirements, where RGS is allowed except for circuits operating at more than 600 V.

D. Electrical Metallic Tubing (EMT)

1. EMT may be used for lighting and receptacle branch circuits, telephone, fire alarm, communications, signal and instrumentation circuits and for control circuits. EMT may be used in masonry walls, above hung ceilings, in equipment rooms, in mechanical and electrical chases and closets, in exposed locations along ceilings or walls above normal traffic level and where not subject to accidental damage or abuse.
2. EMT shall not be used in exposed applications below eight (8) feet above finished floor or in exterior or damp/wet/corrosive locations. Electrical, telephone and communications closets are considered exempt from this restriction and

EMT may be installed below 8' AFF in this application only. EMT shall not be installed underground, in slabs on grade, in exterior locations, in hazardous areas, or for circuits operating at more than 600 V.

E. Miscellaneous Conduit Fittings

1. Expansion/Deflection Fittings: Raceways and conduit buried or secured rigidly on opposite sides of building expansion joints and long runs of exposed conduit subject to expansion and contraction due to variations in temperature shall have expansion fittings. Raceways and conduit shall cross building expansion joints at right angles. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting. Fittings shall safely deflect and/or expand/contract to twice the distance of potential movement.
2. Penetrations of all below grade exterior walls and flooring shall require approval by the Engineer and Architect. Submit proposed penetration points, size openings and penetration methods to Engineer and Architect. Penetrations shall utilize sealing fittings appropriately sized for the application. Duct bank penetrations are excluded from this requirement.
3. Sealing Fittings shall be installed wherever conduits pass from warm to cold locations to minimize condensation within the conduit. Sealing fittings shall be installed with RGS penetration of the wall and terminate in a suitably sized junction box.
4. Refer to other specification sections for requirements pertaining to sealing for hazardous atmospheres.

F. Flexible Metallic Conduit

1. Provide flexible metallic conduits for connections to electrical equipment and to equipment furnished under other Divisions that are subject to movement, vibration or misalignment and/or where noise transmission must be eliminated or reduced.
2. Flexible metallic conduit shall be liquid-tight under the following conditions:
 - a. Exterior locations
 - b. Moisture or humidity-laden atmospheres
 - c. Environments where seepage or dripping of water, grease, oil or other fluids is possible. All mechanical equipment rooms and penthouses, kitchens and;
 - d. Corrosive atmospheres

- G. Wireways shall be provided where specifically shown on the drawings or where the group mounting of controllers, disconnects, enclosures, etc warrant the use for elimination of multiple short conduit runs. Wireways shall be provided complete with all required appurtenances necessary to have a totally enclosed system rated for the environment. Wireways shall not be installed in any location where subject to accidental damage or abuse.

3.4 WIRE AND CABLE (600V)

- A. Homerun designations on the drawings are diagrammatic only. Install branch circuits and feeders from the power source to the attachment point as required for a complete system. Provide slack wire for connections to equipment installed by others. Refer to schedules and risers where specific conductor and associated raceway sizes are not indicated on the floor plans.

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- B. Connect branch circuit homerun with two (2) or three (3) circuits and common neutral only where specifically shown on the drawings. Circuits with common neutrals shall not be connected to the same phase to ensure cancellation of the return current in the neutral conductor.
- C. Install wires and cable in raceways as specified. All conductor sizing is based upon no greater than three (3) current carrying conductors in a conduit. Installation of up to six (6) circuits (no greater than twelve current carrying conductors) in a single conduit will be allowed if the conductor sizing is increased to the required ampacity to accommodate de-rating factors required by the NEC and NFPA 70.
- D. The minimum wire size shall be #12 unless #14 specifically allowed on the drawings for wiring of controls. Branch circuits longer than 75 feet for 120 V from panel to last outlet shall be increased a minimum of one (1) size above that shown on the drawings to minimize voltage drop to less than 3%.
- E. Conductors shall be identified at all accessible locations in the following manner:
1. Color code secondary service, feeders and branch circuit conductors as follows:

<u>208/120 Volts</u>	<u>Phase</u>
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground
 2. Provide nonferrous wire markers, embossed or printed to correspond with the drawings. Labels shall be permanently marked so that the source of the branch circuit or feeder may be readily identified. Hand written labels are not acceptable. Embossed tag equal to 3M Scotch Code STL-TAG or SCS-TM shall be applied with two (2) miniature cable ties or slipped through both end holes. Heat bonded tag equal to 3M Scotch Code SCS-HB shall be permanently affixed with a heat gun.
- F. Cable
1. Flexible Metal Clad (MC) cable *may be used in concealed locations for branch circuit wiring.
 2. Flexible Armored (AC) cable shall not be used.
 3. Flexible Hospital Grade Armored Cable (AC) cable shall not be used.
 4. Conductor color code shall comply with identification requirements as indicated in this section.
- G. Splices and Terminations
1. No more than twelve splices of current carrying conductors or six (6) circuits, whichever is greater, shall be allowed in a single enclosure or junction box.

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2. Splices and terminations shall be sized to the specified conductor. The insulation shall be cut back with the appropriate tools such that the conductors are not nicked or damaged.
3. The compression tool shall be appropriate for the installation of the provided lug or butt splice to ensure pressure necessary for a proper connection is applied.
4. Terminations shall not be stacked or bent unless specifically listed for the application.

H. Cable Pulling

1. Pull cables that share conduit at same time into completely installed raceway. Conductors shall not be pulled in raceways with existing wiring.
2. Submit cable pulling calculations for engineers' approval prior to all mechanically assisted pulls. Attach pull ropes to conductors with basket-weave grips on pulling eyes. Provide means to measure tension during entire pull. Utilize pulling compounds to lessen friction in accordance with the manufacturer's recommendations.
3. Mechanically assisted pulls shall utilize equipment specifically designed for the purpose such as ropes, electric wench, pulleys, etc. The use of a motorized vehicle to assist in a cable pull is prohibited.

3.5 WIRING DEVICES AND PLATES

- A. Branch circuitry shall be attached to all devices using the attachment screw or utilizing back wiring chambers that utilize screws for compressing the connection on the wire. Quick stab features that do not require a positive screw on attachment for the conductor are not acceptable.
- B. Receptacle devices for other than 20 A, 120 V, 2 W, circuits shall be provided with tags indicating voltage characteristics and circuit number of outlet that match the nameplate or engraving required on the faceplate.

3.6 OUTLET BOXES

- A. Outlet and switch boxes shall be securely fastened to metal studs with a minimum of two (2) self-tapping screws. Boxes three (3) gang and greater shall be securely fastened to studs on both sides of the box.
- B. Fasteners for mounting boxes in damp or wet locations shall be stainless steel.
- C. Pressed steel boxes shall not be used for exposed surface mounted locations below 8 feet-0 inches AFF.
- D. Outlet and switch boxes shall not be installed back to back. Stagger box installation to adjacent stud spaces to maintain sound separation between rooms.

3.7 JUNCTION AND PULL BOXES

- A. Junction box covers shall be accessible. Do not install junction boxes above suspended ceilings except where ceiling is removable or where an access panel is provided.

- B. Pull boxes connected to concealed conduits shall be mounted with covers flush with finished wall or ceiling.
- C. Pull boxes exposed to rain or in damp/wet locations shall be weatherproof NEMA 3R unless noted otherwise on the drawings.
- D. No pull box shall be within two (2) feet of another.
- E. Provide clamps, grids, cable ties and other non-conductive or combustible appurtenances to secure cables. No cable shall be unsupported for more than thirty (30) inches. Cables shall not touch or be unsupported within one (1) inch of the box cover.
- F. Each junction and pull box shall have a suitable laminated plastic nameplate with white cut letters identifying power source, voltage and driven load of the associated branch circuits or feeders.
- G. Submit box sizing calculations to confirm all box dimensions are in accordance with code requirements with product data prior to installation.

3.8 SAFETY DISCONNECT SWITCHES

- A. Provide safety disconnects as required and indicated on the drawings. Each motor shall be provided with a local disconnecting means in accordance with code requirements.
- B. Manual motor starters may be used for 120, 208, 240, or 277V, single-phase motors up to 1 HP. Switches shall disconnect all ungrounded conductors. Overload heating elements shall be properly sized and coordinated for the associated motor in accordance with code and manufactures recommendations.
- C. Disconnect switches for all applications with available fault current in excess of 10,000 amperes RMS symmetrical shall be fusible. Fuses shall be Class J, L or R and rejection clips shall be installed in the fuse holders to prohibit the installation of non-current limiting fuses.
- D. Each disconnect switch shall have a suitable laminated plastic nameplate with white cut letters identifying power source, voltage and driven load.

3.9 MOTOR STARTERS

- A. Each starter shall have a suitable laminated plastic nameplate with white cut letters identifying power source, voltage and driven load.
- B. Overload relay heater ratings shall be properly sized and coordinated for the associated motor in accordance with code and manufacturers recommendations.
- C. Field Adjustments
 - 1. The following minimum work shall be performed under the technical direction of the manufacturer's service representative.
 - a. Verify basic operation of starter from control power source.
 - b. Follow the manufacturer's instruction and the contract documents concerning any short circuit device settings, HMCP settings or timing

relays. All adjustable settings shall be documented and included in the final O. and M. manual.

3.10 LIGHTING FIXTURES

A. Fixtures

1. General

- a. Do not install fixtures until work of other trades that may damage fixtures is completed.
- b. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified.
- c. Handling of reflectors shall be done only with cotton gloves to avoid imprinting fingerprints on reflective surfaces.

2. Accessories

- a. Installation and support of fixtures shall as a minimum be in accordance with the NFPA 70 and manufacturer's recommendations.
- b. Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.
- c. Open type fluorescent fixtures with exposed lamps shall have a wire-basket type guard.

3. Suspended and Pendant Fixtures

- a. Suspended fixtures shall be provided with adjustable swivel hangers in order to ensure a plumb installation.
- b. Single unit suspended fluorescent fixtures shall have twin-stem hangers.
- c. Multiple unit or continuous-row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be ten (10) feet.
- d. Provide threaded rod to rigidly support the weight of the fixture independently of the ceiling support system. Threaded rod shall be concealed where fixture installed in an area with suspended ceilings. Support luminaries on a minimum of two (2) points (one at each end) to prevent rotation. Threaded rod, pendants or factory supplied fixture accessories (such as rods or chains) four (4) feet or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional, 120 degrees apart.
- e. Branch circuitry shall be routed to the outlet box utilizing the wiring methods outlined on the drawings and as described in these specifications. Flexible raceway may be installed to each fixture from an overhead junction where concealed above a ceiling. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

4. Support

- a. Do not suspend or support lighting fixtures, threaded rod and safety chains from hung ceiling, conduit or duct. Support fixtures with threaded rod and safety chain from structural members only. Provide supplemental steel (factory fabricated channel equal to Unistrut) where required to span structural steel members.
- b. Provide supplemental steel below ducts where fixture locations coincide with HVAC duct or mechanical piping runs and access to structure is inhibited.

- c. Supplemental steel shall be rigidly supported from structure. Where suspension is required, support supplemental steel with threaded rods to structure. Sizing of all supplemental support components is the responsibility of the Contractor.

3.11 VARIABLE FREQUENCY DRIVES

A. Storage

1. Store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals. Store all VFDs in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic.
2. Storage shall be located in well-ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between -30 °C and +25 °C. Indoor locations shall be protected to prevent moisture from entering enclosure. Heat enclosures to prevent condensation where required by the manufacturer.

B. Installation

1. Provide ½ inch spacers for VFDs mounted at exterior walls below grade to establish ½ inch air space behind enclosure.
2. Inspect installed VFDs for anchoring, alignment, grounding and physical damage. Clean interiors to remove construction debris, dirt and shipping materials.
3. Check tightness of all electrical connections with calibrated torque wrench. Minimum acceptable values are specified in manufacturer's instructions.
4. Each VFD shall have laminated plastic nameplates with white cut letters identifying power source, voltage and circuit identified for both inputs and the output. Label each VFD with the arc flash and PPE requirements defined in the power system study.
5. Coordinate the interface of all control devices into the VFD with the controls Contractor responsible for the driven equipment.

C. Start-Up and Testing

1. Provide the services of a qualified factory-trained manufacturer's representative to assist in the installation and start-up of the equipment. The manufacturer's representative shall provide technical direction and assistance in the general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
2. After installation is complete and normal and emergency power is available, the manufacturer's local dealer shall perform the following:
 - a. Verify that the equipment has been properly installed.
 - b. Check all functions for proper operation over the entire expected operating range and any special sequences such as loss of power (momentary and long term), operation from alternative power sources such as standby generation (transfer in and out), operation of the bypass system (if applicable) and sequences for all emergency modes.
 - c. Verify that all remote monitoring capabilities are fully functional.
 - d. Adjust the switching frequency to minimize audible motor noise.
 - e. Perform harmonic measurements to verify compliance to the 5% THD calculation where more than 100HP or 50% of the load at any point in the system is VFD driven. Measurements shall be done with building and systems at or near full load conditions.

3. Provide on-site training to instruct the Owner's personnel in the proper operation and maintenance of the equipment. Review operation and maintenance manuals, parts manuals and emergency service procedures with the trainees.

3.12 BASIC ACCEPTANCE TESTS

A. General Scope

1. This section covers the required field tests and inspections to assess the suitability for initial energization of electrical power distribution equipment and systems. Failed components shall be replaced and retested for no additional cost to the project.
2. The purpose of this specification is to assure that all tested electrical equipment and systems are operational and within applicable standards and manufacturer's tolerances and that the equipment and systems are installed in accordance with design specifications.
3. All testing shall be performed by the Contractor responsible for the installation of the systems or by an independent testing organization under contract with the Contractor.
4. All equipment utilized for testing shall have a valid calibration sticker. All test reports shall indicate the equipment utilized and its associated calibration due date.
5. Coordinate all required shutdowns with the Owner. Any and all testing required after the Owner has taken occupancy (temporary or permanent) shall be assumed to be conducted during premium time.
6. A written record of all tests and a final report summarizing the findings shall be submitted for approval prior to energizing any electrical power distribution equipment and systems. All equipment shall be left in clean operational condition.

B. Inspection and Test Procedures

The following tests shall be conducted using the noted section of the latest edition of NETA ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems as a reference:

1. Low Voltage Cables - All feeders illustrated on the one line diagram shall be inspected and tested in accordance with the referenced standard. Visually inspect cables for physical damage, color code and proper termination. Check continuity for proper labeling and megger for insulation resistance. Megger test voltage shall be 1000VDC for one (1) minute with no values less than 50 megohms. Tabulate readings for each feeder. NETA ATS-7.3
2. Low Voltage, Molded and Insulated Case Circuit Breakers with frame size greater than 225 amperes and/or with adjustable trip units shall be tested and adjustable settings dialed to match the coordination study criteria. Perform an insulation resistance test at 1000VDC (thermal magnetic) or 500VDC (solid state) for one (1) minute from pole to pole and pole to ground, resistance values shall not be less than 100 megohms. Perform resistance test across open and closed breaker contacts of each phase. Test trip settings tolerance with primary current injection. Tabulate readings for each breaker. NETA ATS-7.6
3. Disconnect the main bonding jumper at the service and at each separately derived system and verify single connection between the grounded and grounding conductor. Reconnect all disconnected bonding connections. Test the grounding electrode system for resistance to earth to verify a maximum of 25 ohms. NETA ATS-7.13

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END OF SECTION 26 00 00

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SECTION 26 30 12

FIRE ALARM – ADDRESSABLE MODIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. All criteria establish within Specification 26 00 00 shall apply to this section unless specifically noted otherwise.

1.2 SUMMARY

- A. Section Includes:
 - 1. Initiating Devices
 - 2. Notification Appliances.
 - 3. Acceptance and Reacceptance Testing
- B. Related Sections include the following:
 - 1. Division 26 00 00 Electrical

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Product Data: For each required component provide manufacturer's standard cut sheet containing technical details, listings and general information illustrating compliance with these specification requirements.
- B. Provide the following detailed documentation for review and evaluation:
 - 1. Point to point wiring diagrams of the entire system including all conductor quantity and sizing, labeling (numerical and color coding) and interconnections.

2. Floor plans illustrating each initiating device and notification appliance with an assigned unique identification. This identification and audible notification appliance tap settings shall be illustrated on the floor plans and submitted for approval with the wiring diagrams.
 3. Individual device interconnection diagrams. Panel layouts shall indicate module placement and spare capacity allowance for future expansion.
 4. Manufacturers catalog cut sheets of all components and devices.
 5. Battery capacity calculations clearly indicating required and spare capacity.
 6. Power supply capacity calculations including each circuit load, voltage drop and spare capacity.
- C. Submission of certification records for qualifications of the technicians performing final connection and testing.
- D. Submit written test report in accordance with NFPA72 Chapter 14 for notification of successful completion of each required test and a system Record of Completion in accordance with NFPA72 Section 10.18. Provide floor plan illustrating ambient and alarm sound levels to document notification appliance testing.

1.5 CLOSEOUT SUBMITTALS

- A. Submit operations manual detailing all functions and operations of the system. User operating instructions shall be provided prominently displayed on a separate sheet located next to the control unit in accordance with UL Standard 864.
- B. Submit maintenance manuals and recommended spare parts list required to conform to NFPA maintenance guidelines. Instructions shall include but not be limited to:
1. Instructions for replacing any components of the system, including internal parts.
 2. Instructions for periodic cleaning and adjustment of equipment with a schedule of these functions.
 3. A complete list of all equipment and components with information as to the address and telephone number of both the manufacturer and local supplier of each item.
- C. As-built drawings shall include all device addresses, alphanumeric descriptors assigned in the control panel, and final notification appliance tap settings with modified spare power supply capacity illustrated.

1.6 QUALITY ASSURANCE

- A. The system design and installation shall conform to the following standards
1. All equipment shall be UL listed for its intended purpose.
 2. All applicable NFPA standards, including but not limited to: 70, 72, 90A, 92A, and 101.
 3. State Building Code.
 4. The Americans with Disabilities Act (ADA)
 5. All requirements of the Authority Having Jurisdiction (AHJ)
- B. The equipment supplier and the Contractor shall demonstrate a minimum five (5) years' experience in the successful design and installation of addressable fire alarm systems

similar in size and scope to that required for this project.

1.7 WARRANTY

- A. The installer and manufacturer's warranty shall be for a minimum period of one (1) year from the date of the final acceptance test approval.
- B. Include as part of their base bid the cost of a one-year test and inspection contract, to be held by the company which shall certify the completed installation. The contract shall provide for quarterly inspections in accordance with NFPA72 and local requirements. Any equipment found to be defective during the warrantee period shall be replaced by the Contractor at no additional charge to the Owner.

1.8 COORDINATION

- A. Coordinate sizes and locations actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide the illustrated changes to the existing addressable fire detection, alarm and control system with signaling devices in compliance with all applicable codes and authorities having jurisdiction.
- B. Provide automatic and manual, closed circuit, multiplex fire alarm communications according to the following Specifications and as shown on the Drawings, wired, connected and left in first class operating condition.
 - 1. System shall operate from 3 wire AC supply with emergency generator backup on failure of normal system and integral standby battery source backup on failure of the emergency generator.
 - 2. Equipment shall be UL listed for use with the existing FACP.

2.2 SEQUENCE OF OPERATION

- A. Refer to Sequence of Operation Matrix on the plans and the Fire Protection Narrative for the intended system operation.

2.3 CONTROL

- A. General Requirements
 - 1. Standby batteries shall support the system in the event of a loss of primary power for twenty-four (24) hours of full supervisory operation followed by fifteen (15) minutes of alarm.
 - 2. Addressable loop wiring (Signaling Line Circuits - SLC) shall be wired in a Class

Class A method. Each circuit shall allow for a minimum of 25% additional devices.

3. Communication circuits between networked fire alarm control panels shall be Class A.
4. Isolation Modules shall be provided to maintain circuit integrity in the event of an open, short or ground fault. Each addressable loop shall have a minimum of one (1) isolation module for every twenty (20) devices or one (1) per floor; whichever is greater.
5. Non-addressable loop wiring (Initiating Device Circuits - IDC) shall be wired in a Class A method.
6. Audible and visual circuits (Notification Appliance Circuits - NAC) shall be wired in a Class A method. Each circuit shall allow for a minimum of 25% additional devices. Provide a minimum of two (2) circuits per floor or area, alternately wiring adjacent notification appliances between circuits.

B. Remote Cabinets

1. Provide distributed intelligent power supplies to accommodate the power requirements of NAC circuits. Power supplies shall communicate with the FACP via data communications, whereby each power supply shall report a loss of AC power, battery fail or ground fault, and each notification appliance circuit served shall be individually monitored for wiring integrity.
2. Provide fire alarm terminal cabinets where necessary. The cabinets shall have a removable hinged cover with lock and high barrier terminal strips with 64 or 128 point capacity mounted to a plywood backboard. Terminal cabinets shall be red and labeled with permanent white lettering

2.4 INITIATING DEVICES AND ACCESSORIES

- A. Provide addressable detectors as shown on the drawings. Detectors shall be connected to the addressable loop with two (2) wires. All detectors shall incorporate built-in identification for the system to automatically identify various types of sensors. Detectors shall utilize a flashing LED which denotes normal operation, and latched LED which indicates an alarm condition. All common types of analog detectors shall be interchangeable with common twist-lock bases. The standard base shall have a supervised LED output and optional relay and isolator bases shall be available.
- B. Analog sensors shall provide indication to the control panel that a detector requires maintenance, and shall operate in stand-alone mode in the event of an addressable loop communications failure.
- C. Analog Photoelectric Smoke Detectors shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, air temperature, humidity, etc.), and shall allow changes in sensitivity levels within the UL approved sensor's range. The photoelectric detector shall consist of a dust resistant, field cleanable photo chamber with microprocessor based solid state electronics.
- D. Analog Duct Smoke Detectors shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, air temperature, humidity, etc.), and shall allow changes in sensitivity levels within the UL approved sensor's range. Detector shall be in accordance with the ceiling mounted device specified above. Duct detectors

shall be supplied with a housing, remote indicator and sampling tubes sized according to duct width.

- E. Furnish each duct smoke detector with alarm and remote test control station. Test control shall be key actuated two position Test-Normal.
- F. Analog Thermal detectors shall monitor the ambient temperature from 32 to 158° F, and provide fast response to rapid increases in temperature. Rate of rise detection rate and fixed set point shall be panel selectable.
- G. Manual Pull Stations shall be double action type with screw terminals and an integral toggle switch. The station shall be constructed of red Lexan with white raised letters, a key reset switch. The station shall have integral addressable electronics and mount to a standard single gang switch box or to a red cast aluminum, surface mount box when required.
- H. Provide clear Lexan covers over specified pull stations. Cover shall be provided with integral battery operated alarm module, which will emit a loud audible alert when the cover is opened. Covers shall be equal to Stopper or Sentry.
- I. Monitor Modules shall be provided to monitor and connect conventional initiating devices onto the addressable loop.

2.5 NOTIFICATION APPLIANCES

- A. Primary Notification Appliances shall be flush mounted combination horn/strobe speaker/strobe units. Assembly shall be mounted on red lexan frame, on surface or flush wall box. Where box is surface mounted, it shall be red cast aluminum.
- B. Visual notification appliances shall be self-synchronizing xenon strobes rated by UL 1971 test criteria and in accordance with the Americans with Disabilities Act and NFPA 72. Appliances shall have a field adjustable intensity listing ranging from 15 candela(cd) to 110 candela(cd) or as otherwise specified on the drawings.
- C. Audible notification appliances shall have a field adjustable UL 464 sound pressure level listing ranging from 80dBA to 90dBA at ten (10) feet.
- D. Remote Alarm Indicators shall be LED indicators on single gang plastic plates for smoke detectors as indicated on the plans.
- E. Control Modules shall be to supervise and control conventional devices (notification circuits, AHUs, door holders, etc.) over the addressable loop. Control modules shall provide a supervised output rated for 2 amps at 24VDC, and .5 amps at 120VAC.

2.6 ACCESSORIES

- A. Remote Alarm Indicators shall be LED indicators on single gang plastic plates for smoke

detectors as indicated on the plans.

- B. Control and Relay Modules shall be used to control conventional devices (notification circuits, AHUs, door holders, etc.) over the addressable loop. Modules shall provide a supervised output rated for 2 amps at 24VDC, and .5 amps at 120VAC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All interconnections shall be installed in accordance with the manufacturer's system wiring diagrams.
- B. Final connections, program editing, and testing shall be conducted by qualified personnel with one of the following qualifications:
 - 1. Factory trained and certified by the equipment manufacturer.
 - 2. National Institute of Certification in Engineering Technologies (NICET) or IMSA fire alarm certified.
 - 3. Trained and qualified by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Labels
 - 1. All panels, terminal cabinets and annunciators shall be labeled with the Red plastic nameplates in accordance with other sections of this specification.
 - 2. Remote Alarm Indicators and Remote Test and Alarm Stations shall be labeled with the Red plastic nameplates in accordance with other sections of this specification. The label shall indicate the device monitored and associated mechanical equipment tag or room designation where applicable.
 - 3. All detectors shall be labeled with its assigned address on both the detector housing and the base with a black on clear typed label equal to Kroy 0.375 Industrial UV. The base address shall be legible without removal of the detector. The detector address shall be concealed when placed into the base.
- D. Wiring
 - 1. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems.
 - 2. Wiring for the fire alarm system shall be installed in conduit with limitations as outlined in 26 00 00. Exposed plenum rated wire/cable and/or fire alarm low energy cable will not be accepted.
 - 3. Minimum wire sizes shall be as follows:
 - a. Addressable loop wiring shall utilize minimum #16 AWG.
 - b. Notification appliance circuits shall utilize minimum #14 AWG.
 - c. Network communications wiring shall be a solid conductor non-shielded #16 twisted pair minimum.
 - d. All junction boxes shall be sprayed red and labeled "Fire Alarm". Conduit couplings shall be spray painted red prior to installation.
 - e. Connections and splices shall be made using screw terminal blocks. No more than one conductor shall be installed under any screw terminal. The uses of wire nut type connectors are prohibited in the system.

- f. All circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be labeled in accordance with the wiring diagram. Labeling and color coding shall be consistent throughout the conductor run.
 - g. Wiring within any enclosure shall be readily accessible without removing any component parts.
 - h. No more than half loudspeaker/strobes or horn/strobes serving any floor or zone shall be connected to same circuit. Adjacent devices shall be alternately wired between circuits.
 - i. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.
4. Detectors
- a. Detectors placement shall be in accordance with NFPA 72 requirements and recommendations.
 - b. Detectors shall be at least twelve (12) inches from any part of any lighting fixture and at least three (3) feet from diffusers of air handling systems.
 - c. Each detector shall be provided with appropriate mounting hardware as required by its mounting location.
 - d. Smoke detectors shall not be installed until the building has been thoroughly cleaned. Dust covers shall be installed over all smoke detectors until final testing commences. All detectors, which indicate reduced sensitivity due to dirty condition, shall be cleaned prior to commencement of final testing.
 - e. Detectors shall be provided with wire guard cages where subjected to physical abuse, such as in gymnasiums.
5. Notification Appliances
- a. Notification appliances shall be mounted in accordance with NFPA 72.
 - b. Coordinate final quantity, location and power settings of audible notification appliances with ambient sound levels and interior finishes to comply with minimum & maximum sound pressure level requirements as follows:
 - 1) Total sound pressure level produced by combining ambient with all audible notification appliances operating shall not exceed 110dBA at the minimum hearing distance.
 - 2) An average ambient sound pressure level of 105dBA shall require the use of visible notification appliances.
 - 3) Unless otherwise permitted by NFPA 72, minimum sound pressure level produced by audible notification appliances shall be 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of at least 60 seconds, whichever is greater, measured five (5) feet above the floor.
6. Modify the system annunciator to indicate the added devices in accordance with the drawings.

3.2 TESTING

- A. Notify the Owner's Representative ten (10) business days before the tests are to be conducted. The tests shall be performed in accordance with the approved test

procedures in the presence of the Owner's Representative. Furnish all instruments and personnel required for the tests.

B. Preliminary Tests

1. Perform insulation testing (megger), continuity and loop resistance checks on all new system conductors to determine that the system is free from grounded, shorted, or open circuits. These tests shall be conducted prior to the installation of fire alarm equipment. Loop resistance measurement shall verify that the loop resistance does not exceed the manufacturer's specified limits. Corrections shall be made and the system shall be retested to assure if deficiencies are found.
2. Measure air flow with pressure sensor at each duct smoke detector sampling port, at the lowest design air flow of the duct system. Sampling air flow shall exceed smoke detector manufacturer's requirements.
3. Perform complete functional and operational performance tests. Testing shall include verification that the circuits and components are electrically supervised and operate as intended. Coordinate functional testing with Elevator and HVAC Contractors where applicable to verify function of all control interfaces such as elevator recall and air handling unit shutdowns.
4. Reacceptance testing shall be performed in accordance with NFPA 72 14.4.1.2 where applicable (testing of 10% of existing devices not affected by scope of work, etc.).
5. A written report detailing the results of the preliminary tests shall accompany the request for Final Acceptance Test. The written Preliminary Test Report shall be submitted with:
 - a. Copy of FACP printer output verifying proper operation of each device in alarm or trouble, time stamped throughout the testing process.
 - b. The Operations and Maintenance Manual for the system.
 - c. The record (as-built) drawings.

C. Final Acceptance Test

1. The Fire Alarm System, other systems and equipment associated with the fire alarm system and accessory equipment shall be tested in accordance with NFPA 72. Verification of system completion shall be documented with a fully executed copy of the Record of Completion per NFPA 72 Figure 10.18.2.1.1. The listed tests in NFPA 72 Table 14.4.2.2 shall be conducted and documented with an executed copy of Figure 14.6.2.4 as well as manufacturer and job specific procedures to verify that the circuits and components are electrically supervised and operate as intended. The test shall include but shall not be limited to the following:
 - a. Visual inspection of all wiring connections.
 - b. Test of each function of the control panel.
 - c. Test of each circuit in both trouble and normal modes.
 - d. Tests of each alarm initiating device in both normal and trouble conditions. Remove each device from its base to test the supervisory feature.
 - e. Tests of each control circuit and device.
 - f. Tests of each alarm notification appliance. Open the wiring at the midpoint of the circuit to test the wiring supervisory feature. Provide copy of FACP printer output verifying proper operation. Verify each device's audible and visual output.
 - g. Tests of the primary and secondary power supplies and associated loss of each.

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- h. Complete operational tests under emergency power supply.
- i. Ground fault monitoring circuit function.
- j. Measurement of sound pressure levels throughout the protected space.
Provide background and evacuation signal sound levels on the floor plan submitted with device address and tap settings.

END OF SECTION 26 30 12

SECTION 323113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 SUMMARY

- A. Section Includes:
 - 1. Chain-link fences.
 - 2. Swing gates.
 - 3. Privacy slats.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 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 the following:
 - a. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Accessories: Privacy slats.
 - d. Gates and hardware.
- B. Shop Drawings: For each type of fence and gate assembly.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include accessories, hardware, gate operation, and operational clearances.
- C. Samples for Initial Selection: For each type of factory-applied finish.
- D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:
 - 1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

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- E. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer licensed in the State of Connecticut responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Product Certificates: For each type of chain-link fence and gate.
- C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to comply with performance requirements.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7 and the Connecticut State Building Code.
 - 1. Design Wind Load: As indicated on Drawings.

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- a. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

2.2 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Steel Wire for Fabric: Wire diameter of 9 gauge.
 - a. Mesh Size: 2 inches.
 - b. Polymer-Coated Fabric: ASTM F 668, Class 2b over zinc-coated steel wire.
 - 1) Color: As selected by Architect from manufacturer's full range, according to ASTM F 934.
 - c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
2. Selvage: Twisted top and knuckled bottom.

2.3 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: 72 inches.
2. Heavy-Industrial-Strength Material:
 - a. Line Post: 1.9 inches in diameter.
 - b. End, Corner, and Pull Posts: 2.375 inches (60 mm) in diameter.
3. Horizontal Framework Members: Top and bottom rails according to ASTM F 1043.
 - a. Top Rail: 1.66 inches in diameter.
4. Brace Rails: ASTM F 1043.
5. Metallic Coating for Steel Framework:
 - a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.

2.4 SWING GATES

- A. General: ASTM F 900 for gate posts and double swing gate types.
 1. Gate Leaf Width: As indicated.
 2. Framework Member Sizes and Strength: Based on gate fabric height of 72 inches.

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- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework.
 - 2. Gate Posts: Round tubular steel.
 - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Assembled with corner fittings].
- D. Hardware:
 - 1. Hinges: 180-degree outward swing.
 - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

2.5 FITTINGS

- A. Provide fittings according to ASTM F 626.
- B. Post Caps: Provide for each post.
 - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
 - 2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch- diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- H. Finish:
 - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.
 - a. Polymer coating over metallic coating.

2.6 PRIVACY SLATS

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- A. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch thick, sized to fit mesh specified for direction indicated.
- B. Color: As selected by Architect from manufacturer's full range.

2.7 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
 - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
 - b. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and

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placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- E. Line Posts: Space line posts uniformly at 96 inches o.c., maximum.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- H. Intermediate and Bottom Rails: Secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- K. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- L. Privacy Slats: Install slats in direction indicated, securely locked in place.
 - 1. Vertically, for privacy factor of 70 to 75.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 ADJUSTING

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- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13

DRAWINGS

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ARCHITECT:
CGKV Architects, Inc.

ENGINEERS AND CONSULTANTS:

NV5 - MEP Engineers
Lin Associates, Inc. - Structural Engineers
A.M. Fogarty & Associates - Cost Estimators
Architx Architecture - Specifications

ABBREVIATIONS

ACT	Acoustical Ceiling Tile	FL	Floor	MISC	Miscellaneous
A.F.F.	Above Finished Floor	FL	Flashing	M.O.	Masonry Opening
ALUM	Aluminum	F.T.	Fire Treated	MOD	Modified
BIT	Bituminous	FTG	Footing	MTL	Metal
BM	Beam	GA	Gauge	OC	On Center
BOT/BOTT	Bottom	GALV	Galvanized	OPNG	Opening
CJ	Control Joint	G.C.	General Contractor	PLAS	Plaster
CLNG	Ceiling	GL	Glass	P.T.	Pressure Treated
CLOS	Closet	G.R.	Ground	R.D.	Roof Drain
CMU	Concrete Masonry Unit	G.W.B.	Gyp. Wall Board	RM	Room
CON	Construction	GYP	Gypsum	SEC	Section
CONC	Concrete	H.C./HC	Handicap	SF	Square Feet
CONT	Continuous	HM	Hollow Metal	STOR	Storage
CORR	Corridor	HORIZ	Horizontal	STRUCT	Structural
C.R.	Class Room	HR	Hand Rail	TMP	Tempered
DOC	Documents	HVAC	Heating, Ventilating...	T&G	Tongue & Groove
DN	Down	INC	Incorporated	TME	To Match Existing
DRG/DWG	Drawing	JAN	Janitor	TYP	Typical
EA	Each	LAM	Laminated	U.O.N.	Unless Otherwise Noted
ELEC	Electrical	LAV	Lavatory	VCT	Vinyl Composition Tile
EL/ELEV	Elevation	MANUF	Manufacturer	VERT	Vertical
EQ	Equal	MAX	Maximum	VEST	Vestibule
EX/EXIST	Existing	MECH	Mechanical	V.I.F.	Verify In Field
F.A.	Forced Air	M/E/P/FP	Mechanical/Electrical/ Plumbing/Fire Protection	WD	Wood
FIN	Finish				

GENERAL NOTES:

- ALL DETAILS ARE TYPICAL. LOCATIONS NOT DETAILED SHALL BE CONSTRUCTED IN A SIMILAR MANNER.
- ALL WORK TO BE IN COMPLIANCE WITH APPLICABLE LOCAL, STATE, AND FEDERAL REGULATIONS.
- CONTRACTOR IS RESPONSIBLE FOR FIELD MEASURING EXISTING CONDITIONS PRIOR TO CONSTRUCTION. VERIFY ALL EXISTING CONDITIONS IN THE FIELD. DISCREPANCIES NOTED BY THE CONTRACTOR MUST BE BROUGHT TO THE OWNER'S ATTENTION PRIOR TO CONSTRUCTION. DIMENSIONS INDICATED IN THESE DRAWINGS ARE APPROXIMATE.
- MECHANICAL, ELECTRICAL, AND PLUMBING ITEMS TO BE REMOVED AND REINSTALLED BY LICENSED CONTRACTOR. DRAWINGS ARE DIAGRAMMATIC ONLY. EXACT LOCATIONS SHALL BE COORDINATED IN THE FIELD. FURNISH AND INSTALL ALL INCIDENTAL ACCESSORIES NECESSARY TO MAKE THE WORK COMPLETE FOR OPERATION.
- PROVIDE TEMPORARY OVERHEAD PROTECTION AT ALL ENTRANCES, AND EXITS BELOW WORK AREAS.
- REFER TO SPECIFICATIONS.
- EXISTING DETERIORATED MATERIALS SHALL NOT BE CONCEALED. REPORT TO OWNER UPON DISCOVERY.
- PROPERLY PROTECT EXISTING COMPONENTS FROM DAMAGE DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR REPLACING OR RESTORING DAMAGED MATERIALS DURING DEMOLITION AND CONSTRUCTION.
- DUMPSTERS AND ALL OTHER CONSTRUCTION EQUIPMENT LOCATIONS SHALL BE ACCEPTABLE TO THE OWNER. PROPERLY PROTECT PAVING AND OTHER SURROUNDING MATERIALS FROM DAMAGE DURING CONSTRUCTION.
- ALL MATERIALS ARE NEW UNLESS OTHERWISE NOTED AS EXISTING.
- THE BUILDING WILL BE OCCUPIED DURING CONSTRUCTION. COORDINATE WITH THE OWNER TO AVOID CONFLICTS AND PROTECT THE SAFETY OF THE BUILDING OCCUPANTS. REFER TO THE SPECIFICATIONS FOR ACCEPTABLE HOURS OF CONSTRUCTION.
- MEANS AND METHODS OF CONSTRUCTION AS WELL AS COMPLIANCE WITH OSHA AND OTHER SAFETY LAWS AND REGULATIONS IS EXCLUSIVE RESPONSIBILITY OF THE CONTRACTOR.
- ALL APPROPRIATE PERMIT FEES SHALL BE INCLUDED IN BID PRICE.
- ROOF SHALL BE WEATHERTIGHT AT THE END OF EACH WORK DAY.
- AREAS OF NEW ROOFING SHALL BE CORRECTED WHERE PONDING WATER IS EVIDENT.
- THE BUILDING WILL BE OCCUPIED AND ALL NECESSARY MEASURES SHALL BE TAKEN TO PROVIDE CONTINUOUS OPERATION, INCLUDING TEMPORARY HEAT OR POWER AS REQUIRED TO MAINTAIN CONTINUED USE. ENTRANCES AND EXITS SHALL BE AVAILABLE TO THE PUBLIC.

LIST OF DRAWINGS

T-1 Title Sheet

Architectural Drawings

- AD-1 Ground Floor Plan - Demo
- AD-2 First Floor Plan - Demo
- AD-3 Second Floor Plan - Demo
- AD-4 Roof Plan - Demo
- AD-5 Ground Floor Reflected Ceiling Plan - Demo
- AD-6 First Floor Reflected Ceiling Plan - Demo
- AD-7 Second Floor Reflected Ceiling Plan - Demo
- A-1 Roof Plan - Proposed
- A-2 Test Cuts / Details
- A-3 Details

Mechanical Drawings

- M-0.0 Mechanical Legend Notes and Abbreviations
- M-0.1 Mechanical Notes
- MD-2.1 Mechanical Ground Floor Demo Plan
- MD-2.2 Mechanical First Floor Demo Plan
- MD-2.3 Mechanical Second Floor Demo Plan
- MD-2.4 Mechanical Roof Demo Plan
- M-2.1 Mechanical Ground Floor New Work Plan
- M-2.2 Mechanical First Floor New Work Plan
- M-2.3 Mechanical Second Floor New Work Plan
- M-2.4 Mechanical Roof New Work Plan
- M-6.0 Mechanical Controls
- M-6.1 Mechanical Controls
- M-6.2 Mechanical Controls
- M-6.3 Mechanical Controls
- M-7.0 Mechanical Details
- M-7.1 Mechanical Details

Mechanical Drawings

- M-8.0 Mechanical Schedules
- M-8.1 Mechanical Schedules
- M-8.2 Mechanical Schedules

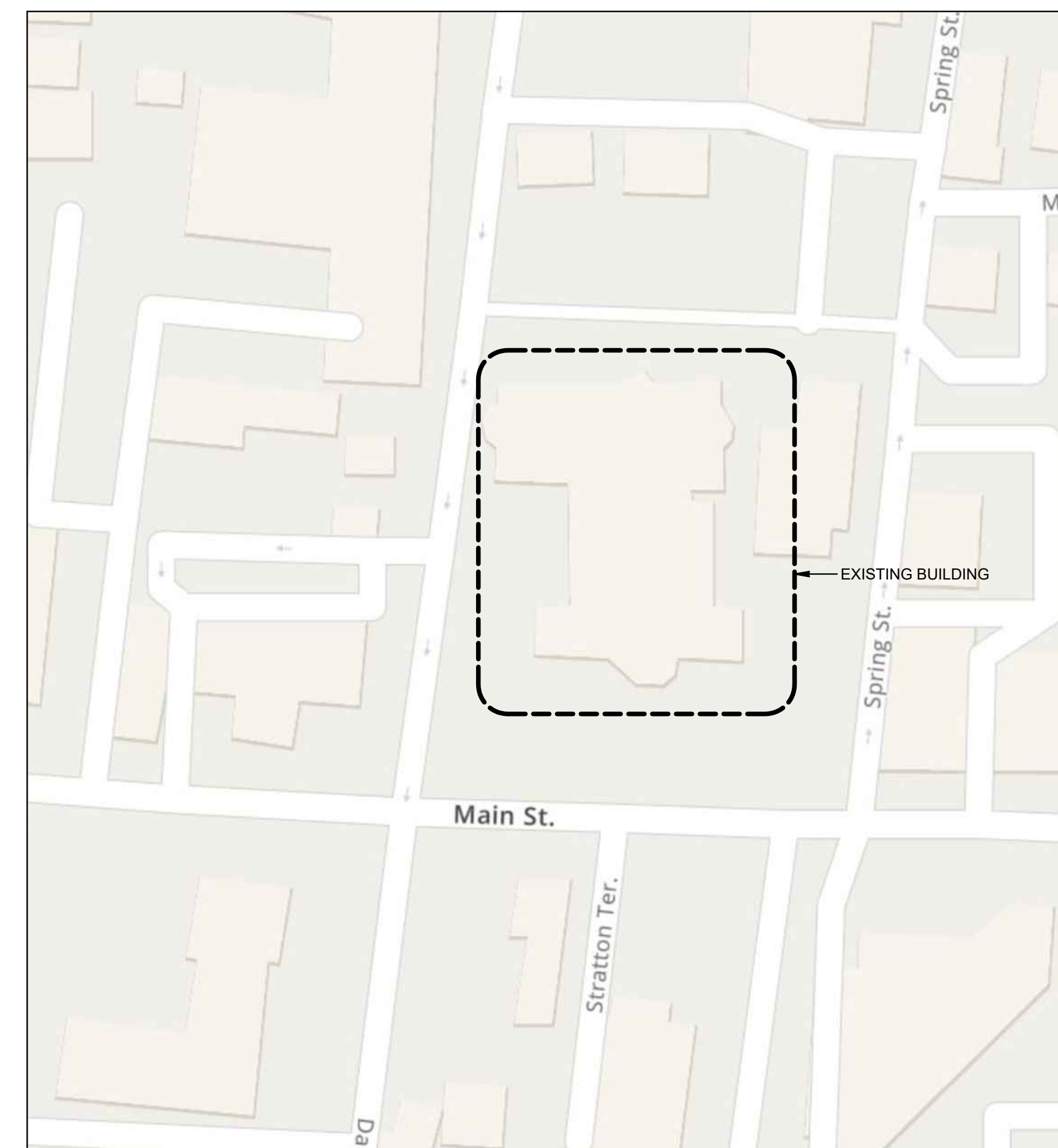
Electrical Drawings

- E-0.0 Electrical Legend Notes and Abbreviations
- ED-2.1 Electrical Power Ground Floor Demo Plan
- ED-2.2 Electrical Power First Floor Demo Plan
- ED-2.3 Electrical Power Second Floor Demo Plan
- ED-2.4 Electrical Power Roof Demo Plan
- E-2.1 Electrical Power Ground Floor New Work Plan
- E-2.2 Electrical Power First Floor New Work Plan
- E-2.3 Electrical Power Second Floor New Work Plan
- E-2.4 Electrical Power Roof New Work Plan
- E-8.0 Electrical Details
- E-9.0 Electrical Schedules

Fire Alarm Drawings

- FA-0.0 Electrical Fire Alarm Legend Notes and Abbreviations
- FA-2.3 Electrical Fire Alarm Second Floor New Work Plan

LOCUS MAP



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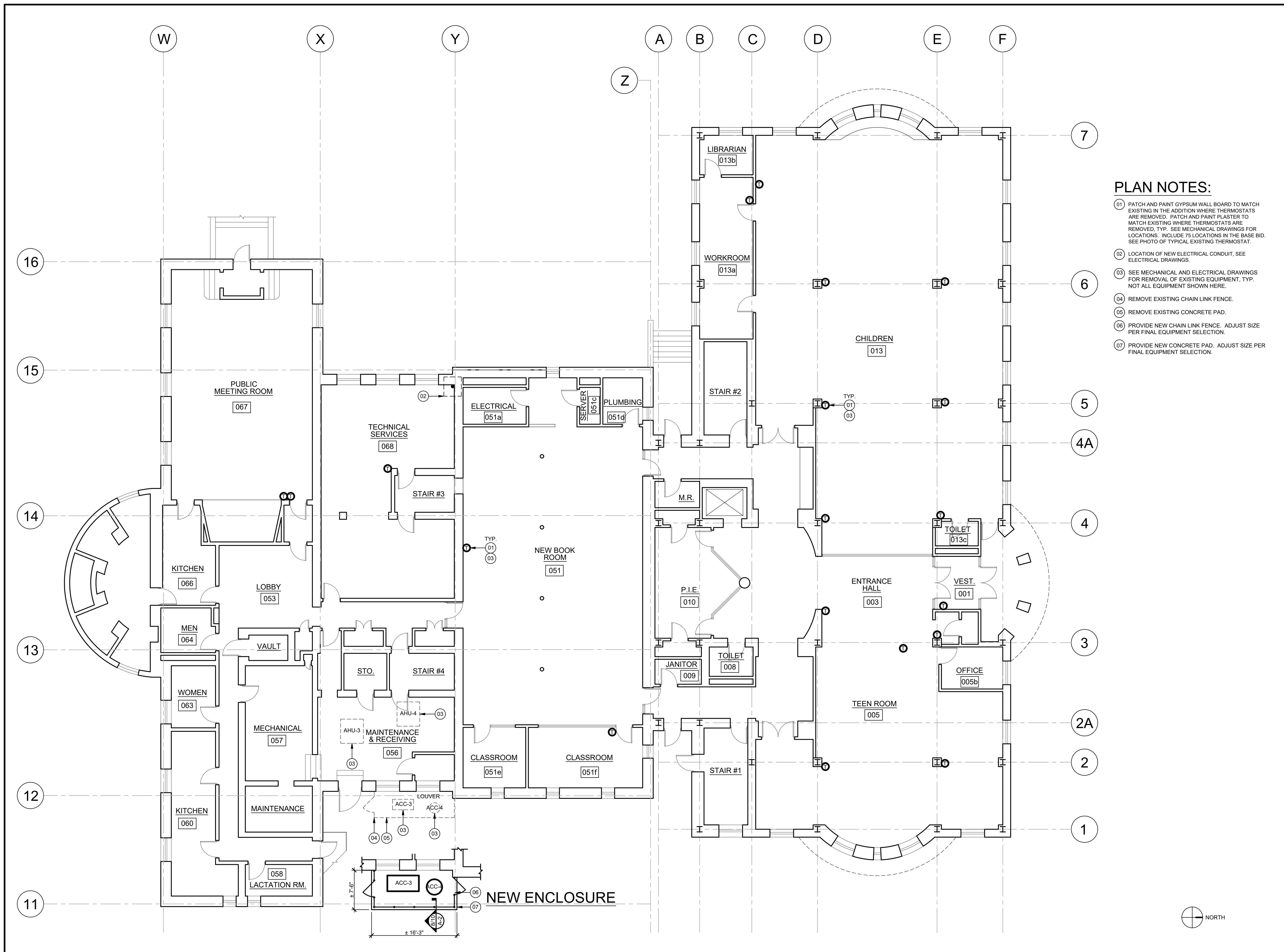
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TITLE SHEET



PLAN NOTES:

- 01 PATCH AND PAINT GYPSUM WALL BOARD TO MATCH EXISTING IN THE ADDITION WHERE THERMOSTATS ARE REMOVED. PATCH AND PAINT PLASTER TO MATCH EXISTING WHERE THERMOSTATS ARE REMOVED. TYP. SEE MECHANICAL DRAWINGS FOR LOCATIONS. INCLUDE 75 LOCATIONS IN THE BASE BID. SEE PHOTO OF TYPICAL EXISTING THERMOSTAT.
- 02 LOCATION OF NEW ELECTRICAL CONDUIT. SEE ELECTRICAL DRAWINGS.
- 03 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR REMOVAL OF EXISTING EQUIPMENT, TYP. NOT ALL EQUIPMENT SHOWN HERE.
- 04 REMOVE EXISTING CHAIN LINK FENCE.
- 05 REMOVE EXISTING CONCRETE PAD.
- 06 PROVIDE NEW CHAIN LINK FENCE. ADJUST SIZE PER FINAL EQUIPMENT SELECTION.
- 07 PROVIDE NEW CONCRETE PAD. ADJUST SIZE PER FINAL EQUIPMENT SELECTION.

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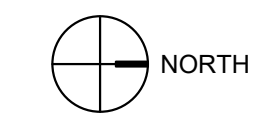
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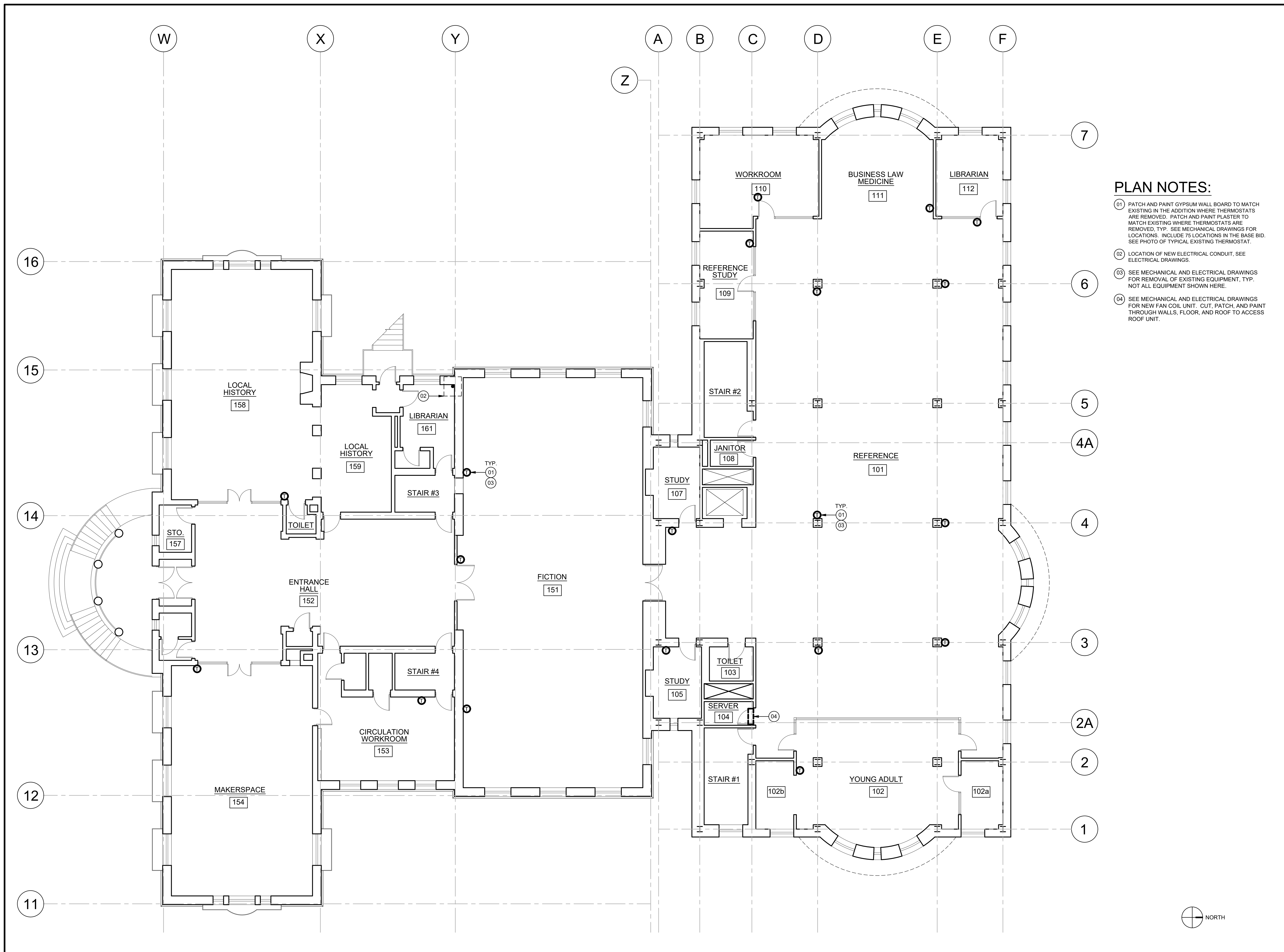
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GROUND FLOOR PLAN - DEMO





PLAN NOTES:

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- 02 LOCATION OF NEW ELECTRICAL CONDUIT. SEE ELECTRICAL DRAWINGS.
- 03 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR REMOVAL OF EXISTING EQUIPMENT. TYP. NOT ALL EQUIPMENT SHOWN HERE.
- 04 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR NEW FAN COIL UNIT. CUT, PATCH, AND PAINT THROUGH WALLS, FLOOR, AND ROOF TO ACCESS ROOF UNIT.

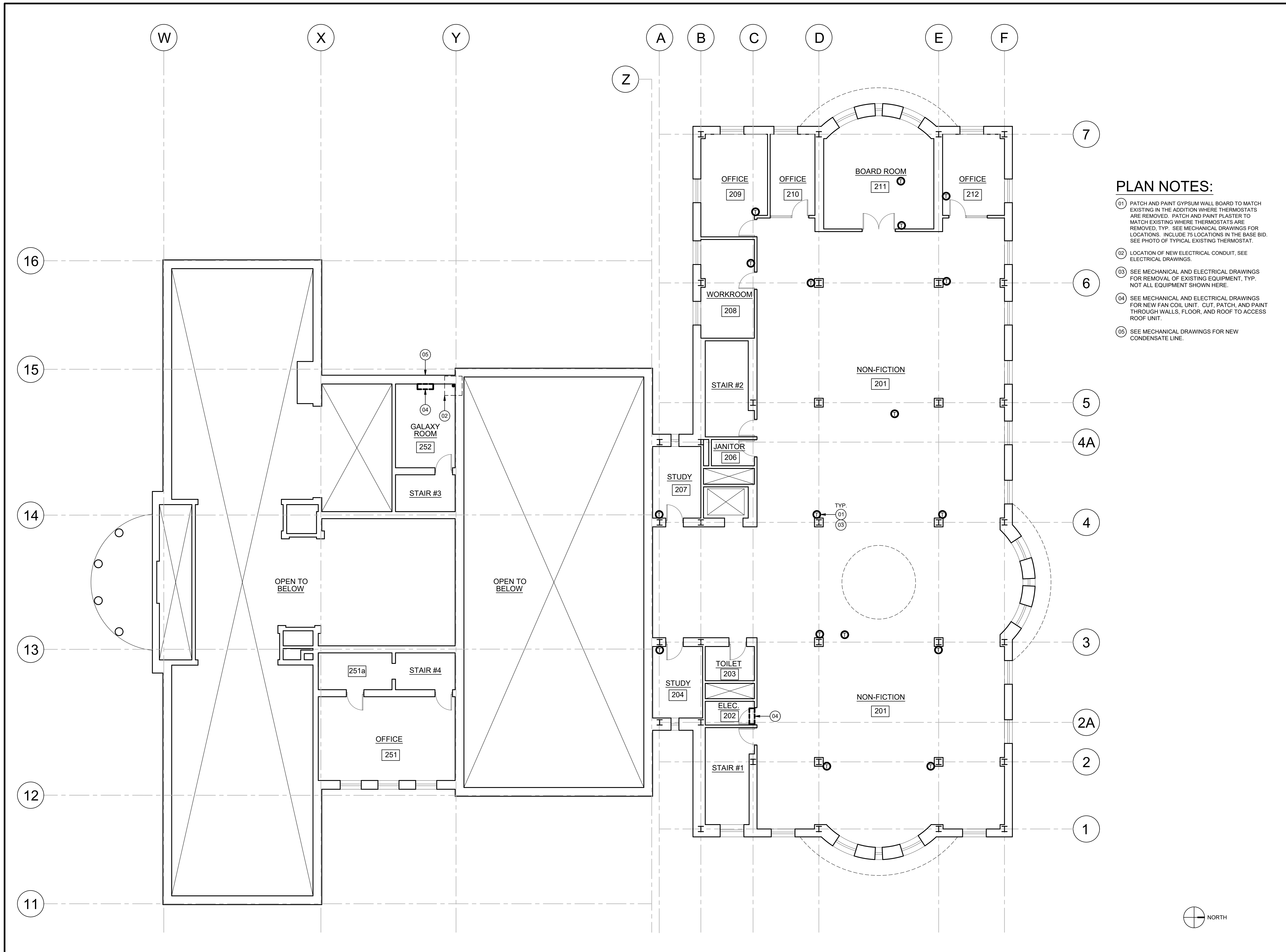
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FIRST FLOOR PLAN - DEMO



PLAN NOTES:

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- 02 LOCATION OF NEW ELECTRICAL CONDUIT. SEE ELECTRICAL DRAWINGS.
- 03 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR REMOVAL OF EXISTING EQUIPMENT. TYP. NOT ALL EQUIPMENT SHOWN HERE.
- 04 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR NEW FAN COIL UNIT. CUT, PATCH, AND PAINT THROUGH WALLS, FLOOR, AND ROOF TO ACCESS ROOF UNIT.
- 05 SEE MECHANICAL DRAWINGS FOR NEW CONDENSATE LINE.

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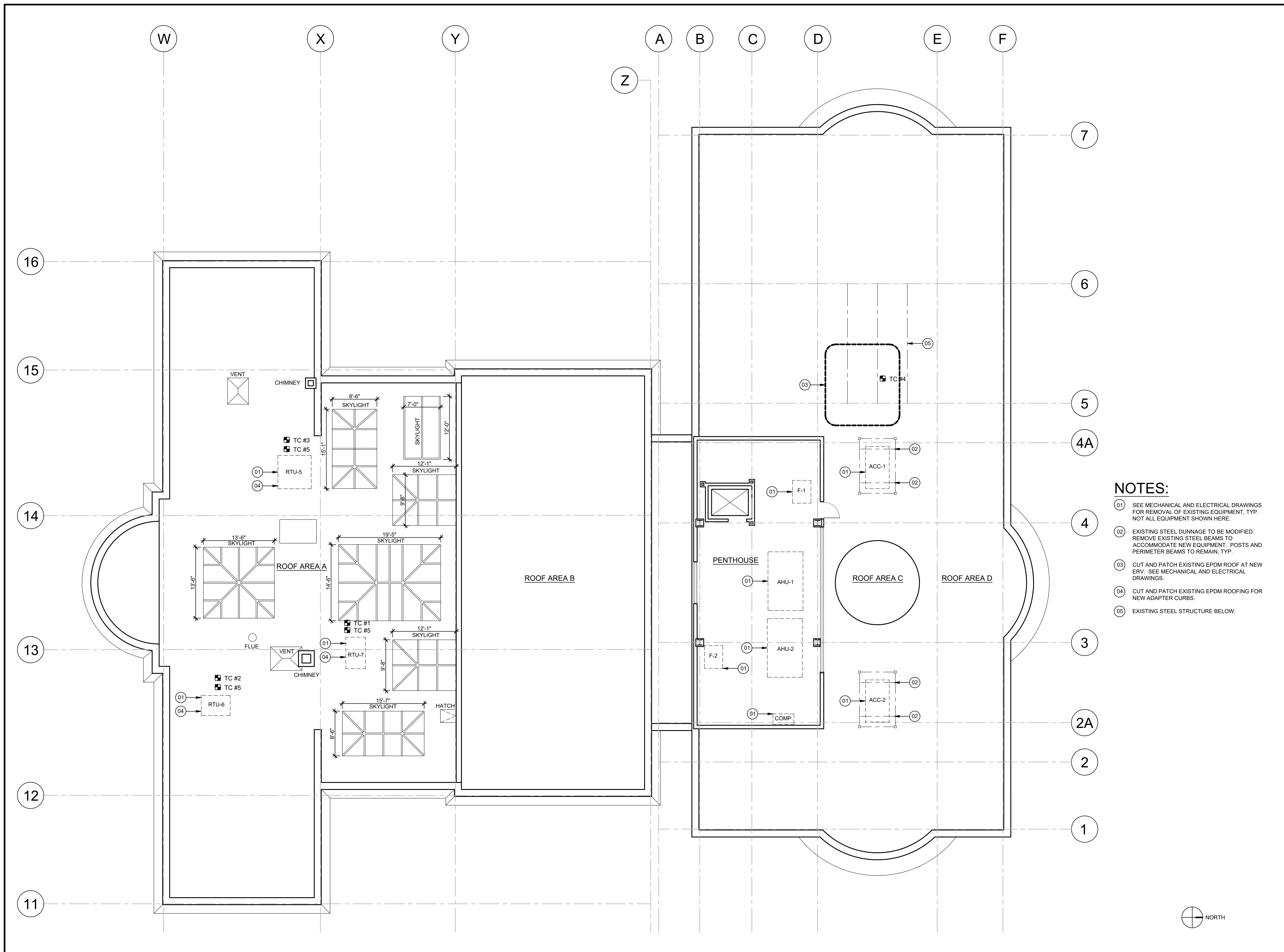
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SECOND FLOOR PLAN - DEMO





NOTES:

- 01 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR REMOVAL OF EXISTING EQUIPMENT, TYP. NOT ALL EQUIPMENT SHOWN HERE.
- 02 EXISTING STEEL DUNNAGE TO BE MODIFIED. REMOVE EXISTING STEEL BEAMS TO ACCOMMODATE NEW EQUIPMENT. POSTS AND PERIMETER BEAMS TO REMAIN, TYP.
- 03 CUT AND PATCH EXISTING EPDM ROOF AT NEW ERV. SEE MECHANICAL AND ELECTRICAL DRAWINGS.
- 04 CUT AND PATCH EXISTING EPDM ROOFING FOR NEW ADAPTER CURBS.
- 05 EXISTING STEEL STRUCTURE BELOW.

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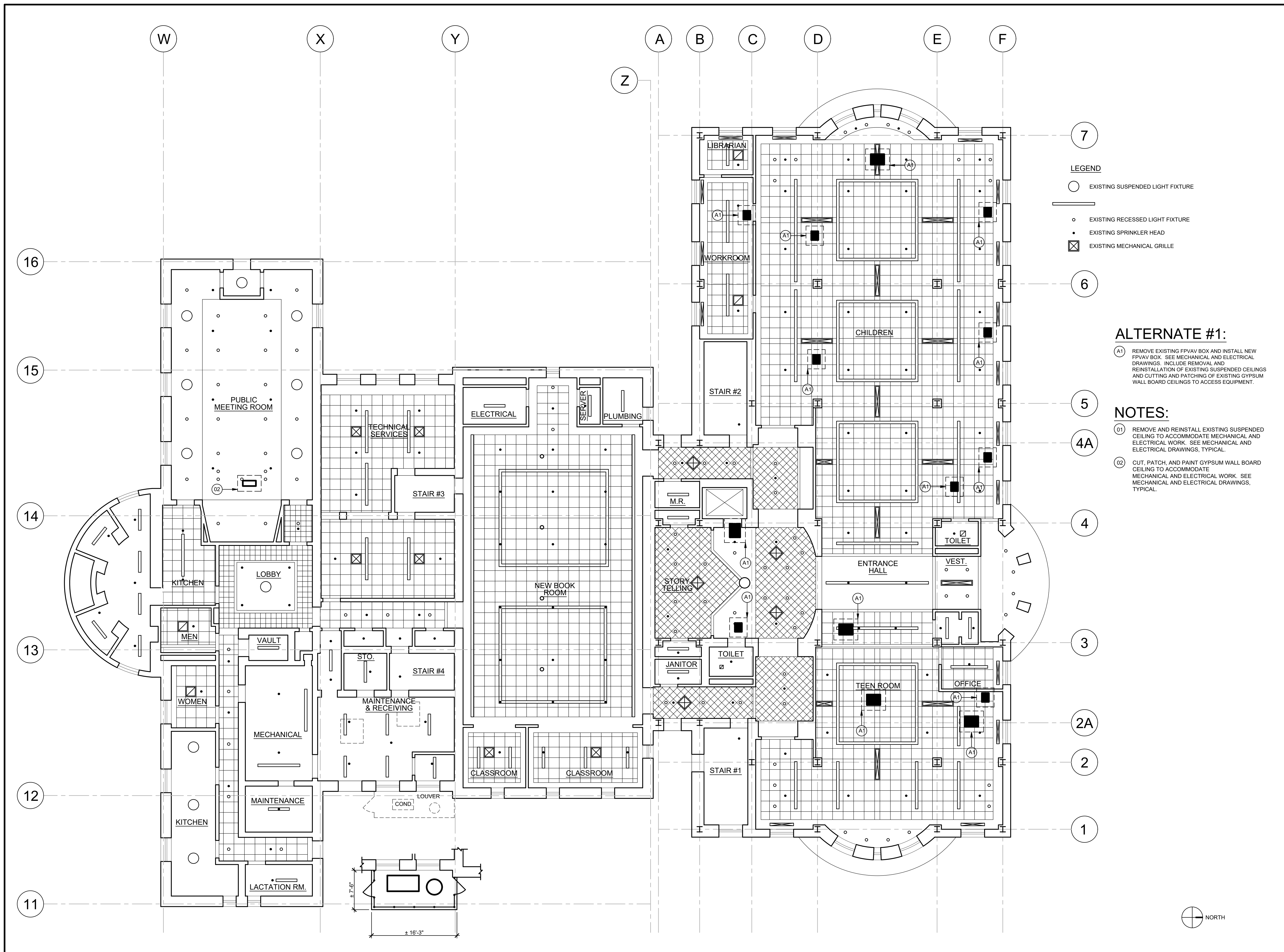
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ROOF PLAN - DEMO





- 7**
- LEGEND**
- EXISTING SUSPENDED LIGHT FIXTURE
 - EXISTING RECESSED LIGHT FIXTURE
 - EXISTING SPRINKLER HEAD
 - ⊠ EXISTING MECHANICAL GRILLE

6

ALTERNATE #1:

A1 REMOVE EXISTING FPVAV BOX AND INSTALL NEW FPVAV BOX. SEE MECHANICAL AND ELECTRICAL DRAWINGS. INCLUDE REMOVAL AND REINSTALLATION OF EXISTING SUSPENDED CEILINGS AND CUTTING AND PATCHING OF EXISTING GYPSUM WALL BOARD CEILINGS TO ACCESS EQUIPMENT.

5

NOTES:

01 REMOVE AND REINSTALL EXISTING SUSPENDED CEILING TO ACCOMMODATE MECHANICAL AND ELECTRICAL WORK. SEE MECHANICAL AND ELECTRICAL DRAWINGS, TYPICAL.

02 CUT, PATCH, AND PAINT GYPSUM WALL BOARD CEILING TO ACCOMMODATE MECHANICAL AND ELECTRICAL WORK. SEE MECHANICAL AND ELECTRICAL DRAWINGS, TYPICAL.

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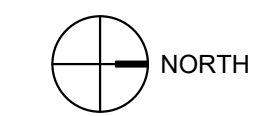
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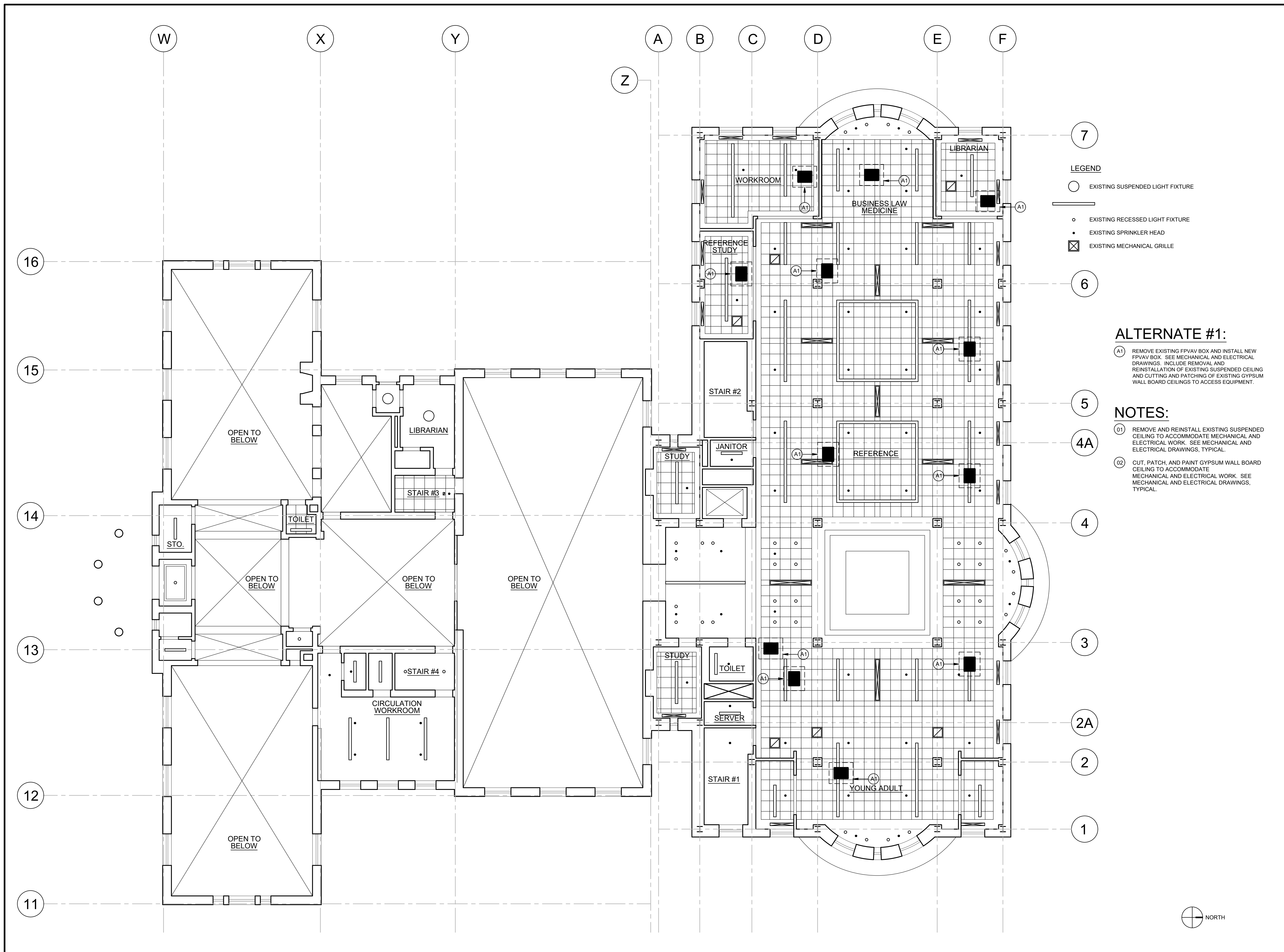
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GROUND FLOOR REFLECTED CEILING PLAN - DEMO





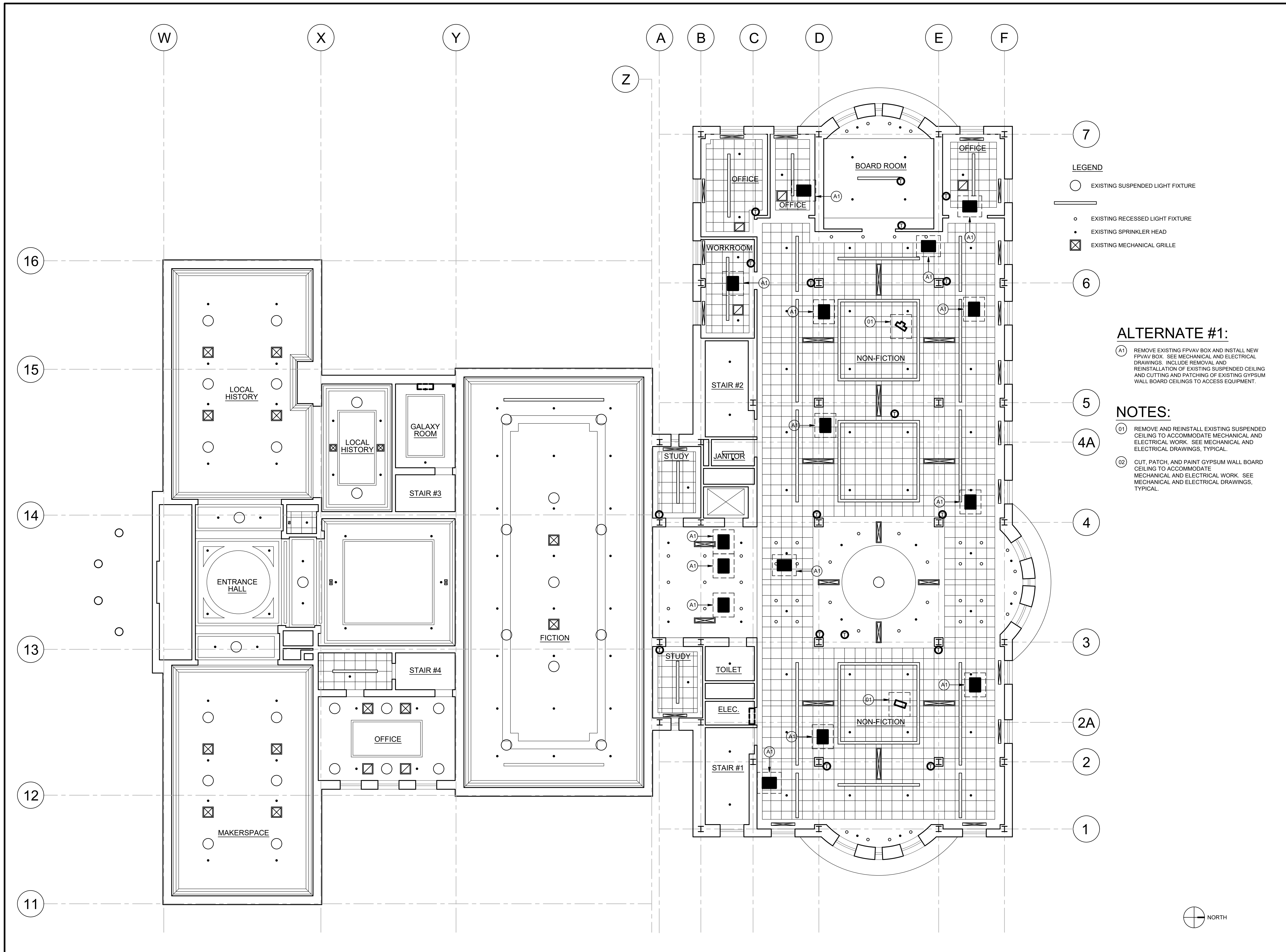
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FIRST FLOOR REFLECTED CEILING PLAN - DEMO



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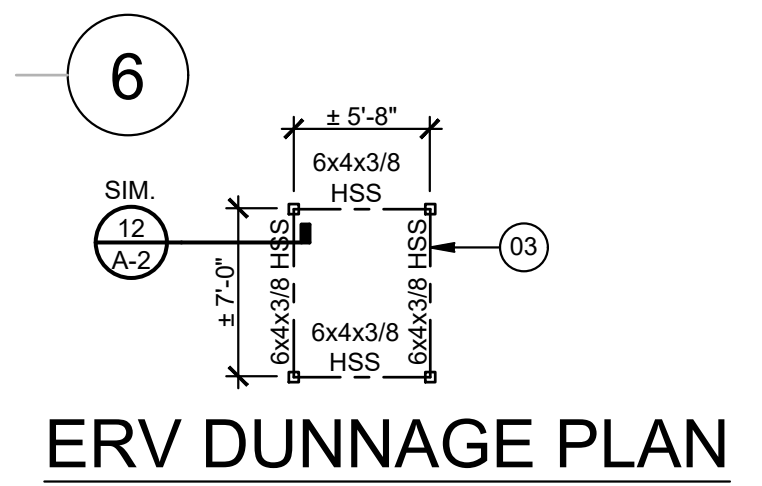
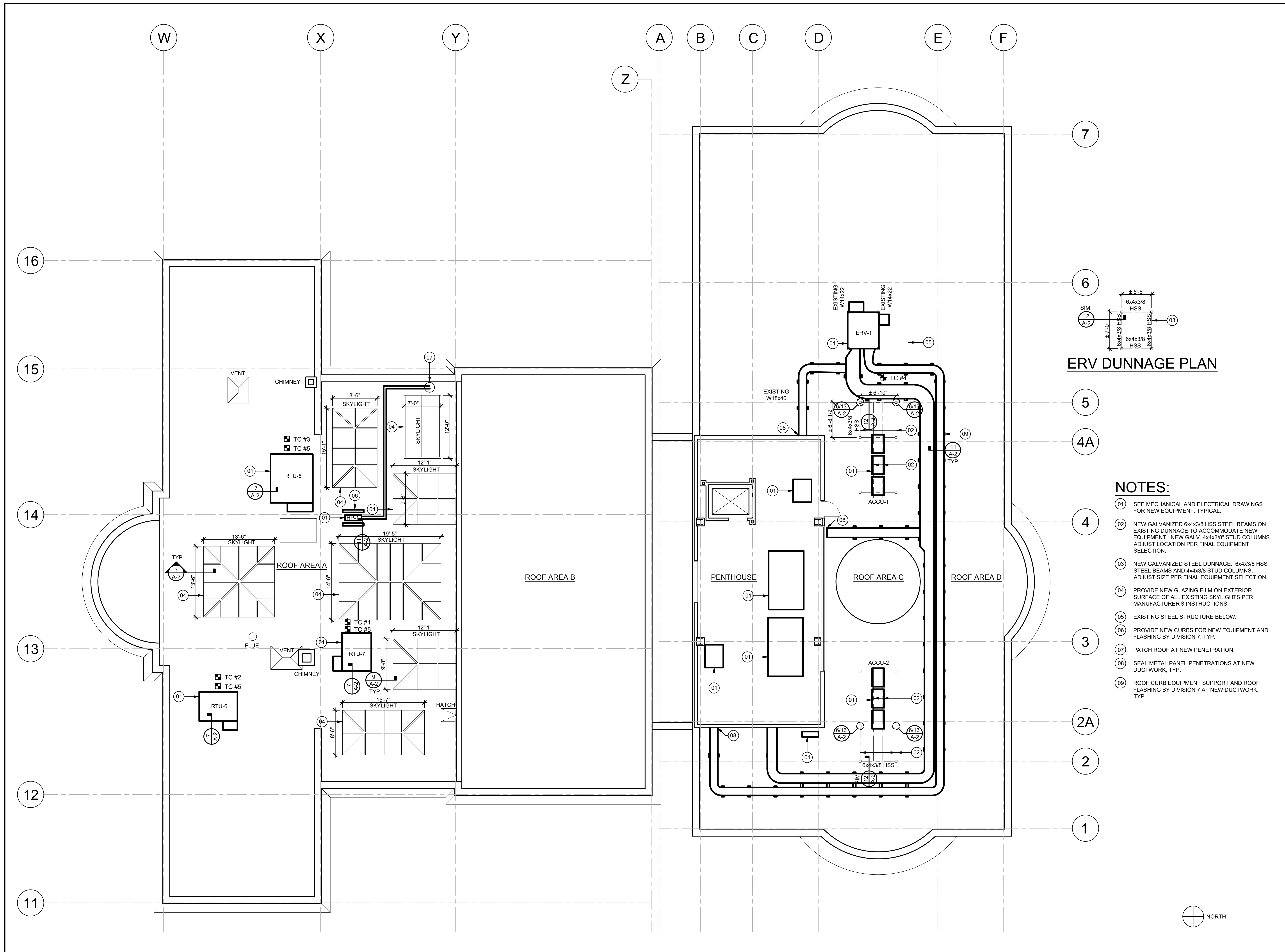
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 SECOND FLOOR
 REFLECTED
 CEILING PLAN -
 DEMO

AD-7



ERV DUNNAGE PLAN

NOTES:

- 01 SEE MECHANICAL AND ELECTRICAL DRAWINGS FOR NEW EQUIPMENT, TYPICAL.
- 02 NEW GALVANIZED 6x4x3/8 HSS STEEL BEAMS ON EXISTING DUNNAGE TO ACCOMMODATE NEW EQUIPMENT. NEW GALV. 4x4x3/8" STUD COLUMNS. ADJUST LOCATION PER FINAL EQUIPMENT SELECTION.
- 03 NEW GALVANIZED STEEL DUNNAGE. 6x4x3/8 HSS STEEL BEAMS AND 4x4x3/8 STUD COLUMNS. ADJUST SIZE PER FINAL EQUIPMENT SELECTION.
- 04 PROVIDE NEW GLAZING FILM ON EXTERIOR SURFACE OF ALL EXISTING SKYLIGHTS PER MANUFACTURER'S INSTRUCTIONS.
- 05 EXISTING STEEL STRUCTURE BELOW.
- 06 PROVIDE NEW CURBS FOR NEW EQUIPMENT AND FLASHING BY DIVISION 7, TYP.
- 07 PATCH ROOF AT NEW PENETRATION.
- 08 SEAL METAL PANEL PENETRATIONS AT NEW DUCTWORK, TYP.
- 09 ROOF CURB EQUIPMENT SUPPORT AND ROOF FLASHING BY DIVISION 7 AT NEW DUCTWORK, TYP.

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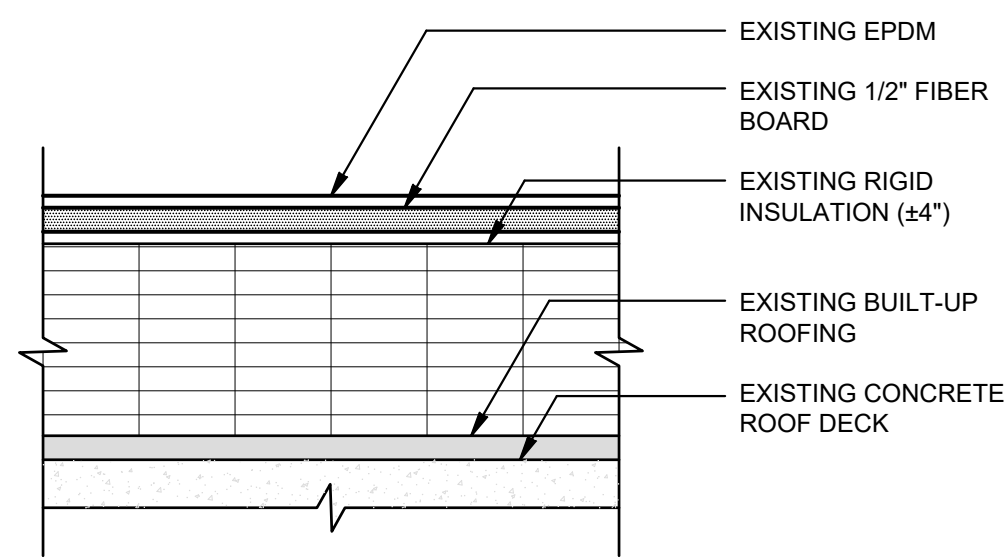
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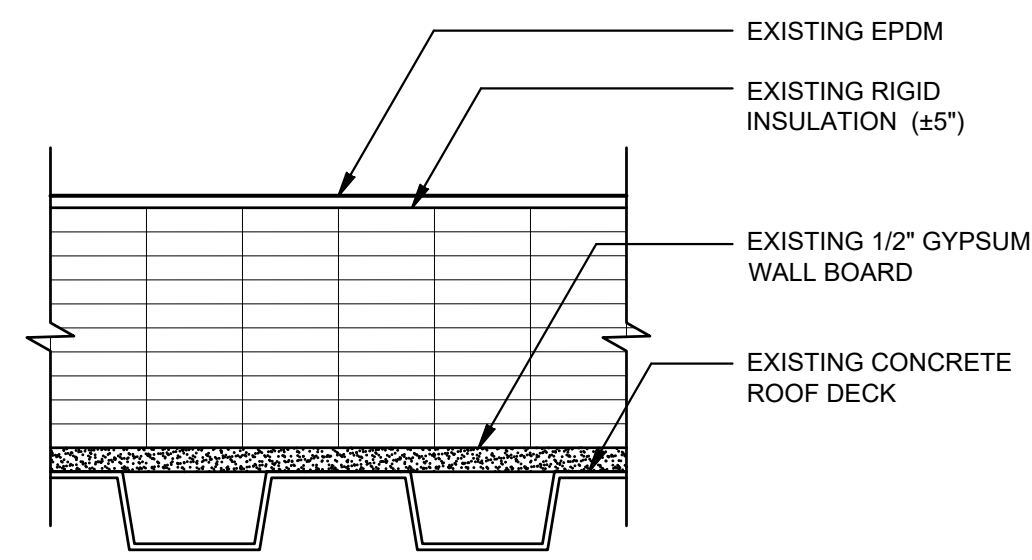
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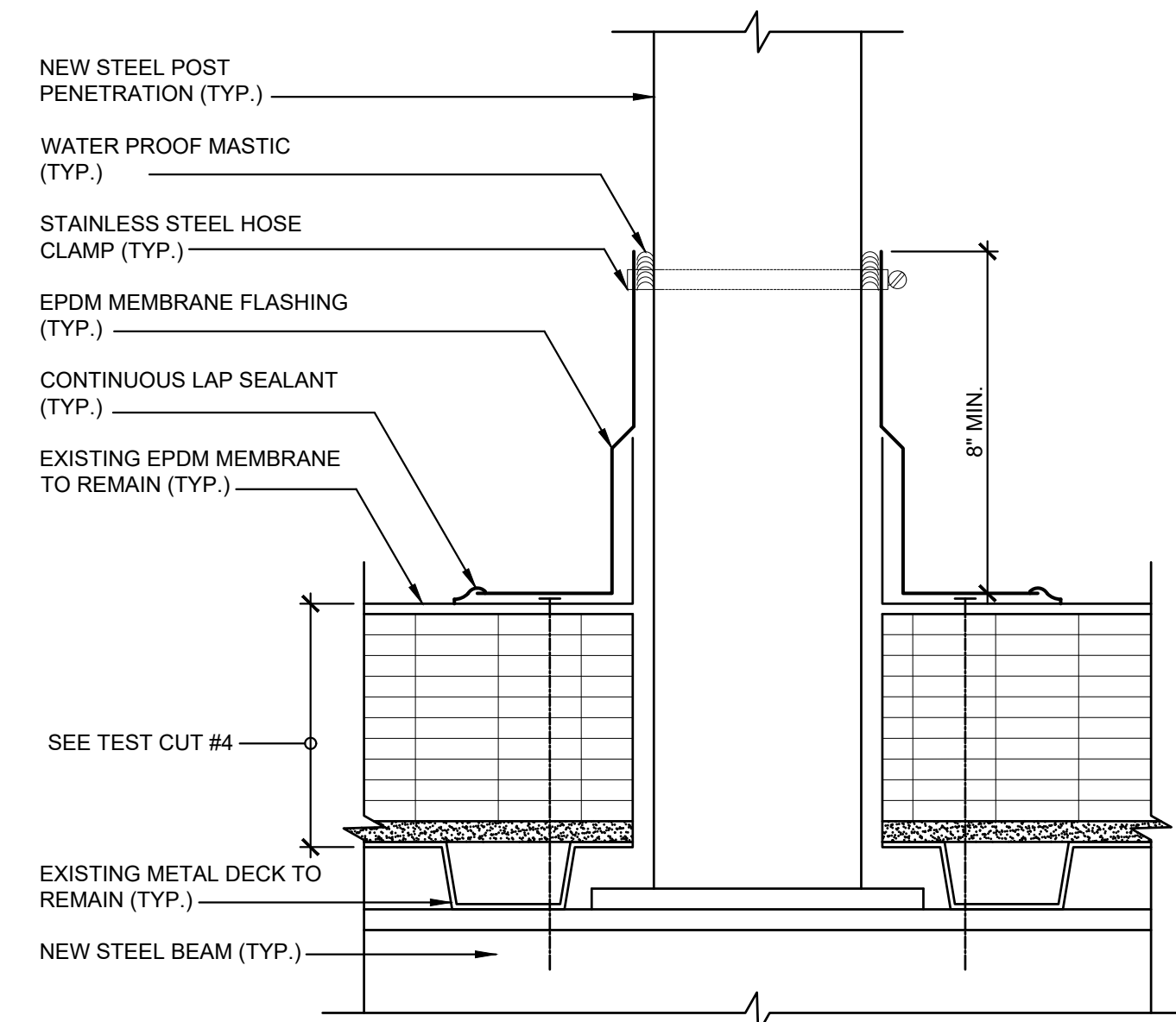
ROOF PLAN - PROPOSED



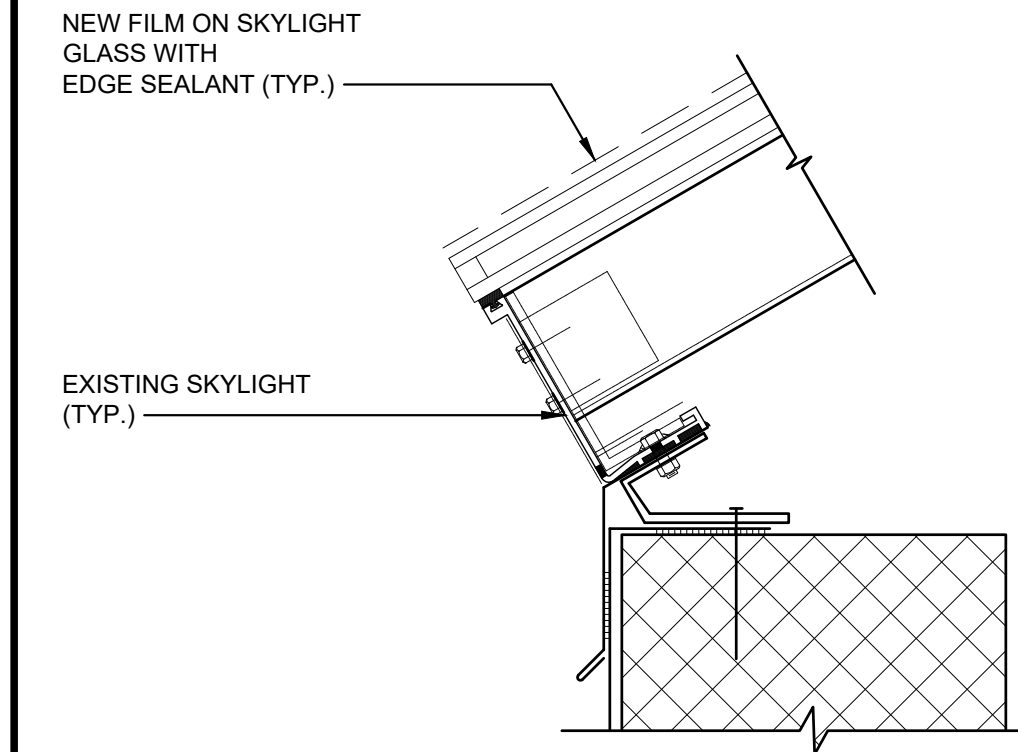
1 TEST CUT #1
SCALE: 3" = 1'-0"



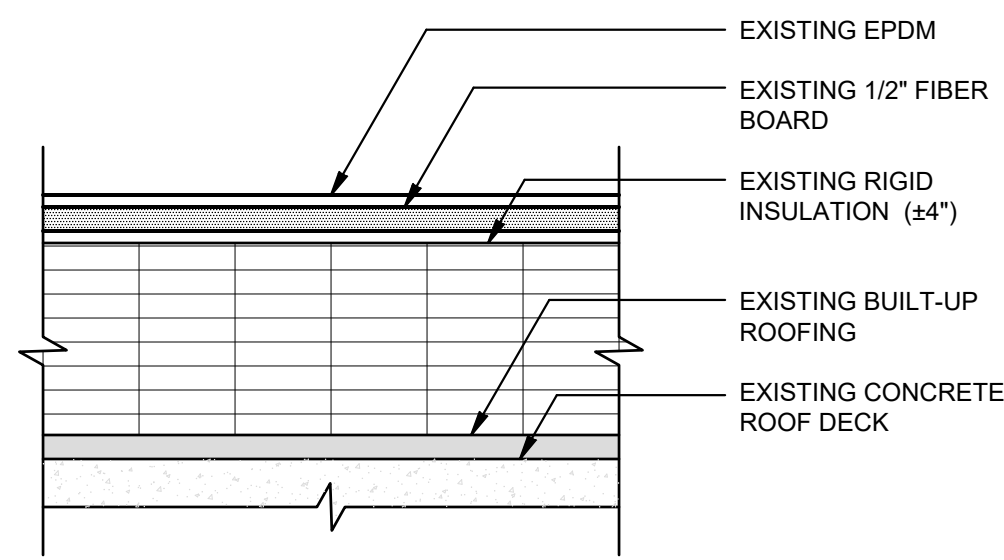
4 TEST CUT #4
SCALE: 3" = 1'-0"



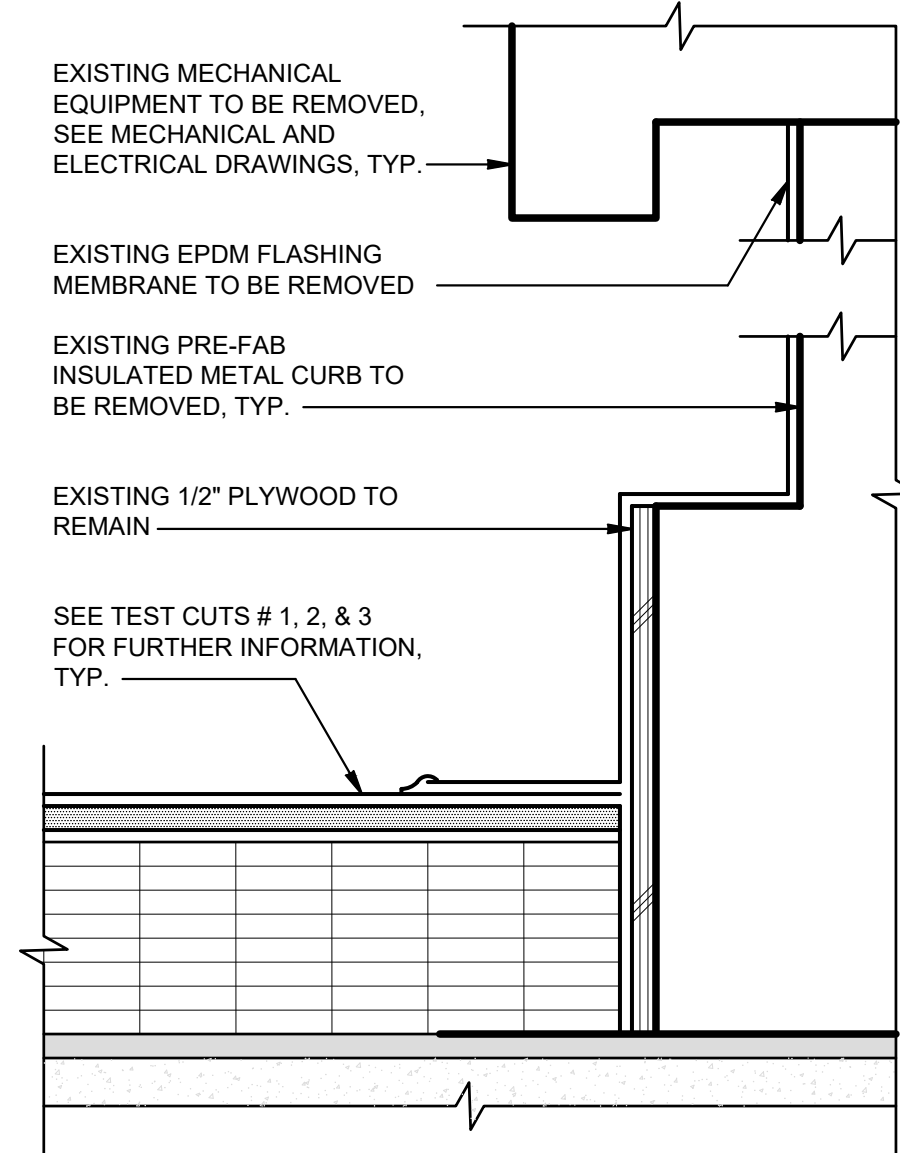
6 DETAIL AT NEW PENETRATION
SCALE: 3" = 1'-0"



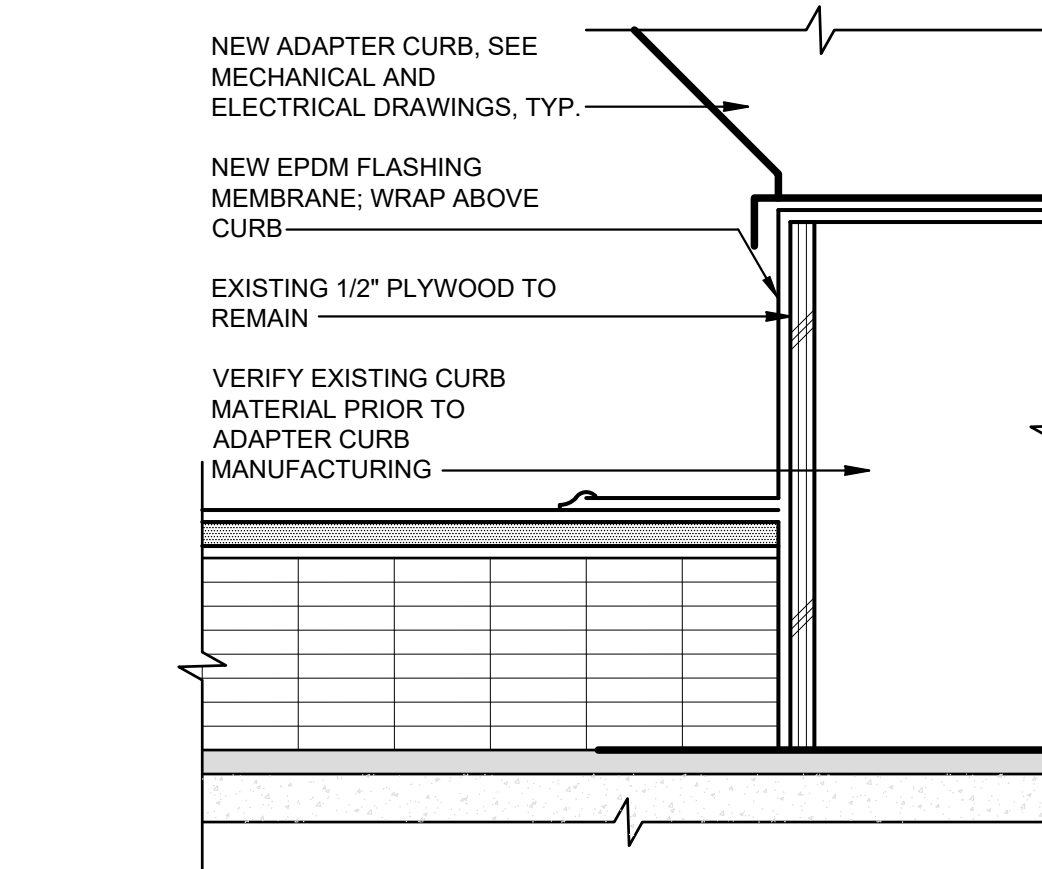
9 DETAIL AT SKYLIGHTS
SCALE: 3" = 1'-0"



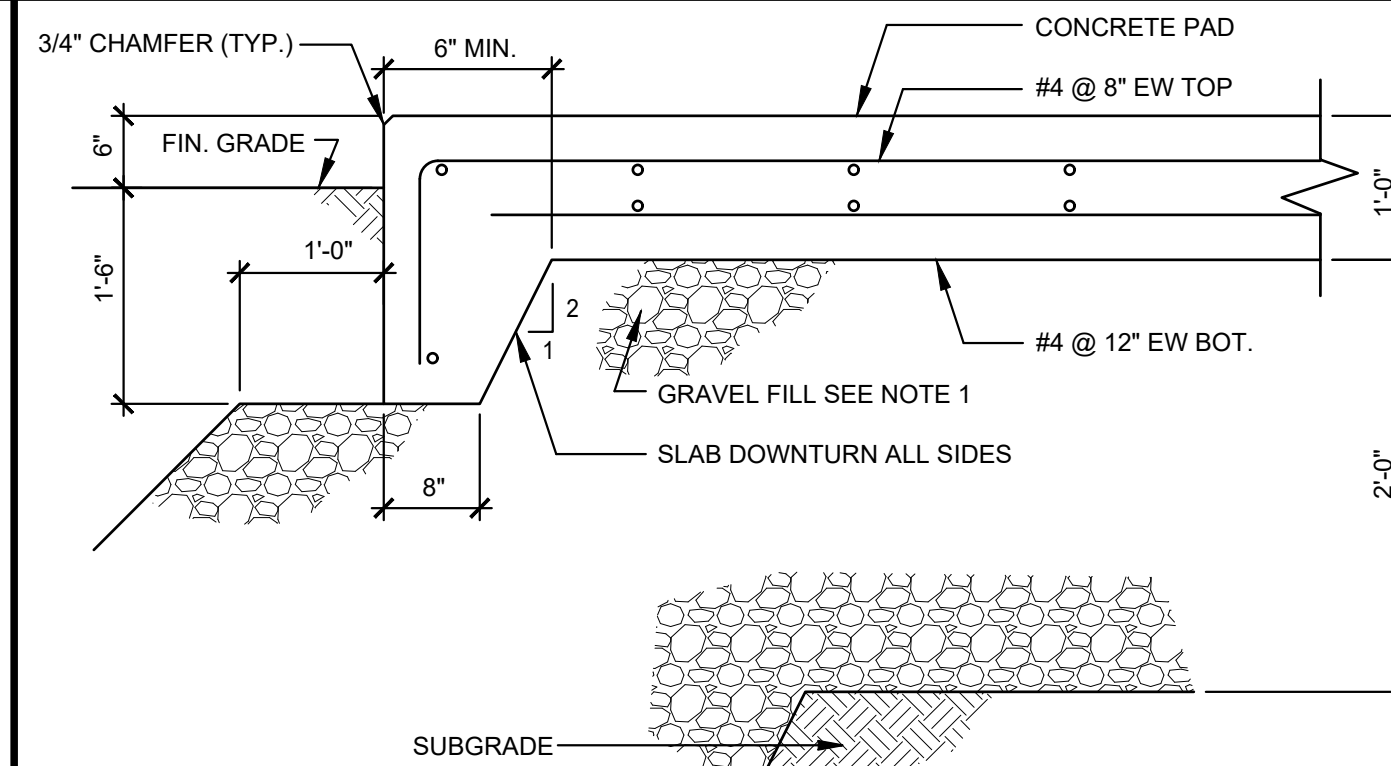
2 TEST CUT #2
SCALE: 3" = 1'-0"



5 TEST CUT #5 / 6 / 7
SCALE: 3" = 1'-0"

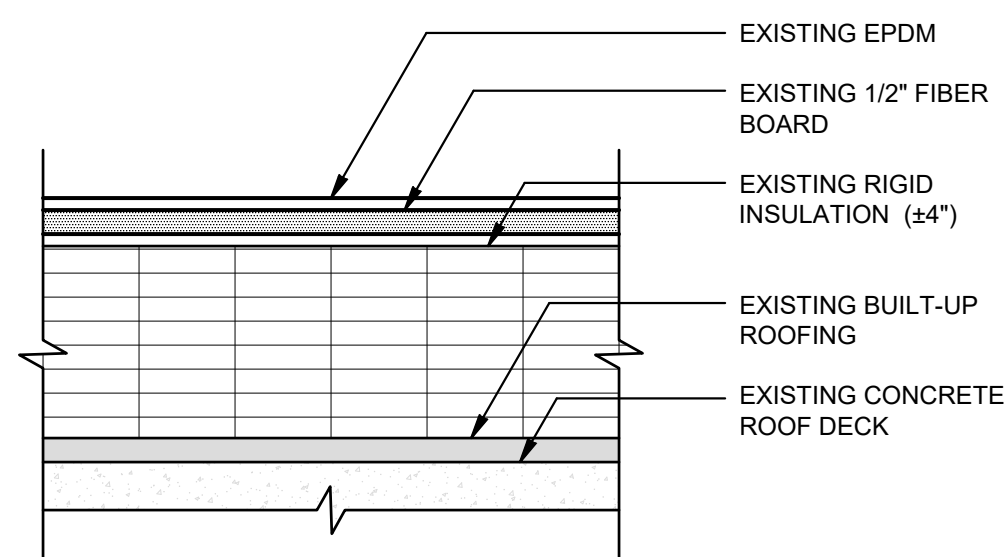


7 DETAIL AT NEW ADAPTER CURBS
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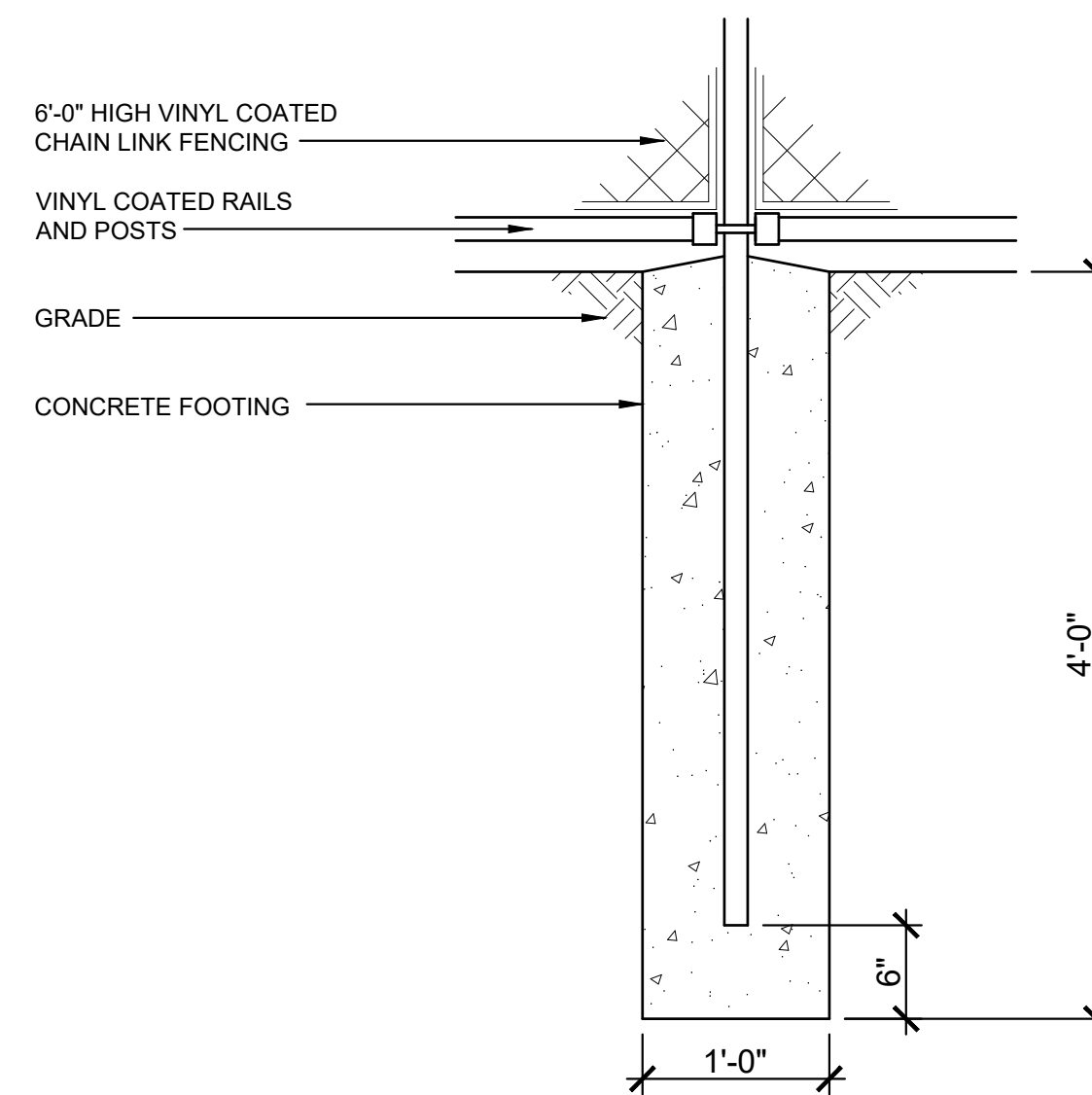


- NOTES:
- BELOW THE CONCRETE PAD PROVIDE A MINIMUM 24 INCHES OF GRAVEL FILL EXTENDING LATERALLY BEYOND THE LIMITS OF THE FOUNDATION CONCRETE A DISTANCE EQUAL TO THE DEPTH OF THE FILL PLUS 1 FEET IN ALL PLAN DIRECTIONS. THE GRAVEL FILL SHOULD BE PLACED IN 6-INCH LIFTS, AND EACH LIFT SHOULD BE COMPACTED TO 95 PERCENT OF THE MAXIMUM MODIFIED PROCTOR DENSITY. PRIOR TO PLACING THE GRAVEL FILL, THE SUBGRADE SHOULD BE PROOF COMPACTED WITH AT LEAST 6 PASSES OF A 5-TON VIBRATORY ROLLER.
 - VERIFY SLAB SIZE WITH EQUIPMENT MANUFACTURER AND COORDINATE WITH MECHANICAL AND ELECTRICAL DRAWINGS.
 - ATTACHMENT OF EQUIPMENT TO CONC. PAD TO BE DESIGNED & FURNISHED BY EQUIPMENT SUPPLIER.

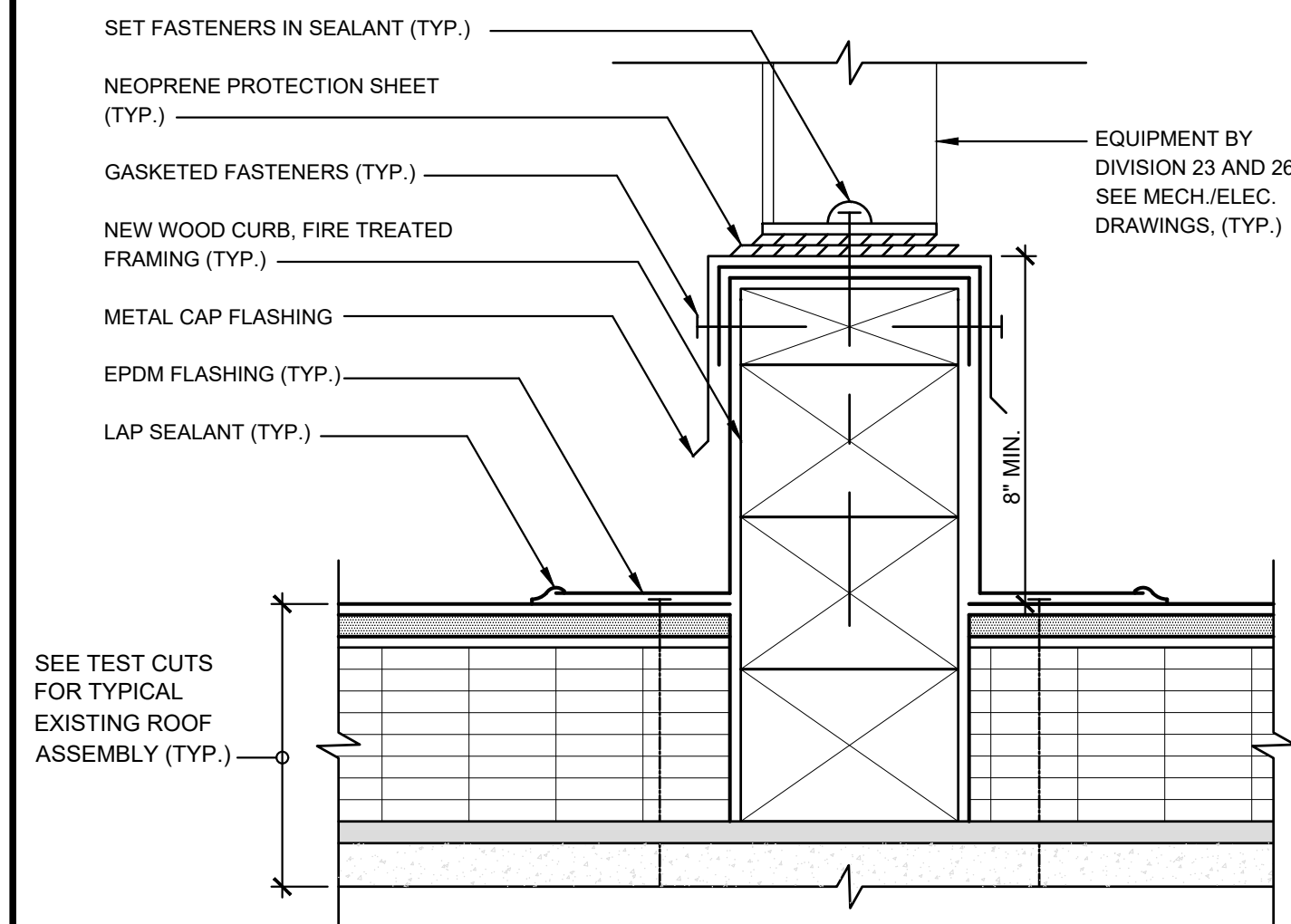
10 DETAIL AT NEW CONC. SLAB
SCALE: 3/4" = 1'-0"



3 TEST CUT #3
SCALE: 3" = 1'-0"



8 DETAIL AT FENCING
SCALE: 1" = 1'-0"



11 DETAIL AT NEW CURB
SCALE: 3" = 1'-0"

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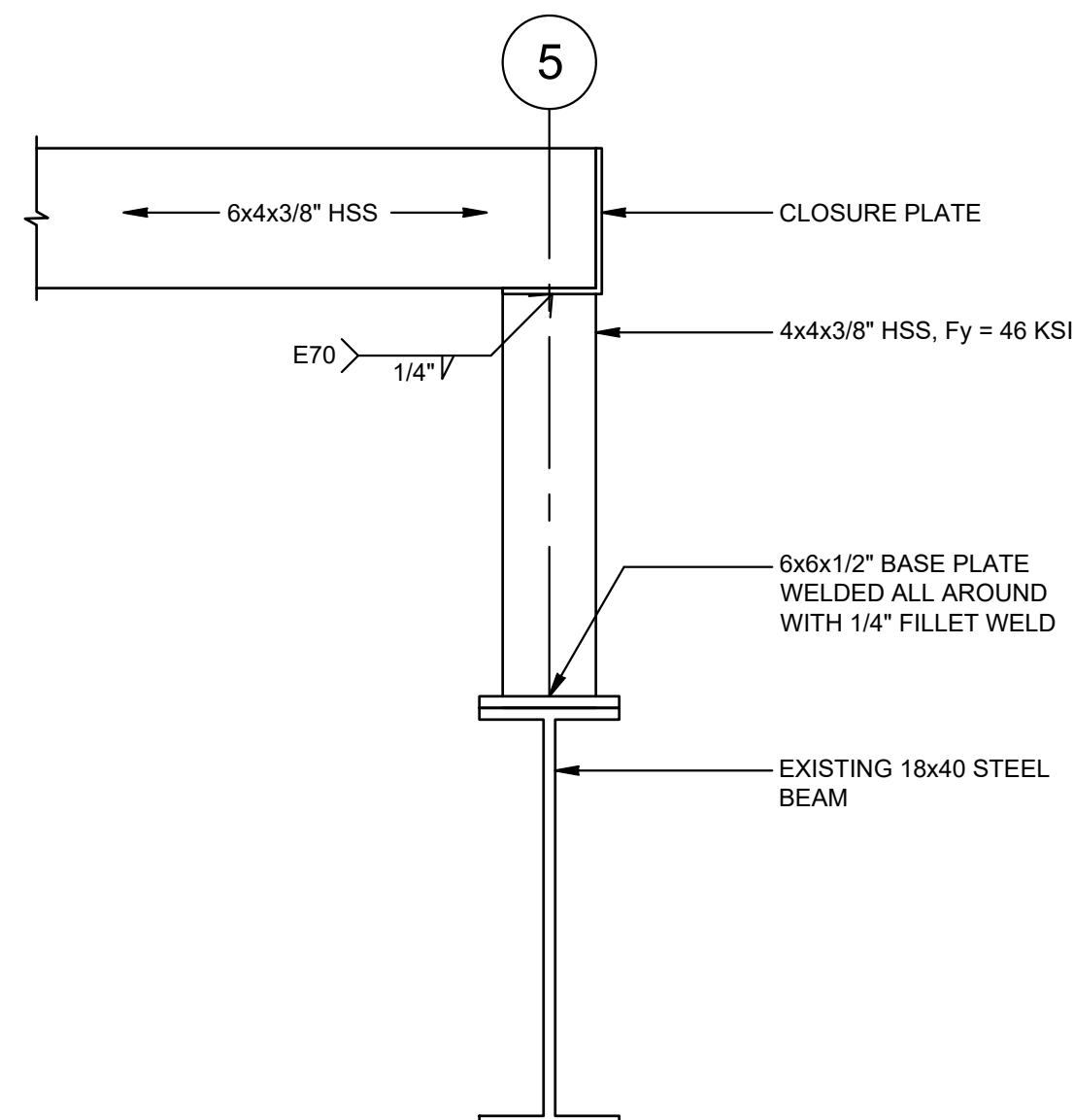
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DATE: JANUARY 31, 2024
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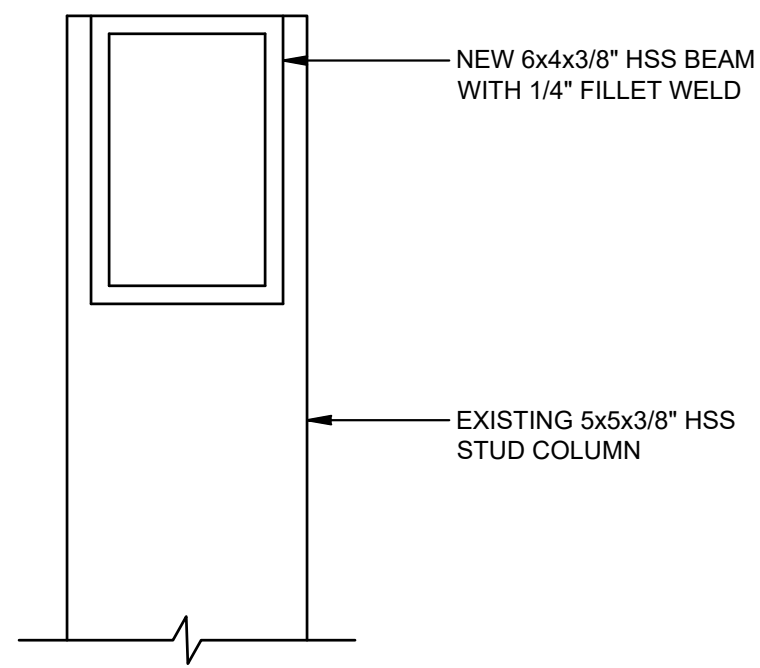
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TEST CUTS / DETAILS



DETAIL AT DUNNAGE EXTENSION /
NEW DUNNAGE

12
SCALE: 1 1/2" = 1'-0"



DETAIL AT EXISTING POST

13
SCALE: 3" = 1'-0"

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DETAILS

ABBREVIATIONS

Table of abbreviations for HVAC systems, including terms like AC, ACT, ACQU, ACD, ACU, etc., and their corresponding full names.

NOTE: SOME OR ALL SYMBOLS MAY BE USED ON THIS PROJECT.

DUCTWORK

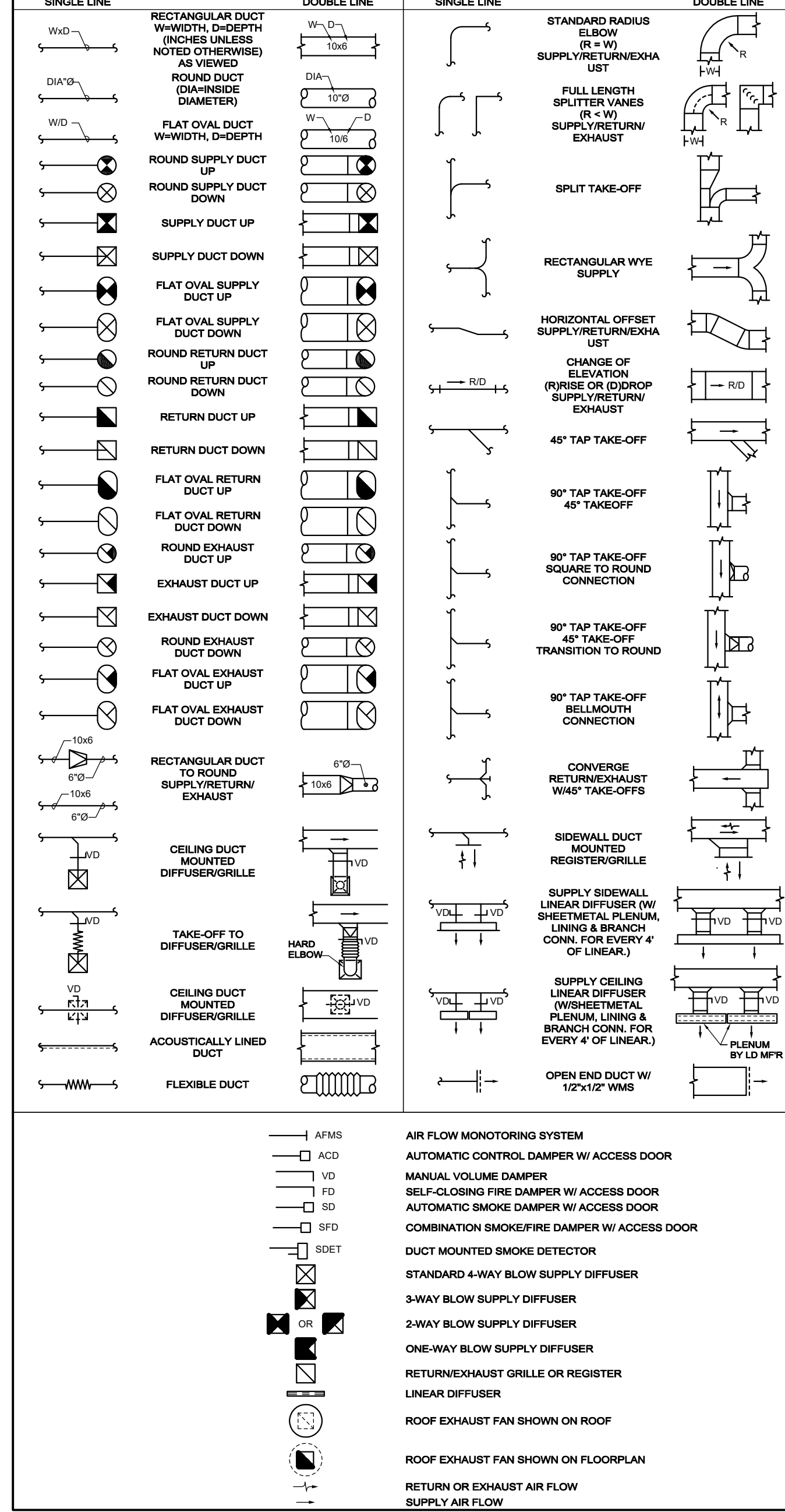
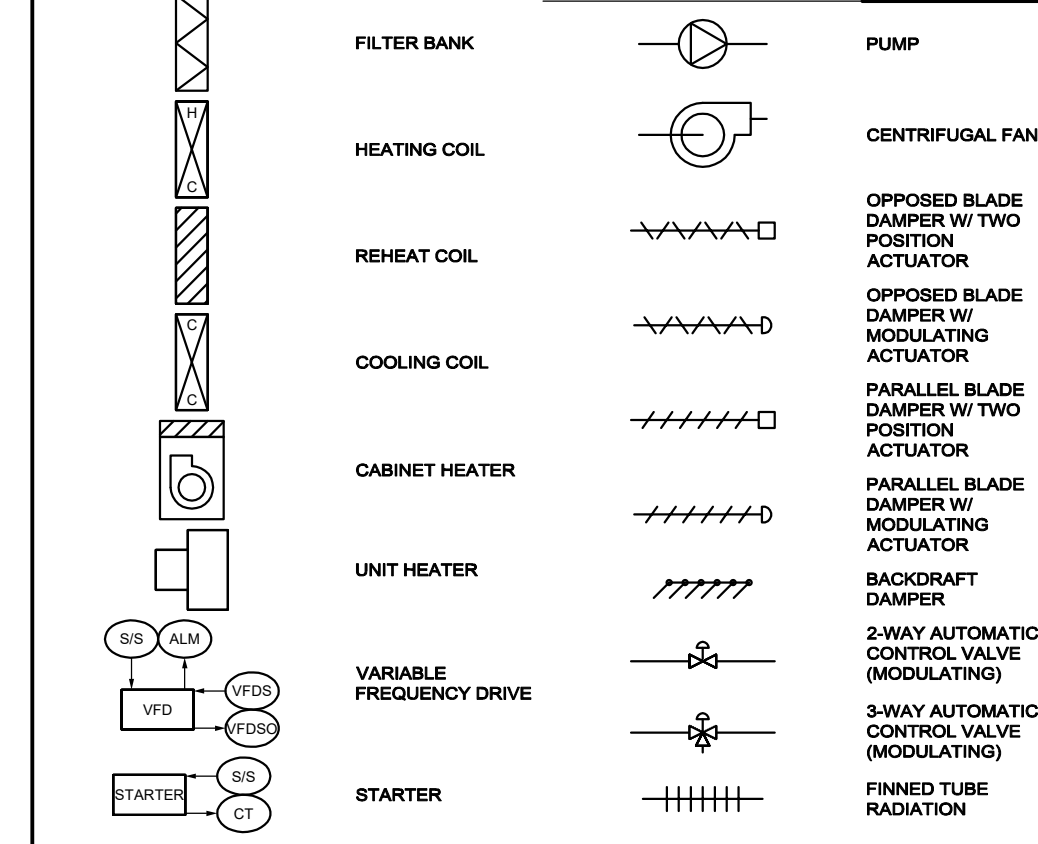


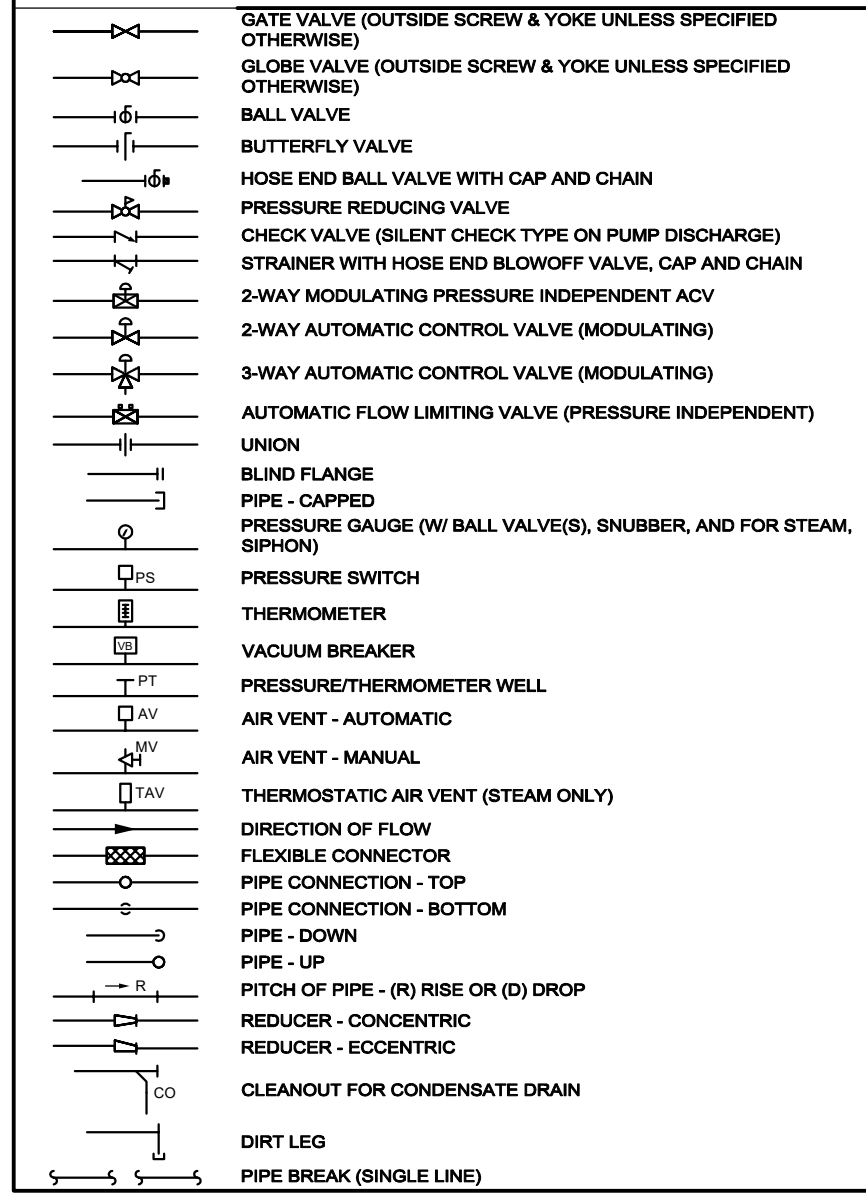
DIAGRAM EQUIPMENT SYMBOLS



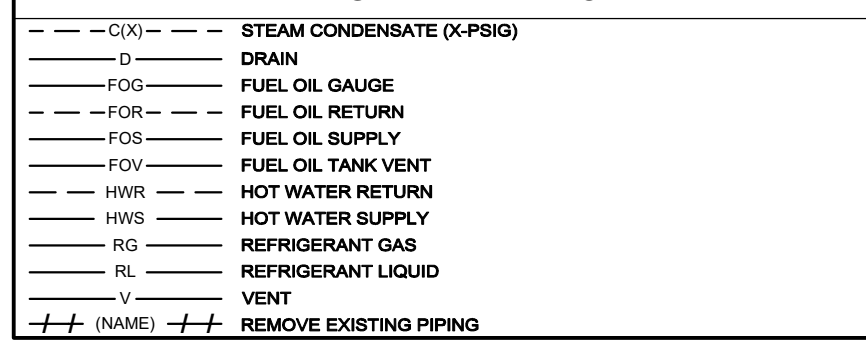
MECHANICAL SHEET LIST

Table listing mechanical sheets with titles such as M-0.0 MECHANICAL LEGENDS, NOTES, AND ABBREVIATIONS, M-0.1 MECHANICAL NOTES, etc.

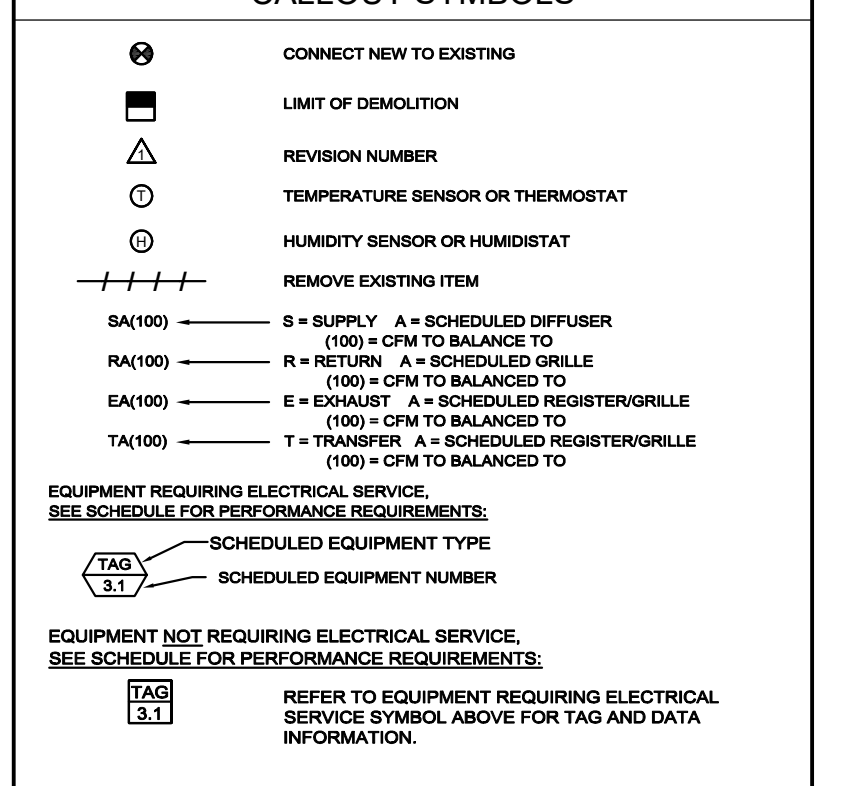
PIPING SYMBOLS



PIPING ABBREVIATIONS



CALLOUT SYMBOLS



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2024-01-31: CD'S

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MECHANICAL LEGENDS, NOTES, AND ABBREVIATIONS

HVAC DEMOLITION NOTES

- DEMOLITION NOTES SHALL APPLY TO ALL MECHANICAL DEMOLITION DRAWINGS.
- THE DEMOLITION PLANS INDICATE THE GENERAL INTENT AND ARE NOT INTENDED TO SHOW ALL ITEMS TO BE REMOVED OR RETAINED. ALL PIPE AND DUCTWORK SIZES INDICATED ARE APPROXIMATE. CONTRACTOR SHALL VERIFY EXACT SIZES IN THE FIELD.
- TRACE AND LABEL ALL EXISTING SYSTEMS WITHIN THE DEMOLITION AREA AND BEYOND PRIOR TO DISCONNECTION AND REMOVAL TO ENSURE THAT NO AREA OUTSIDE THE DEMOLITION AREA IS AFFECTED. REVIEW IN DETAIL WITH THE OWNER WHAT IS TO BE REMOVED AND REMAIN PRIOR TO WORK COMMENCING THE DEMOLITION. THERE SHALL BE NO INTERRUPTION OF SERVICES OUTSIDE THE DEMOLITION AREA WITHOUT APPROVAL FROM THE OWNER.
- NOTIFY THE ENGINEER IMMEDIATELY OF ANY UNANTICIPATED HIDDEN CONDITIONS ENCOUNTERED DURING THE DEMOLITION.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPORARILY REMOVING ANY OWNER EQUIPMENT, CEILING TILES AND OTHER OBSTACLES (I.E. LIGHTING, CONDUIT, CEILING SUPPORTS, ETC.), PROVIDING TEMPORARY WEATHER PROTECTION, STORAGE AND REINSTALLATION OF ITEMS REMOVED. DO NOT BURN WASTE MATERIALS.
- ALL ITEMS REMOVED SHALL BE OFFERED TO THE OWNER FOR SALVAGE. IF THE OWNER DOES NOT TAKE POSSESSION, DISPOSE OF THE ITEMS IN A SAFE AND LEGAL MANNER. ALL ITEMS CLASSIFIED AS HAZARDOUS SHALL BE DISPOSED AS HAZARDOUS WASTE AND A UNIFORM HAZARDOUS WASTE MANIFEST SHALL BE PROVIDED TO THE OWNER.
- DO NOT DISCHARGE VOLATILE, HARMFUL, OR DANGEROUS MATERIALS INTO THE DRAINAGE SYSTEMS. REMOVE AND DISPOSE OF ALL WASTE MATERIALS, OIL, OIL PIPING, PACKAGING MATERIALS, SKIDS, ETC. FROM THE SITE AND DISPOSE OF IN A LAWFUL MANNER IN ACCORDANCE WITH MUNICIPAL, STATE, AND FEDERAL REGULATIONS.
- NOTIFY UTILITY COMPANIES IN ACCORDANCE WITH THEIR REQUIREMENTS PRIOR TO DEMOLITION. VERIFY THAT THE UTILITIES HAVE BEEN DISCONNECTED, VALVED, CAPPED AND MADE SAFE PRIOR TO DEMOLITION.
- PROVIDE ALL LABOR AND MATERIAL TO DRAIN THE EXISTING HEATING HOT WATER SYSTEM NECESSARY TO DO THE WORK AS SHOWN.
- ALL EXISTING MECHANICAL EQUIPMENT, DUCTWORK, PIPING, ETC. TO REMAIN UNLESS OTHERWISE NOTED.
- ENSURE THE SAFE PASSAGE OF PERSONS IN AND AROUND THE BUILDING DURING DEMOLITION. PREVENT INJURY TO PERSONS AND DAMAGE TO PROPERTY. PROVIDE ADEQUATE SHORING AND BRACING TO PREVENT COLLAPSE. IMMEDIATELY REPAIR DAMAGED PROPERTY TO THE CONDITION BEFORE BEING DAMAGED. TAKE EFFECTIVE MEASURES TO PREVENT WINDBLOWN DUST.
- DO NOT USE CUTTING TORCHES OR PERFORM WELDING WORK UNTIL WORK AREA IS CLEARED OF FLAMMABLE MATERIALS. MAINTAIN FIRE WATCH AND PORTABLE FIRE-SUPPRESSION DEVICES DURING FLAME-CUTTING OR WELDING OPERATIONS. MAINTAIN ADEQUATE VENTILATION WHEN USING CUTTING TORCHES OR WELDERS.
- DRAIN, PURGE, OR OTHERWISE REMOVE, COLLECT, AND DISPOSE OF CHEMICALS, LIQUIDS, GASES, EXPLOSIVES, ACIDS, FLAMMABLES, OR OTHER DANGEROUS MATERIALS BEFORE PROCEEDING WITH DEMOLITION OPERATIONS.
- THE CONTRACTOR SHALL BROOM SWEEP THE AREAS AFFECTED BY CONSTRUCTION OR DEMOLITION ON A DAILY BASIS.
- PROPERLY LABEL ALL UNLABELED PIPES THAT REMAIN WITH COLOR PIPE MARKERS.
- ALL DEMOLITION SCOPE ASSOCIATED WITH LOW VOLTAGE WIRING FOR CONTROLS AND ASSOCIATED INTERLOCKS SHALL BE INCLUDED IN THIS CONTRACT.
- PROVIDE ALL REQUIRED CUTTING AND PATCHING FOR WORK INDICATED. PROVIDE PATCHING FOR VOIDS LEFT BY THE REMOVAL OF EXISTING CONTROLS (INCLUDING EXISTING THERMOSTATS AND SENSORS). PATCHING SHALL BE PROVIDED FOR FLOORS, WALLS AND CEILINGS. PATCHING SHALL BE MADE WITH SIMILAR MATERIALS TO MATCH EXISTING CONDITIONS AND PAINTED TO MATCH ADJACENT SURFACES.
- DEMOLITION OF HOT WATER, STEAM AND REFRIGERANT PIPING SHALL BE AS INDICATED. PROVIDE ALL NECESSARY TEMPORARY OR PERMANENT CAPS OR PLUGS FOR PIPING. DO NOT LEAVE PIPING OPEN ENDED. PROVIDE BALL VALVES ON ALL PIPING TO BE RECONNECTED TO.

GENERAL NOTES

- TEMPORARY COOLING SHALL BE PROVIDED BY OWNERSHIP DURING THE CONSTRUCTION, UNDER A SEPARATE CONTRACT.
- THE SITE IS CONSIDERED A HISTORICAL BUILDING. GREAT CARE SHOULD BE TAKEN WHILE WORKING WITHIN THE BUILDING. AESTHETICS OF THE BUILDING SHOULD BE CONSIDERED FOR ANY EXTERIOR OR INTERIOR WORK.

HVAC GENERAL WORK NOTES

- THIS PROJECT INVOLVES CONSTRUCTION INSIDE AN EXISTING STRUCTURE. CONTRACTORS, BY SUBMITTING A BID, ARE DEEMED TO BE COMPLETELY FAMILIAR WITH THE EXISTING CONDITION OF THE BUILDING AS IT INFLUENCES THE WORK DESCRIBED. ABSOLUTELY NO CLAIMS FOR EXTRA COMPENSATION WILL BE CONSIDERED FOR EXISTING CONDITIONS VISIBLE OR REASONABLY INFERRABLE FROM A CAREFUL EXAMINATION OF THE EXISTING BUILDING.
- THIS CONTRACTOR SHALL INSPECT THE EXISTING FIELD CONDITIONS AT THE SITE PRIOR TO THE START OF ANY WORK TO DETERMINE WHAT EFFECT THE EXISTING CONDITIONS WILL HAVE ON HIS WORK. POTENTIAL PROBLEM AREAS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IMMEDIATELY.
- THIS CONTRACTOR SHALL CONNECT HIS WORK TO VARIOUS EXISTING PIPING, DUCTWORK, AND CONTROL SYSTEMS IN THE BASE BUILDING. THE NEW WORK SHALL BE COMPATIBLE WITH THE EXISTING SYSTEMS. LOCATION OF EQUIPMENT OR THE ROUTING OF THE VARIOUS SYSTEMS AS WELL AS OPENINGS IN FLOOR SLABS OR WALLS SHALL BE GOVERNED BY THE EXISTING CONDITIONS AS THEY APPEAR IN THE FIELD.
- CARE SHALL BE TAKEN DURING THE INSTALLATION TO NOT DAMAGE OR INTERRUPT BUILDING SYSTEMS AND SERVICES THAT ARE ALREADY INSTALLED. DAMAGE TO SUCH SYSTEMS OR EQUIPMENT CAUSED BY THIS CONTRACTOR DURING INSTALLATION SHALL BE REPAIRED AND/OR REPLACED AT THIS CONTRACTOR'S EXPENSE TO THE COMPLETE SATISFACTION OF THE OWNER.
- SHUTDOWN OF EXISTING SYSTEMS FOR CONNECTION TO EXISTING SERVICES SHALL BE COORDINATED WITH THE OWNER. THIS CONTRACTOR SHALL SUBMIT REQUESTS, WHERE THEY AFFECT THE OPERATION OF THE BUILDING SYSTEMS, AT LEAST ONE WEEK IN ADVANCE OF ANY REQUIRED SHUTDOWN. THE ACTUAL SHUTDOWN PERIOD SHALL BE AS SHORT AS POSSIBLE AND AT A TIME MUTUALLY AGREEABLE TO THE OWNER.
- DRAWINGS ARE DIAGRAMMATIC, THEREFORE DETERMINE EXACT LOCATIONS OF SYSTEMS AND COMPONENTS IN FIELD.
- ALL WORK SHALL BE COORDINATED WITH ALL TRADES INVOLVED. OFFSETS IN PIPING AND DUCTS (INCLUDING DIVIDED DUCTS) AND TRANSITIONS AROUND OBSTRUCTIONS SHALL BE PROVIDED AT NO ADDITIONAL COST TO THE OWNER.
- VERIFY ALL EQUIPMENT CONNECTIONS WITH MANUFACTURER'S CERTIFIED DRAWINGS. VERIFY AND PROVIDE DUCT AND/OR PIPE TRANSITIONS TO FURNISHED EQUIPMENT. FIELD VERIFY AND COORDINATE ALL DIMENSIONS BEFORE FABRICATION.
- ALL MATERIALS AND EQUIPMENT UNLESS SPECIFICALLY INDICATED AS REUSED, SHALL BE NEW.
- DUCTWORK SHALL NOT RUN ALONG FULL HEIGHT PARTITIONS.
- ACCESS PANELS SHALL BE PROVIDED TO ALLOW FOR CLEANING OF COILS AND SERVICING OF DAMPERS, HEATERS, VALVES, AND ALL CONCEALED MECHANICAL EQUIPMENT.
- THE INSIDE OF ALL DUCTWORK VISIBLE THROUGH A GRILLE OR DIFFUSER SHALL BE PAINTED FLAT BLACK.
- WHEN SECTION OF DUCTWORK IS NOT LABELED FOR SIZE, THE LARGER SIZE INDICATED ON THE CONNECTED DUCT SHALL PREVAIL. SIZE OF DUCT RUN-OUTS TO DIFFUSER SHALL EQUAL DIFFUSER NECK SIZE.
- THE FIRE PROOFING OF THE BUILDING STRUCTURE IS NOT TO BE REMOVED FOR THE INSTALLATION OF HANGERS, SUPPORTS, DUCTWORK, ETC. IF FIRE PROOFING IS DAMAGED, IT SHALL BE REPAIRED AT THE EXPENSE OF THE TRADE.
- THE CONTRACTOR SHALL TEST AND CALIBRATE ALL CONTROLS AND VERIFY ALL ARE FULLY FUNCTIONAL AND SUBMIT DOCUMENTATION.
- PROVIDE AND SUBMIT DOCUMENTATION FOR TESTING AND BALANCING OF ALL AIR AND WATER SYSTEMS, DUCT AND PIPING PRESSURE AND LEAKAGE TESTS, OPERATING AND MAINTENANCE MANUALS, AND AS BUILT DRAWINGS. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
- PROVIDE ADEQUATE COVERING TO ALL OPEN ENDS OF DUCTWORK AND PIPING TO PREVENT DUST, DIRT AND DEBRIS FROM ENTERING DURING CONSTRUCTION.
- PROVIDE ALL REQUIRED CUTTING AND PATCHING FOR WORK INDICATED. PROVIDE PATCHING FOR VOIDS LEFT BY THE REMOVAL OF EXISTING PIPING, DUCTWORK, EQUIPMENT, CONTROLS, ETC. PATCHING SHALL BE PROVIDED FOR FLOORS, WALLS, CEILINGS, AND ROOFS. PATCHING SHALL BE MADE WITH SIMILAR MATERIALS TO MATCH EXISTING CONDITIONS AND PAINTED TO MATCH ADJACENT SURFACES.
- PROVIDE ALL LABOR, RIGGING AND MATERIALS REQUIRED TO MOVE NEW EQUIPMENT INTO THE BUILDING. THE CONTRACTOR IS RESPONSIBLE TO PROVIDE ALL LABOR AND MATERIALS REQUIRED FOR EQUIPMENT THAT MUST BE DISMANTLED AND REASSEMBLED INSIDE THE BUILDING.
- THE CONTRACTOR SHALL REMOVE, TEMPORARILY STORE AND RE-INSTALL SUSPENDED CEILINGS AS REQUIRED FOR WORK INDICATED. REPLACE ANY CEILING TILES DAMAGED DURING CONSTRUCTION WITH NEW CEILING TILES TO MATCH THE EXISTING CEILING TILES. MODIFY EXISTING CEILING TILES TO ACCOMMODATE NEW WORK INDICATED.
- THE CONTRACTOR SHALL NOTE THAT THE BUILDING IS BEING USED BY THE OWNER'S EMPLOYEES AND CUSTOMERS. ALL WORK SHALL BE PERFORMED IN AS SAFE A MANNER AS POSSIBLE. ALL WORK AREAS SHALL BE MADE AS SAFE AT THE END EACH DAY.
- ALL WORK SHALL BE DONE IN ACCORDANCE WITH ALL APPLICABLE STATE AND LOCAL CODES.
- PROVIDE SECURITY AND WEATHER PROTECTION FOR TEMPORARY LOUVER/WALL OPENINGS.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPORARILY RELOCATING ALL FURNITURE, SORTING STATIONS, STORAGE CABINETS, STORAGE RACKS, ETC. AS REQUIRED TO COMPLETE WORK INDICATED. COORDINATE RELOCATION WITH THE OWNER.
- PROVIDE IDENTIFICATION FOR ALL DUCTWORK. LABELS SHALL INDICATE DIRECTION OF FLOW AND SYSTEM SERVED.
- REFER TO THE PROJECT SPECIFICATIONS FOR FURTHER REQUIREMENTS.
- THE CONTRACTOR SHALL PROVIDE ALL EQUIPMENT (INCLUDING ALL BATTERY OPERATED LIFTS, LADDERS, TOOLS, ETC.) REQUIRED TO COMPLETE THE WORK INDICATED ON THE PLANS.
- THE CONTRACTOR SHALL FOLLOW ALL OSHA AND OWNER'S SAFETY GUIDELINES WHEN WORKING IN THE FACILITY AND PAY PARTICULAR ATTENTION TO THE OWNER'S SAFETY REQUIREMENTS WHEN WORKING FROM A LADDER OR BATTERY OPERATED LIFT. WORK AREAS SHALL BE ISOLATED FROM THE OWNER'S PERSONNEL WITH ORANGE SAFETY CONES AND YELLOW CAUTION TAPE OR ORANGE BARRICADES.

HVAC NEW WORK NOTES

- MECHANICAL NEW WORK NOTES SHALL APPLY TO ALL MECHANICAL NEW WORK DRAWINGS.
- EXISTING DUCT AND PIPE SIZES INDICATED ARE APPROXIMATE. FIELD VERIFY EXISTING DUCT AND PIPE SIZES AFTER INSULATION IS REMOVED. PROVIDE TRANSITIONS FROM EXISTING DUCT AND PIPING TO NEW DUCT AND PIPING AS REQUIRED.
- PROVIDE ALL SERVICE CLEARANCES RECOMMENDED OR REQUIRED BY THE MANUFACTURERS AT ALL EQUIPMENT.
- WHEN THE INSTALLATION IS COMPLETE, THE NEW AND EXISTING PIPING SHALL BE DRAINED TO WASTE UNTIL THE RETURN IS CLEAR AND FREE OF ALL DEBRIS AND RUST. PROVIDE ALL LABOR AND MATERIAL TO REFILL THE ENTIRE HEATING HOT WATER SYSTEM. PROVIDE CHEMICAL TREATMENT FOR THE ENTIRE HEATING HOT WATER SYSTEM.
- 1" FILTER MEDIA SHALL BE TEMPORARILY INSTALLED OVER ALL SUPPLY AIR DIFFUSERS AND REGISTERS PRIOR TO STARTING UP THE NEW AIR HANDLING EQUIPMENT. AFTER THE NEW AIR HANDLING EQUIPMENT HAS RUN FOR A SHORT PERIOD OF TIME, THE CONTRACTOR SHALL REMOVE THE FILTER MEDIA. THE CONTRACTOR SHALL PROVIDE ALL REQUIRED LADDERS AND BATTERY OPERATED LIFTS.
- BALANCE DIFFUSERS, REGISTERS, GRILLES, AND EQUIPMENT TO FLOWS INDICATED.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR CLEANING ALL OF THE EXISTING-TO-REMAIN DIFFUSERS, GRILLES, AND REGISTERS.
- PROVIDE FIRE STOPPING FOR ALL PIPING AND CONDUIT PENETRATIONS THROUGH WALLS.
- THE CONTRACTOR SHALL FIELD VERIFY INSTALLATION AND WORKING CONDITION OF EXISTING MANUAL VOLUME DAMPERS. CONTRACTOR SHALL PROVIDE NEW MANUAL VOLUME DAMPERS WHERE EXISTING DAMPERS ARE MISSING OR NOT FUNCTIONING PROPERLY.
- THE CONTRACTOR SHALL PROVIDE MINIMUM OF 20 LINEAR FEET OF 1" DUCT LINING FROM NEW AIR HANDLING UNITS AND NEW TERMINAL BOXES, WHERE POSSIBLE.
- FIELD VERIFY RIGGING REQUIREMENTS PRIOR TO SUBMITTING A PROPOSAL. COORDINATE ALL RIGGING WITH EXISTING CONDITIONS (INCLUDING ON STREET CONDITIONS AND PARKING). COORDINATE ALL RIGGING WITH THE OWNER. PAY FOR ALL POLICE DETAILS (IF CRANE IS LOCATED ON TOWN PROPERTY OR STREETS). PROVIDE 72 HOUR WRITTEN NOTICE TO THE OWNER.
- PROVIDE LOW-VOLTAGE WIRING FROM ELECTRICAL SOURCE TO MISCELLANEOUS ATC DEVICES. REFER TO AND COORDINATE WITH DIVISION 26.

HVAC ROOF NEW WORK NOTES

- ROOF WORK NOTES SHALL APPLY TO ALL MECHANICAL NEW WORK DRAWINGS.
- PROVIDE ADEQUATE WEATHER PROTECTION AGAINST WIND, RAIN, SNOW, ETC. FOR ALL ROOF OPENINGS DURING CONSTRUCTION.
- THE INSTALLATION OF THE NEW ROOF CURBS AND MISCELLANEOUS ROOF WORK SHALL BE COORDINATED THROUGH THE MANUFACTURER OF THE EXISTING ROOF AND THE OWNER TO ENSURE THE ROOF WARRANTY REMAINS INTACT. THIS CONTRACTOR SHALL CARRY ALL COSTS ASSOCIATED WITH THE ROOF WORK IN HIS/HER CONTRACT PROPOSAL.
- EXISTING ROOFS SHALL BE THOROUGHLY PROTECTED TO PREVENT DAMAGE FROM CONSTRUCTION AND/OR RIGGING. ANY ROOF DAMAGE SHALL BE REPAIRED TO THE SATISFACTION OF THE OWNER WITHOUT ANY ADDITIONAL COST TO THE CONTRACT.
- FIELD VERIFY RIGGING REQUIREMENTS PRIOR TO SUBMITTING A PROPOSAL. COORDINATE ALL RIGGING WITH EXISTING CONDITIONS (INCLUDING ON STREET CONDITIONS AND PARKING). COORDINATE ALL RIGGING WITH THE OWNER. PAY FOR ALL POLICE DETAILS (IF CRANE IS LOCATED ON TOWN PROPERTY OR STREETS). PROVIDE 72 HOUR WRITTEN NOTICE TO THE OWNER.



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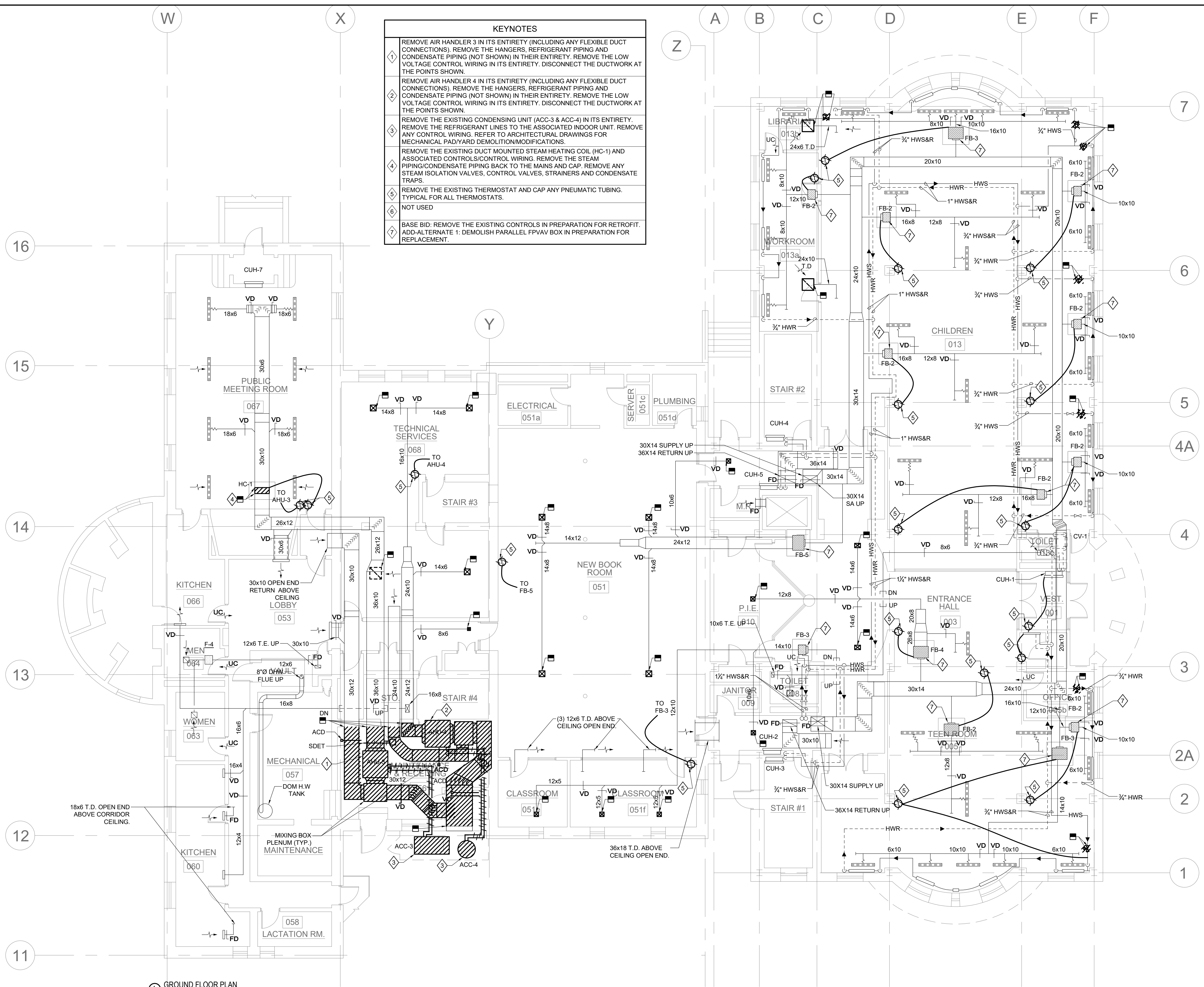
2023-12-22: DD PLUS

2024-01-31: CD'S

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MECHANICAL NOTES

KEYNOTES	
1	REMOVE AIR HANDLER 3 IN ITS ENTIRETY (INCLUDING ANY FLEXIBLE DUCT CONNECTIONS). REMOVE THE HANGERS, REFRIGERANT PIPING AND CONDENSATE PIPING (NOT SHOWN) IN THEIR ENTIRETY. REMOVE THE LOW VOLTAGE CONTROL WIRING IN ITS ENTIRETY. DISCONNECT THE DUCTWORK AT THE POINTS SHOWN.
2	REMOVE AIR HANDLER 4 IN ITS ENTIRETY (INCLUDING ANY FLEXIBLE DUCT CONNECTIONS). REMOVE THE HANGERS, REFRIGERANT PIPING AND CONDENSATE PIPING (NOT SHOWN) IN THEIR ENTIRETY. REMOVE THE LOW VOLTAGE CONTROL WIRING IN ITS ENTIRETY. DISCONNECT THE DUCTWORK AT THE POINTS SHOWN.
3	REMOVE THE EXISTING CONDENSING UNIT (ACC-3 & ACC-4) IN ITS ENTIRETY. REMOVE THE REFRIGERANT LINES TO THE ASSOCIATED INDOOR UNIT. REMOVE ANY CONTROL WIRING. REFER TO ARCHITECTURAL DRAWINGS FOR MECHANICAL PAD/YARD DEMOLITION/MODIFICATIONS.
4	REMOVE THE EXISTING DUCT MOUNTED STEAM HEATING COIL (HC-1) AND ASSOCIATED CONTROLS/CONTROL WIRING. REMOVE THE STEAM PIPING/CONDENSATE PIPING BACK TO THE MAINS AND CAP. REMOVE ANY STEAM ISOLATION VALVES, CONTROL VALVES, STRAINERS AND CONDENSATE TRAPS.
5	REMOVE THE EXISTING THERMOSTAT AND CAP ANY PNEUMATIC TUBING. TYPICAL FOR ALL THERMOSTATS.
6	NOT USED
7	BASE BID: REMOVE THE EXISTING CONTROLS IN PREPARATION FOR RETROFIT. ADD-ALTERNATE 1: DEMOLISH PARALLEL FPVAV BOX IN PREPARATION FOR REPLACEMENT.



1 GROUND FLOOR PLAN
1/8" = 1'-0"

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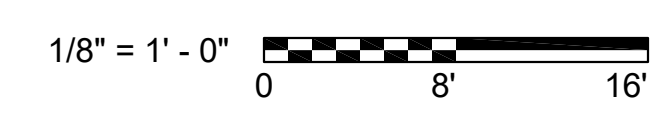
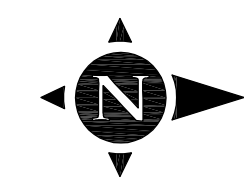
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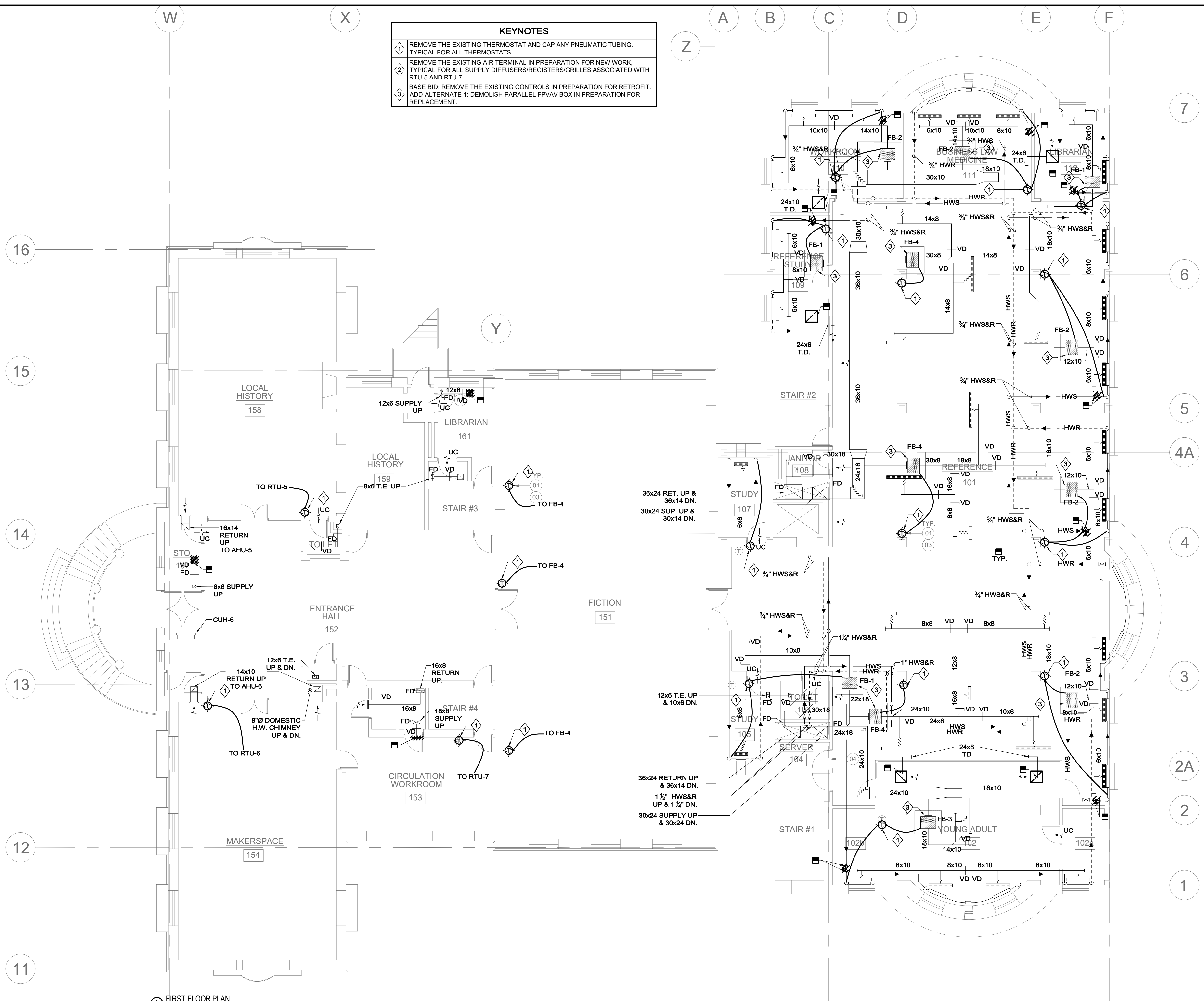
**MECHANICAL
GROUND FLOOR
DEMO PLAN**

MD-2.1



W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\304 HVAC\0220164 MD-2.1 MECHANICAL GROUND FLOOR DEMO PLAN.dwg [PAPER] January 31, 2024 - 10:05am jsh.ambh

KEYNOTES	
①	REMOVE THE EXISTING THERMOSTAT AND CAP ANY PNEUMATIC TUBING. TYPICAL FOR ALL THERMOSTATS.
②	REMOVE THE EXISTING AIR TERMINAL IN PREPARATION FOR NEW WORK. TYPICAL FOR ALL SUPPLY DIFFUSERS/REGISTERS/GRILLES ASSOCIATED WITH RTU-5 AND RTU-7.
③	BASE BID: REMOVE THE EXISTING CONTROLS IN PREPARATION FOR RETROFIT. ADD-ALTERNATE 1: DEMOLISH PARALLEL FPVAV BOX IN PREPARATION FOR REPLACEMENT.



① FIRST FLOOR PLAN
1/8" = 1'-0"

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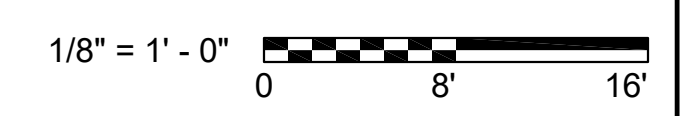
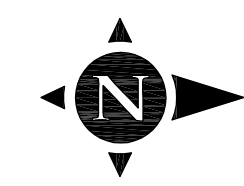
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**MECHANICAL
FIRST FLOOR
DEMO PLAN**

MD-2.2



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KEYNOTES	
1	REMOVE THE EXISTING THERMOSTAT AND CAP ANY PNEUMATIC TUBING. TYPICAL FOR ALL THERMOSTATS.
2	REMOVE THE EXISTING AIR TERMINAL IN PREPARATION FOR NEW WORK. TYPICAL FOR ALL SUPPLY DIFFUSERS/REGISTERS/GRILLES ASSOCIATED WITH RTU-5 AND RTU-7.
3	BASE BID: REMOVE THE EXISTING CONTROLS IN PREPARATION FOR RETROFIT. ADD-ALTERNATE 1: DEMOLISH PARALLEL FPPAV BOX IN PREPARATION FOR REPLACEMENT.
4	REMOVE THE EXISTING HOT WATER UNIT HEATER AND THERMOSTAT IN THE PLENUM.

16

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1 SECOND FLOOR PLAN
1/8" = 1'-0"

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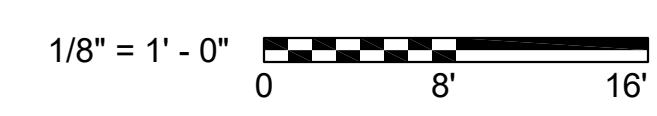
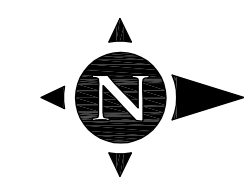
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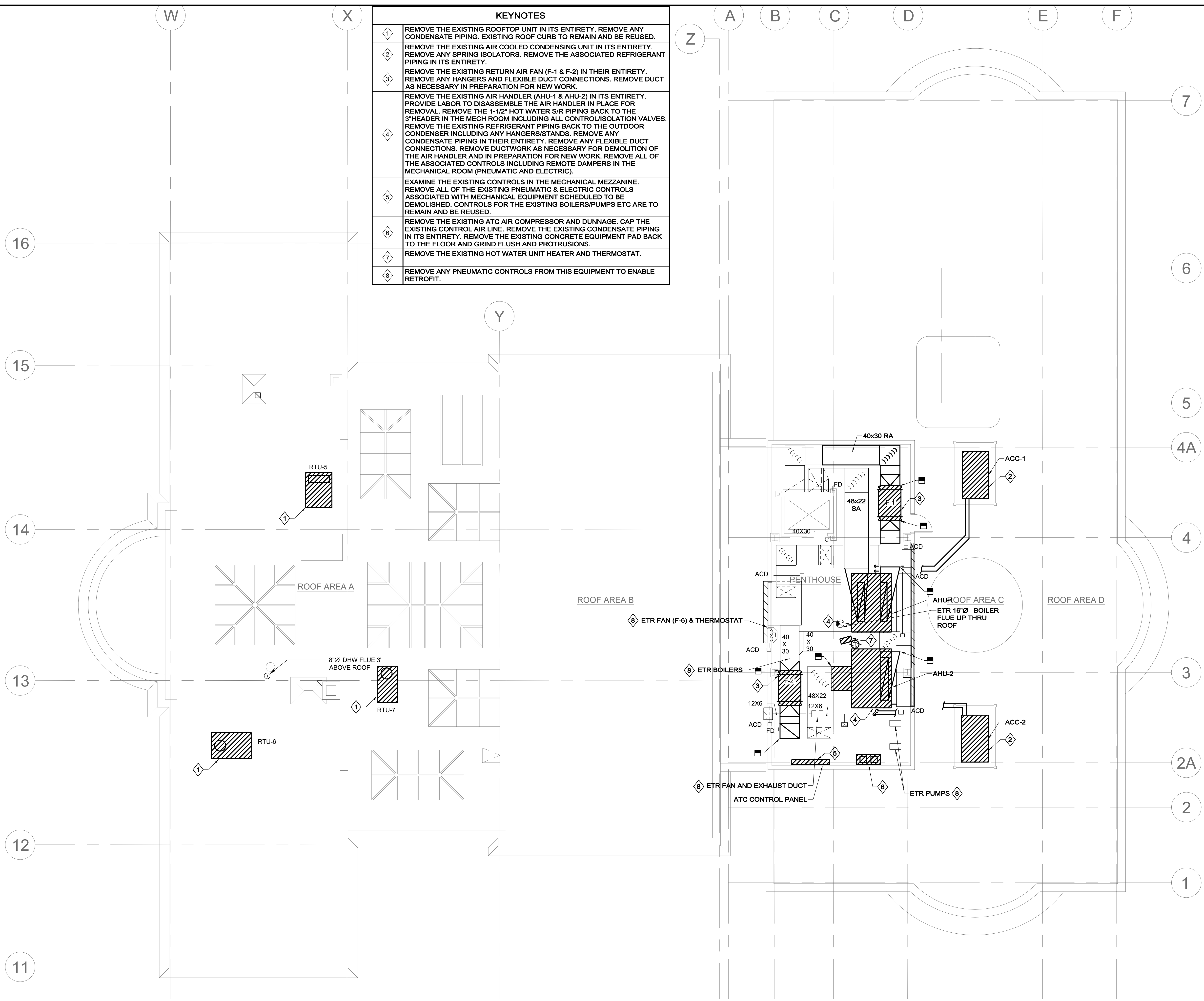
MECHANICAL
SECOND FLOOR
DEMO PLAN

MD-2.3

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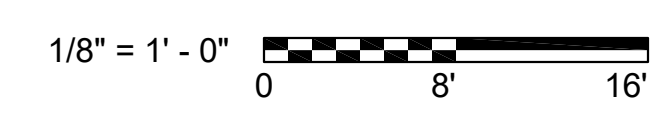


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KEYNOTES	
1	REMOVE THE EXISTING ROOFTOP UNIT IN ITS ENTIRETY. REMOVE ANY CONDENSATE PIPING. EXISTING ROOF CURB TO REMAIN AND BE REUSED.
2	REMOVE THE EXISTING AIR COOLED CONDENSING UNIT IN ITS ENTIRETY. REMOVE ANY SPRING ISOLATORS. REMOVE THE ASSOCIATED REFRIGERANT PIPING IN ITS ENTIRETY.
3	REMOVE THE EXISTING RETURN AIR FAN (F-1 & F-2) IN THEIR ENTIRETY. REMOVE ANY HANGERS AND FLEXIBLE DUCT CONNECTIONS. REMOVE DUCT AS NECESSARY IN PREPARATION FOR NEW WORK.
4	REMOVE THE EXISTING AIR HANDLER (AHU-1 & AHU-2) IN ITS ENTIRETY. PROVIDE LABOR TO DISASSEMBLE THE AIR HANDLER IN PLACE FOR REMOVAL. REMOVE THE 1-1/2" HOT WATER S/R PIPING BACK TO THE 3" HEADER IN THE MECH ROOM INCLUDING ALL CONTROL/ISOLATION VALVES. REMOVE THE EXISTING REFRIGERANT PIPING BACK TO THE OUTDOOR CONDENSER INCLUDING ANY HANGERS/STANDS. REMOVE ANY CONDENSATE PIPING IN THEIR ENTIRETY. REMOVE ANY FLEXIBLE DUCT CONNECTIONS. REMOVE DUCTWORK AS NECESSARY FOR DEMOLITION OF THE AIR HANDLER AND IN PREPARATION FOR NEW WORK. REMOVE ALL OF THE ASSOCIATED CONTROLS INCLUDING REMOTE DAMPERS IN THE MECHANICAL ROOM (PNEUMATIC AND ELECTRIC).
5	EXAMINE THE EXISTING CONTROLS IN THE MECHANICAL MEZZANINE. REMOVE ALL OF THE EXISTING PNEUMATIC & ELECTRIC CONTROLS ASSOCIATED WITH MECHANICAL EQUIPMENT SCHEDULED TO BE DEMOLISHED. CONTROLS FOR THE EXISTING BOILERS/PUMPS ETC ARE TO REMAIN AND BE REUSED.
6	REMOVE THE EXISTING ATC AIR COMPRESSOR AND DUNNAGE. CAP THE EXISTING CONTROL AIR LINE. REMOVE THE EXISTING CONDENSATE PIPING IN ITS ENTIRETY. REMOVE THE EXISTING CONCRETE EQUIPMENT PAD BACK TO THE FLOOR AND GRIND FLUSH AND PROTRUSIONS.
7	REMOVE THE EXISTING HOT WATER UNIT HEATER AND THERMOSTAT.
8	REMOVE ANY PNEUMATIC CONTROLS FROM THIS EQUIPMENT TO ENABLE RETROFIT.

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



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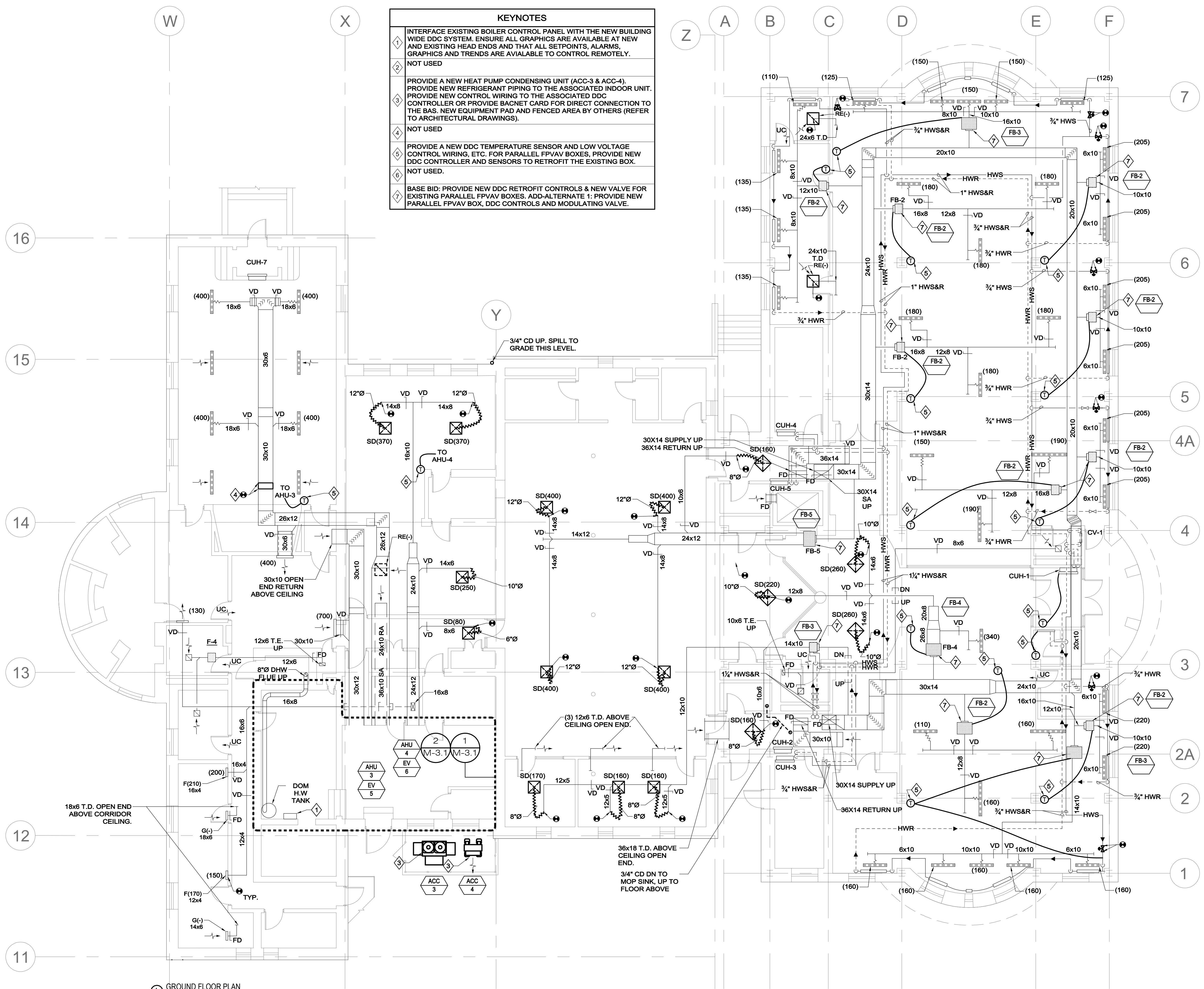
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MECHANICAL ROOF DEMO PLAN

MD-2.4

KEYNOTES	
1	INTERFACE EXISTING BOILER CONTROL PANEL WITH THE NEW BUILDING WIDE DDC SYSTEM. ENSURE ALL GRAPHICS ARE AVAILABLE AT NEW AND EXISTING HEAD ENDS AND THAT ALL SETPOINTS, ALARMS, GRAPHICS AND TRENDS ARE AVAILABLE TO CONTROL REMOTELY.
2	NOT USED
3	PROVIDE A NEW HEAT PUMP CONDENSING UNIT (ACC-3 & ACC-4). PROVIDE NEW REFRIGERANT PIPING TO THE ASSOCIATED INDOOR UNIT. PROVIDE NEW CONTROL WIRING TO THE ASSOCIATED DDC CONTROLLER OR PROVIDE BACNET CARD FOR DIRECT CONNECTION TO THE BAS. NEW EQUIPMENT PAD AND FENCED AREA BY OTHERS (REFER TO ARCHITECTURAL DRAWINGS).
4	NOT USED
5	PROVIDE A NEW DDC TEMPERATURE SENSOR AND LOW VOLTAGE CONTROL WIRING, ETC. FOR PARALLEL FPVAV BOXES. PROVIDE NEW DDC CONTROLLER AND SENSORS TO RETROFIT THE EXISTING BOX.
6	NOT USED
7	BASE BID: PROVIDE NEW DDC RETROFIT CONTROLS & NEW VALVE FOR EXISTING PARALLEL FPVAV BOXES. ADD-ALTERNATE 1: PROVIDE NEW PARALLEL FPVAV BOX, DDC CONTROLS AND MODULATING VALVE.

- GENERAL NOTE**
- BALANCE NEW AND EXISTING SUPPLY/RETURN REGISTERS, GRILLES AND DIFFUSERS TO THE CFM SHOWN IN PARENTHESIS.
 - UNLESS NOTED OTHERWISE ALL REGISTERS GRILLES, AND DIFFUSERS ARE EXISTING TO REMAIN AND SHALL BE CLEANED BY HVAC CONTRACTOR



1 GROUND FLOOR PLAN
1/8" = 1'-0"

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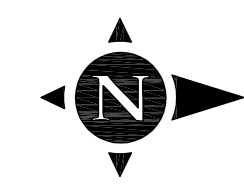
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**MECHANICAL
GROUND FLOOR
NEW WORK PLAN**



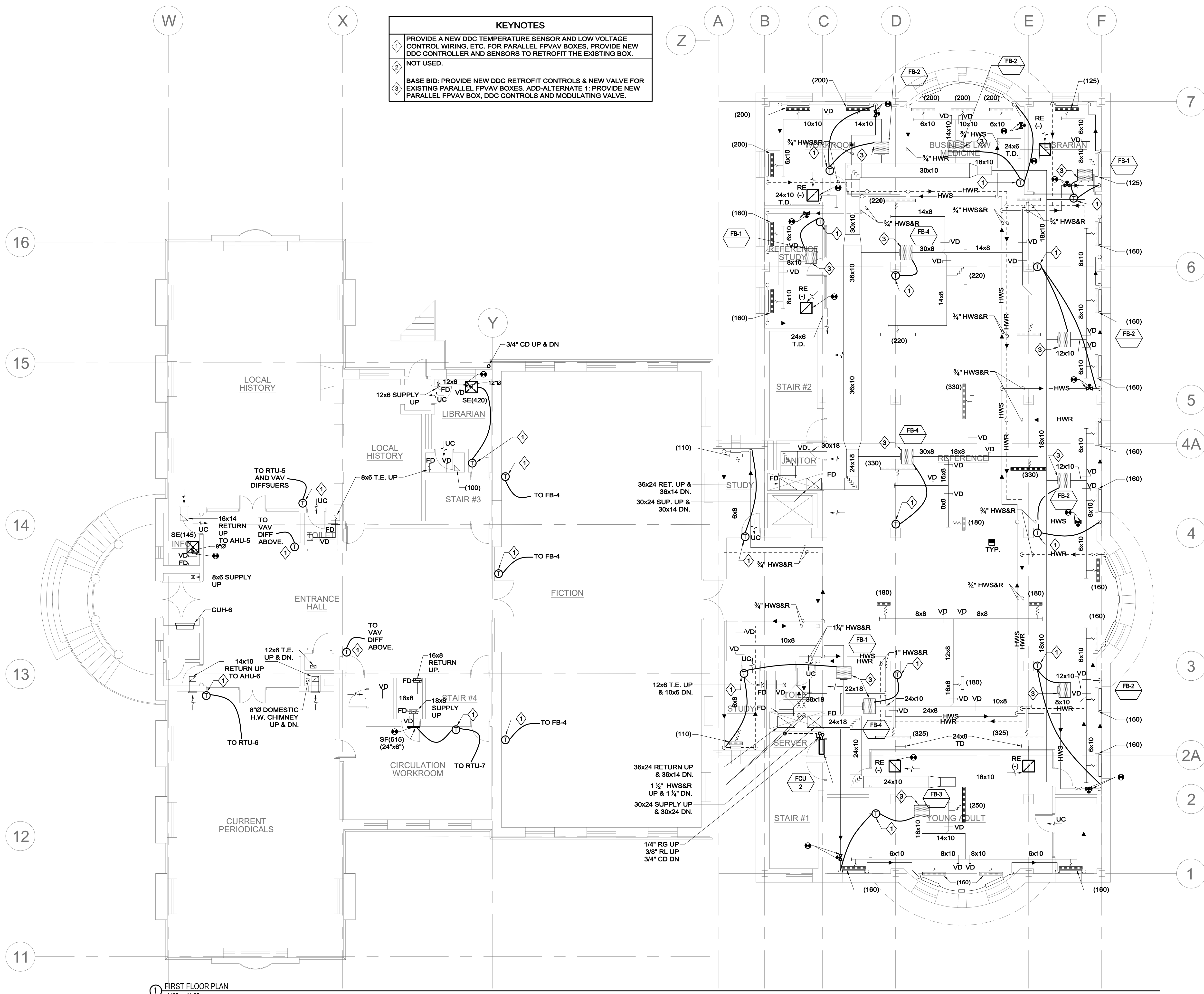
1/8" = 1'-0"
0 8' 16'

M-2.1

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KEYNOTES	
◇	PROVIDE A NEW DDC TEMPERATURE SENSOR AND LOW VOLTAGE CONTROL WIRING, ETC. FOR PARALLEL FPVAV BOXES, PROVIDE NEW DDC CONTROLLER AND SENSORS TO RETROFIT THE EXISTING BOX. NOT USED.
◇	BASE BID: PROVIDE NEW DDC RETROFIT CONTROLS & NEW VALVE FOR EXISTING PARALLEL FPVAV BOXES. ADD-ALTERNATE 1: PROVIDE NEW PARALLEL FPVAV BOX, DDC CONTROLS AND MODULATING VALVE.

GENERAL NOTE	
1.	BALANCE NEW AND EXISTING SUPPLY/RETURN REGISTERS, GRILLES AND DIFFUSERS TO THE CFM SHOWN IN PARENTHESIS.
2.	UNLESS NOTED OTHERWISE ALL REGISTERS GRILLES, AND DIFFUSERS ARE EXISTING TO REMAIN AND SHALL BE CLEANED BY HVAC CONTRACTOR



① FIRST FLOOR PLAN
1/8" = 1'-0"

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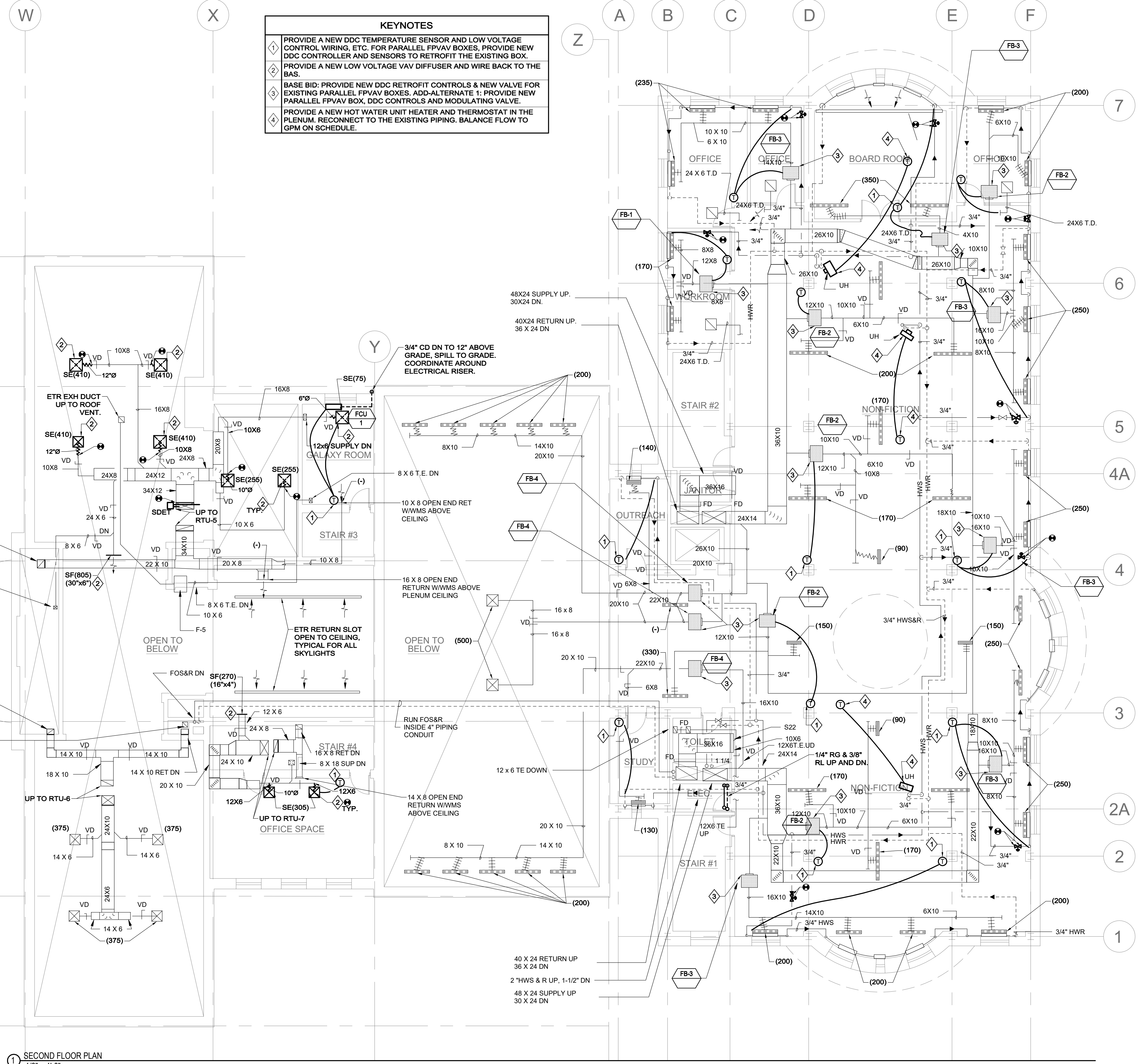
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**MECHANICAL
FIRST FLOOR
NEW WORK PLAN**

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KEYNOTES	
1	PROVIDE A NEW DDC TEMPERATURE SENSOR AND LOW VOLTAGE CONTROL WIRING, ETC. FOR PARALLEL FPVAV BOXES, PROVIDE NEW DDC CONTROLLER AND SENSORS TO RETROFIT THE EXISTING BOX.
2	PROVIDE A NEW LOW VOLTAGE VAV DIFFUSER AND WIRE BACK TO THE BAS.
3	BASE BID: PROVIDE NEW DDC RETROFIT CONTROLS & NEW VALVE FOR EXISTING PARALLEL FPVAV BOXES. ADD-ALTERNATE 1: PROVIDE NEW PARALLEL FPVAV BOX, DDC CONTROLS AND MODULATING VALVE.
4	PROVIDE A NEW HOT WATER UNIT HEATER AND THERMOSTAT IN THE PLENUM. RECONNECT TO THE EXISTING PIPING. BALANCE FLOW TO GPM ON SCHEDULE.

GENERAL NOTE

- BALANCE NEW AND EXISTING SUPPLY/RETURN REGISTERS, GRILLES AND DIFFUSERS TO THE CFM SHOWN IN PARENTHESIS.
- UNLESS NOTED OTHERWISE ALL REGISTERS GRILLES, AND DIFFUSERS ARE EXISTING TO REMAIN AND SHALL BE CLEANED BY HVAC CONTRACTOR

1 SECOND FLOOR PLAN
1/8" = 1'-0"

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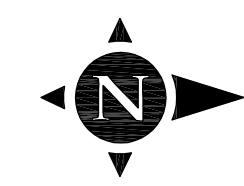
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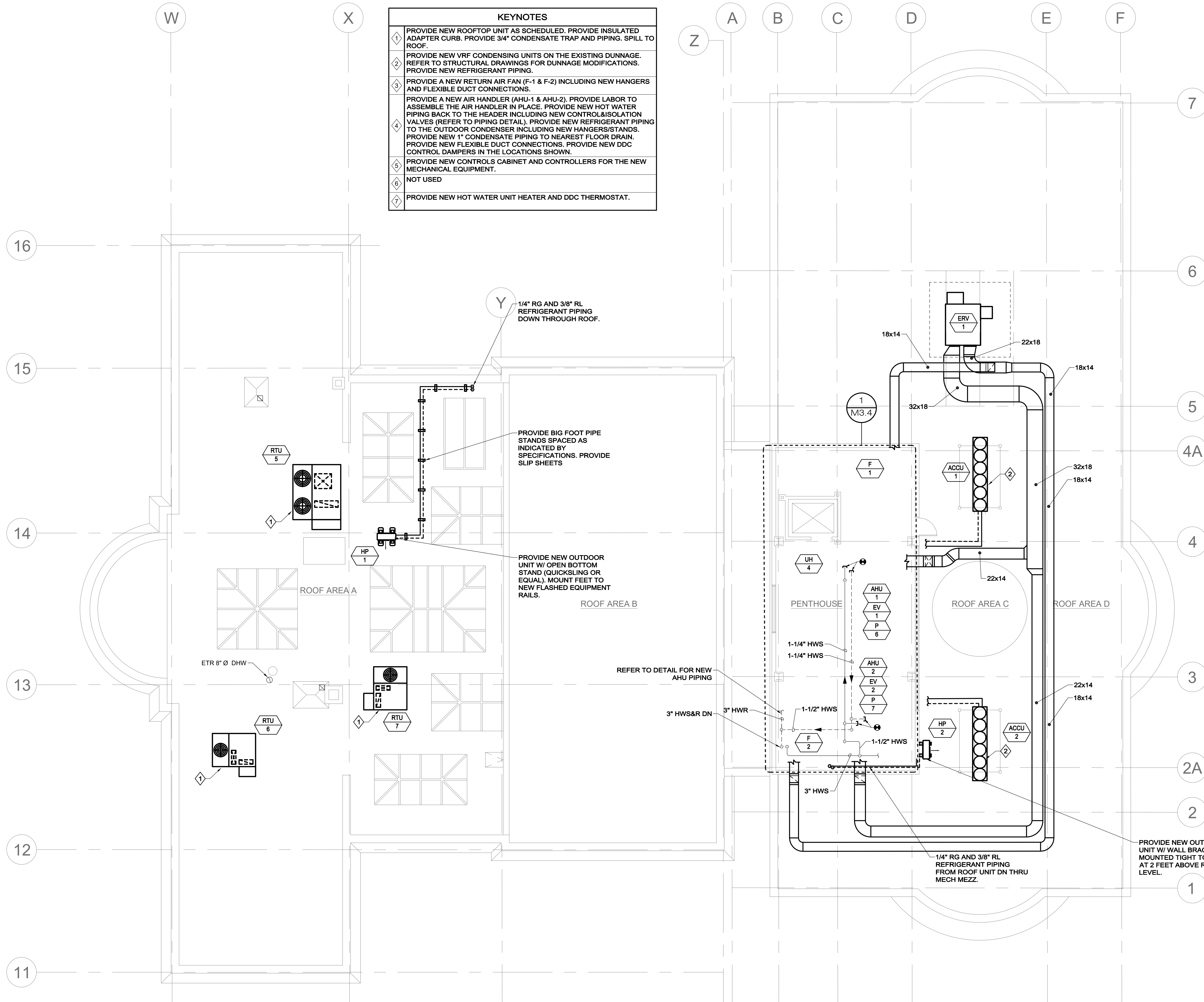
**MECHANICAL
SECOND FLOOR
NEW WORK PLAN**



1/8" = 1'-0"
0 8' 16'

M-2.3

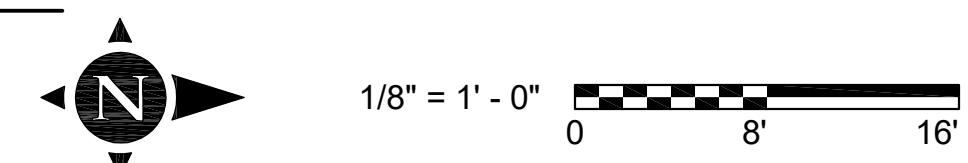
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KEYNOTES	
1	PROVIDE NEW ROOFTOP UNIT AS SCHEDULED. PROVIDE INSULATED ADAPTER CURB. PROVIDE 3/4\" CONDENSATE TRAP AND PIPING. SPILL TO ROOF.
2	PROVIDE NEW VRF CONDENSING UNITS ON THE EXISTING DUNNAGE. REFER TO STRUCTURAL DRAWINGS FOR DUNNAGE MODIFICATIONS. PROVIDE NEW REFRIGERANT PIPING.
3	PROVIDE A NEW RETURN AIR FAN (F-1 & F-2) INCLUDING NEW HANGERS AND FLEXIBLE DUCT CONNECTIONS.
4	PROVIDE A NEW AIR HANDLER (AHU-1 & AHU-2). PROVIDE LABOR TO ASSEMBLE THE AIR HANDLER IN PLACE. PROVIDE NEW HOT WATER PIPING BACK TO THE HEADER INCLUDING NEW CONTROL & ISOLATION VALVES (REFER TO PIPING DETAIL). PROVIDE NEW REFRIGERANT PIPING TO THE OUTDOOR CONDENSER INCLUDING NEW HANGERS/STANDS. PROVIDE NEW 1\" CONDENSATE PIPING TO NEAREST FLOOR DRAIN. PROVIDE NEW FLEXIBLE DUCT CONNECTIONS. PROVIDE NEW DDC CONTROL DAMPERS IN THE LOCATIONS SHOWN.
5	PROVIDE NEW CONTROLS CABINET AND CONTROLLERS FOR THE NEW MECHANICAL EQUIPMENT.
6	NOT USED
7	PROVIDE NEW HOT WATER UNIT HEATER AND DDC THERMOSTAT.

GENERAL NOTES:
 1. UNLESS NOTED OTHERWISE ALL REGISTERS GRILLES, AND DIFFUSERS ARE EXISTING TO REMAIN AND SHALL BE CLEANED BY HVAC CONTRACTOR

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



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**MECHANICAL
 ROOF
 NEW WORK PLAN**

M-2.4

GENERAL ATC NOTES

- PROVIDE NEW DDC AUTOMATIC TEMPERATURE CONTROL SYSTEM INCLUDING OPERATOR WORKSTATION. CONTROL SOFTWARE TO ALLOW GRAPHIC REPRESENTATION OF THE HVAC SYSTEM WITH "POINT AND CLICK" SELECTION OF ALL EQUIPMENT. ALL TEMPERATURE SETPOINT CHANGES, SCHEDULING, ETC. SHALL BE ADJUSTABLE THROUGH THE USE OF A MOUSE. PROVIDE GRAPHIC REPRESENTATION OF ALL FLOOR PLANS SHOWING HVAC EQUIPMENT, VALVES, DAMPERS, TEMPERATURE SENSORS, HUMIDITY SENSORS, ETC.
- OPERATOR WORKSTATION SHALL CONSIST OF CURRENT GENERATION MULTI-CORE INTEL PROCESSOR OPERATING AT 2.4 GHZ MINIMUM SPEED, INCLUDE 2GB RAM AND A MINIMUM OF (1) 160GB/7200RPM HARD DISK DRIVE. PROVIDE A X16 PCIE GRAPHICS CARD, FOUR USB 2.0 PORTS, 100/1000 BASE-T NETWORK CARD, AND 16X DVD±RW DRIVE. PROVIDE 19IN. LCD FLAT SCREEN MONITOR.
- NEW DDC CONTROL SYSTEM SHALL BE CONNECTED TO AND CONTROL NEW AIR HANDLING UNITS, AIR COOLED CONDENSING UNITS, FANS, VAV TERMINAL UNITS, EXISTING PUMPS, ETC.
- OPERATOR WORKSTATION TO BE INSTALLED IN THE MAINTENANCE OFFICE. FINAL LOCATION TO BE DETERMINED BY THE OWNER. PROVIDE SECURITY ACCESS/PASSWORD PROGRAMMING FOR DDC CONTROL SYSTEM.
- ALL ATC CONTROLS SHALL BE HARDWIRED. NO WIRELESS TECHNOLOGY SHALL BE ALLOWED. ALL EXPOSED WIRING SHALL BE INSTALLED IN MINIMUM 1/2 INCH GALVANIZED EMT CONDUIT. CONTRACTOR SHALL INSTALL ALL NEW CONTROL WIRING FOR THE OFFICES, CORRIDORS AND LOBBY IN THE WALL WHERE POSSIBLE. WHERE NOT POSSIBLE, PROVIDE WIREMOLD THAT MATCHES ADJACENT SURFACE.
- ALL DDC CONTROLLERS CONTROLLING THE AIR HANDLING UNITS SHALL BE PROVIDED WITH AN OPERATOR DISPLAY/INTERFACE ALLOWING THE USER TO PERFORM OPERATIONS TASKS ON THE ATC SYSTEM. PROVIDE PASSWORD PROTECTION.
- THE CONTRACTOR SHALL CARRY 16 HOURS OF ADDITIONAL ON-SITE PROGRAMMING (ABOVE BASE CONTRACT) TO ALLOW FOR FIELD MODIFICATIONS THAT MAY BE NEEDED TO OPTIMIZE THE VARIOUS SYSTEMS TO FULLY CONFORM TO THE REQUIREMENTS OF THE SPECIFICATIONS, SEQUENCE OF CONTROLS AND WORK WITH THE ACTUAL OPERATING CONDITIONS AS INSTALLED. THIS WORK SHALL BE DONE AT NO ADDITIONAL COST.
- ON-SITE TRAINING SHALL ALSO INCLUDE A MINIMUM OF 16 HOURS OF HANDS ON INSTRUCTION GEARED TOWARD OPERATION AND MAINTENANCE OF THE SYSTEMS, PRIOR TO TRAINING, THE NECESSARY LESSON PLANS, TRAINING DOCUMENTS, HANDOUTS, ETC. SHALL BE PROVIDED WITH THE CURRICULUM OUTLINE, WHICH SHALL INCLUDE AS A MINIMUM:
 - INITIAL SESSION - 4 HRS
 - 2ND SESSION, 2 WEEKS LATER - 4 HRS
 - REMAINING 8 HRS TO BE SCHEDULED BY THE OWNER AS NEEDED.
- ALL TRAINING SHALL BE RECORDED AND COPIED TO DVD BY THE ATC CONTRACTOR. THREE COPIES OF THE RECORDED SESSIONS SHALL BE SUBMITTED TO THE OWNER FOR THEIR USE.
- PROVIDE WIRING FROM ELECTRICAL SOURCE TO MISCELLANEOUS ATC DEVICES. REFER TO HVAC PLANS, HVAC MECHANICAL ROOM PLANS, AND ELECTRICAL PLANS FOR LOCATION OF POWER SOURCES FOR ATC SYSTEM.
- SUBMIT ACCEPTANCE TESTING PLAN, PRE-FUNCTIONAL PERFORMANCE TEST FORMS/NARRATIVES AND FUNCTIONAL TEST FORMS/NARRATIVES TO ENGINEER FOR REVIEW AND APPROVAL.
- PROVIDE DEMOLITION OF EXISTING CONTROL COMPONENTS WHICH ARE BEING REPLACED BY THE NEW ATC CONTROL SYSTEM.
- ALL MOTOR RATED RELAYS FOR FANS, ETC. SHALL BE FURNISHED BY DIVISION 250000 AND TURNED OVER TO DIVISION 260000 FOR INSTALLATION.
- THE HVAC SYSTEM SHALL BE INDEXED TO HEATING WHEN HOT WATER IS AVAILABLE (GENERALLY BETWEEN THE MONTHS OF OCTOBER AND APRIL). THE HVAC SYSTEM SHALL BE INDEXED TO COOLING WHEN DX IS AVAILABLE (GENERALLY BETWEEN THE MONTHS OF MAY AND SEPTEMBER).
- CONTRACTOR SHALL PROVIDE ALL INTERFACE DEVICES AND SOFTWARE TO PROVIDE AN INTEGRATED SYSTEM CONNECTING THE BUILDING CONTROL SUPERVISORY LANS TO THE OWNER'S NETWORK FOR COMMUNICATION TO THE OWNER'S ENTERPRISE ENERGY MANAGEMENT SERVER (EEMS). THE EEMS IS A NETWORK BASED SYSTEM CONNECTING MULTIPLE FACILITIES WITH A CENTRAL DATA WAREHOUSE AND SERVER, ACCESSIBLE VIA STANDARD WEB-BROWSER AND TERMINAL SERVICES INTERNAL TO THE OWNER'S NETWORK. THIS IS AN EXISTING INFRASTRUCTURE AND CONTRACTOR IS NOT REQUIRED TO CONFIGURE ANY COMPONENTS OF THIS WAN. CONTRACTOR IS HOWEVER REQUIRED TO PROVIDE A SINGLE POINT OF CONNECTION (LOCAL SUPERVISORY DEVICE) TO THE ENTERPRISE ENERGY MANAGEMENT SERVER THROUGH BACNET OBJECTS AND SERVICES VIA THE LOCAL SUPERVISORY LAN VIA BACNET IP PROTOCOL.
- LOCATION OF ALL NEW DDC CONTROL PANELS SHALL BE FIELD VERIFIED WITH THE EXISTING CONDITIONS BY THE CONTRACTOR.

CONTROL ABBREVIATIONS

ACD	AUTOMATIC CONTROL DAMPER
ACV	AUTOMATIC CONTROL VALVE
AFMS	AIR FLOW MEASURING STATION
ALM	ALARM
ATC	AUTOMATIC TEMPERATURE CONTROL
BCV	BASEBOARD CONTROL VALVE
BDD	BACKDRAFT DAMPER (ADJUSTABLE COUNTERWEIGHT)
BV	BYPASS VALVE
C	CARBON DIOXIDE SENSOR
CAP	CAPACITY CONTROL
CCLT	COOLING COIL LEAVING AIR TEMPERATURE SENSOR
CHRT	CHILLED WATER RETURN TEMPERATURE SENSOR
CHST	CHILLED WATER SUPPLY TEMPERATURE SENSOR
CHWRT	CHILLED WATER RESET TEMPERATURE
CO	CARBON MONOXIDE SENSOR
CRT	CONDENSER WATER RETURN TEMPERATURE SENSOR
CST	CONDENSER WATER SUPPLY TEMPERATURE SENSOR
CT	CURRENT TRANSFORMER (STATUS FEEDBACK)
CV	COOLING COIL CONTROL VALVE
DAT	DISCHARGE AIR TEMPERATURE SENSOR
DDC	DIRECT DIGITAL CONTROL
DDCFP	DIRECT DIGITAL CONTROL FIELD PANEL
DL	DEMAND LIMIT
DPS	DIFFERENTIAL PRESSURE SWITCH
DPT	DIFFERENTIAL PRESSURE SENSOR/TRANSMITTER
DPV	DIFFERENTIAL PRESSURE BYPASS VALVE
DSP	DISCHARGE STATIC PRESSURE SENSOR
DWDI	DOUBLE WIDTH DOUBLE INLET
EAD	EXHAUST AIR DAMPER
EHRET	EXHAUST HEAT RECOVERY COIL ENTERING AIR TEMPERATURE SENSOR
EHRLT	EXHAUST HEAT RECOVERY COIL LEAVING AIR TEMPERATURE SENSOR
EHRV	EXHAUST HEAT RECOVERY COIL CONTROL VALVE
ES	END SWITCH
FA	FAULT ALARM
FID	FAN ISOLATION DAMPER
FMT	FLOW METER/TRANSMITTER
FS	FLOW SWITCH
FZ	FREEZESTAT
H	HUMIDITY SENSOR
HALM	HOOD ALARM
HCLT	HEATING COIL LEAVING AIR TEMPERATURE SENSOR
HEPA	HIGH EFFICIENCY PARTICULATE AIR FILTER
HHL	HIGH HUMIDITY LIMIT SENSOR
HIV	HUMIDIFIER ISOLATION VALVE
HLH	HIGH/LOW HUMIDITY LIMIT SENSOR
HOA	HANDS-OFF AUTOMATIC SWITCH
HR	HUMIDITY SENSOR (ROOM)
HRET	HEAT RECOVERY COIL ENTERING AIR TEMPERATURE SENSOR
HRLT	HEAT RECOVERY COIL LEAVING AIR TEMPERATURE SENSOR
HRT	HEAT RECOVERY LOOP TEMPERATURE SENSOR
HRV	HEAT RECOVERY COIL CONTROL VALVE
HRV	HEAT RECOVERY LOOP CONTROL VALVE
HS	HAND SWITCH
HSPS	HIGH STATIC PRESSURE SWITCH
HSS	HOOD SASH SWITCH
HUV	HUMIDIFIER CONTROL VALVE
HV	HEATING COIL CONTROL VALVE
HWRT	HOT WATER RETURN TEMPERATURE SENSOR
HWST	HOT WATER SUPPLY TEMPERATURE SENSOR
IFBD	INTEGRAL FACE & BYPASS DAMPER
IGV	INLET GUIDE VANES
LAT	LEAVING AIR TEMPERATURE SENSOR
LSPS	LOW STATIC PRESSURE SWITCH
LS	LEVEL SENSOR OR LIGHT SWITCH INTERFACE
LSHA	LEVEL SENSOR HIGH ALARM
LSHS	LEVEL SENSOR HIGH SWITCH
LSLA	LEVEL SENSOR LOW ALARM
LSLS	LEVEL SENSOR LOW SWITCH
MAT	MIXED AIR TEMPERATURE SENSOR
MUWV	MAKE-UP WATER VALVE
MD	MOTION DETECTOR
NC	NORMALLY CLOSED (ON LOSS OF POWER)
NO	NORMALLY OPEN (ON LOSS OF POWER)
OAD	OUTSIDE AIR DAMPER
OAH	OUTSIDE AIR HUMIDITY SENSOR (FOR WET BULB READING)
OAT	OUTSIDE AIR TEMPERATURE SENSOR (DRY BULB)
PAD	PRIMARY AIR DAMPER
PCHRT	PRIMARY CHILLED WATER RETURN TEMPERATURE SENSOR
PCHST	PRIMARY CHILLED WATER SUPPLY TEMPERATURE SENSOR
PR	PRESSURE SENSOR (ROOM)
RAD	RETURN AIR DAMPER
RAH	RETURN AIR HUMIDITY SENSOR
RAT	RETURN AIR TEMPERATURE SENSOR
RV	REHEAT CONTROL VALVE
RH	RELATIVE HUMIDITY
RI	RUN INDICATOR
RSID	RETURN SMOKE ISOLATION DAMPER
S	SWITCH
SAD	SUPPLY AIR DAMPER
SCHRT	SECONDARY CHILLED WATER RETURN TEMPERATURE
SCHST	SECONDARY CHILLED WATER SUPPLY TEMPERATURE
SD	SMOKE DAMPER
SDET	SMOKE DETECTOR
SFD	SMOKE/FIRE DETECTOR
SP	STATIC PRESSURE SENSOR
SPD	SPEED CONTROL
S/S	START/STOP
S/S _H	START/STOP HIGH SPEED/CAPACITY
S/S _L	START/STOP LOW SPEED/CAPACITY
SSD	SUPPLY SMOKE ISOLATION DAMPER
SSP	SUCTION STATIC PRESSURE SENSOR
T	TEMPERATURE SENSOR/THERMOSTAT
TR	TEMPERATURE SENSOR/THERMOSTAT (ROOM)
VFDS	VARIABLE FREQUENCY DRIVE SPEED
VFDO	VARIABLE FREQUENCY DRIVE SPEED OUTPUT (FEEDBACK)
VS	VIBRATION SWITCH
WC	WATER COLUMN
X	REMOVE EXISTING ITEM

CONTROL POINT DESCRIPTOR LEGEND

	ATC CONTRACTOR PROVIDED DDC POINT AND HARDWARE
	CONTROL DEVICE FURNISHED BY ELECTRICAL OR PLUMBING CONTRACTOR BUT INTERFACED TO DDC SYSTEM BY ATC CONTRACTOR
	ATC CONTRACTOR INTERFACE TO EQUIPMENT MANUFACTURER'S HARDWARE
	ATC CONTRACTOR PROVIDED LOCAL CONTROL POINT



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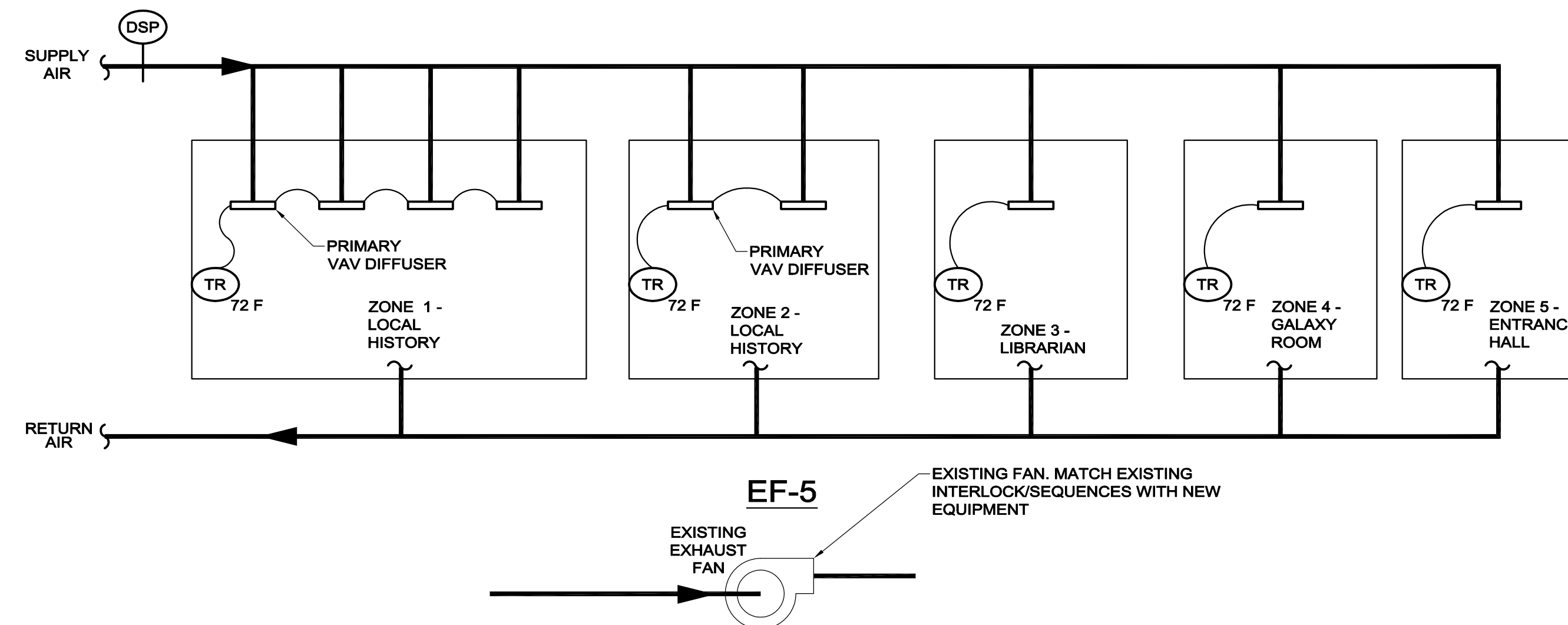
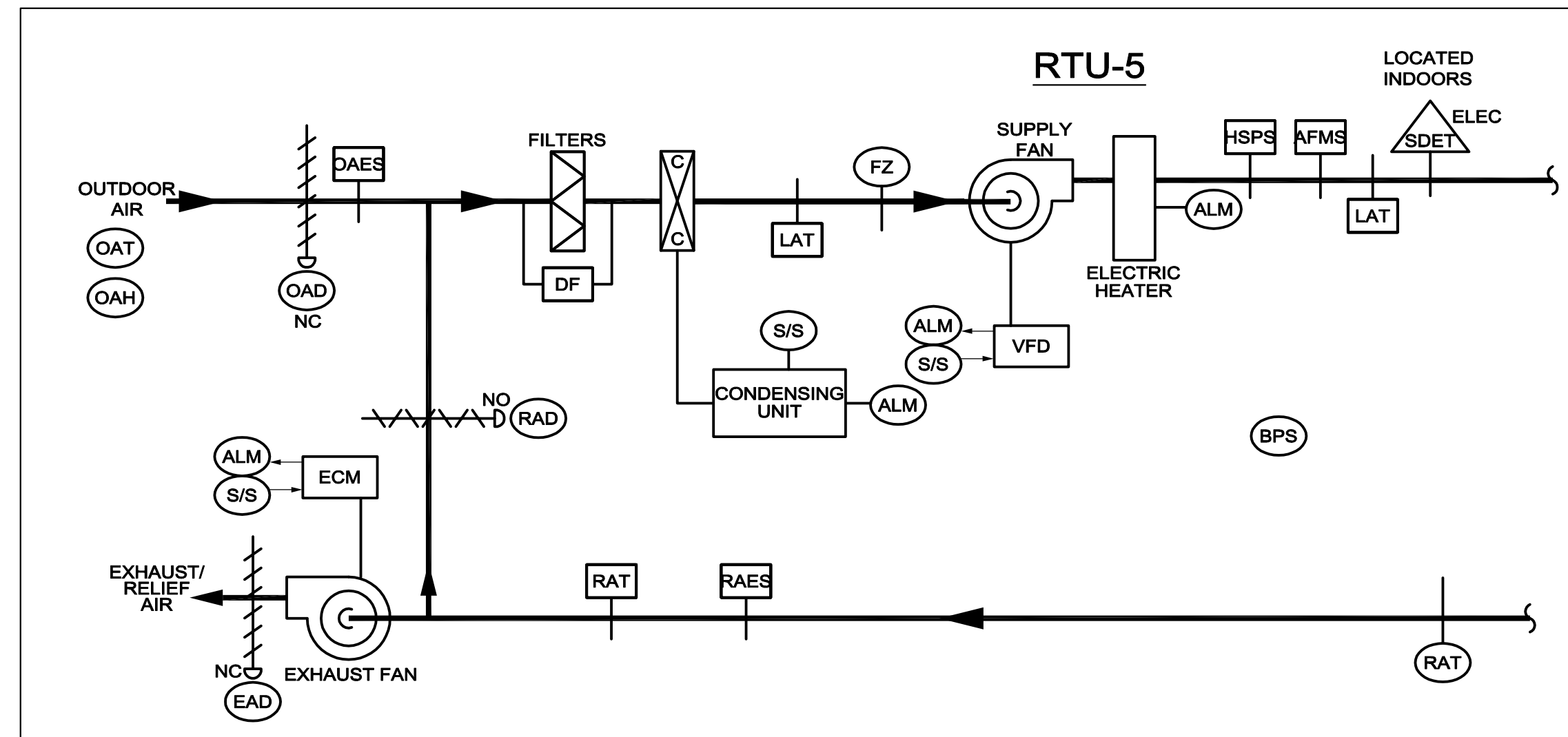
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MECHANICAL CONTROLS



ROOF TOP UNIT CONTROLS

GENERAL

1. ROOF TOP UNIT (RTU) SHALL BE STARTED, STOPPED BY THE RTU SHALL BE CONTROLLED VIA DEDICATED RTU PACKAGED PROGRAMMABLE CONTROLLER. COORDINATE OCCUPIED AND UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC. NO = NORMALLY (FAIL) OPEN ON LOSS OF POWER. NC = NORMALLY (FAIL) CLOSED ON LOSS OF POWER. THE TRANE CONCIERGE CONTROL SYSTEM.
2. LOCAL HAND-OFF-AUTOMATIC SWITCH (H-O-A) FOR FANS SHALL OVERRIDE DDC START/STOP (S/S) COMMANDS. ALL HARDWIRED SAFETIES SHALL BE ACTIVE IN BOTH "H" AND "A" POSITIONS.
3. ALL TEMPERATURES LISTED ARE FAHRENHEIT AND SHALL BE ADJUSTABLE.
4. ALL TEMPERATURE SENSORS IN THE UNIT AND DUCTWORK SHALL BE AVERAGING TYPE.
5. PROVIDE APPROPRIATE ANTI-RECYCLE TIME DELAYS AND SAFETIES ON COMPRESSOR AND GAS HEATER STAGING.

FAN CONTROL

1. WHILE IN UNOCCUPIED MODE (OR OFF ON SAFETY OR MANUAL DISCONNECT) THE SUPPLY FAN SHALL BE OFF WITH THE OUTSIDE AIR DAMPER (OAD) CLOSED, THE CONDENSING UNIT AND GAS HEATER OFF, AND THE RETURN AIR DAMPER (RAD) OPEN.
2. WHEN STARTED IN OCCUPIED MODE, THE SUPPLY FAN SHALL START IN RECIRCULATION MODE, THEN THE OAD AND RAD SHALL OPEN TO THE MINIMUM OUTDOOR AIR POSITION. THE SUPPLY FAN SHALL OPERATE AT CONSTANT VOLUME.
3. THE EXHAUST FAN SHALL BE ENERGIZED VIA STARTER BASED ON OAD POSITION THROUGH THE MANUFACTURER'S PACKAGED CONTROLS TO MAINTAIN SETPOINT OF BUILDING PRESSURE (BPS). INITIAL SETPOINT SHALL BE POSITIVE 0.01" W.C.

OCCUPIED HEATING CONTROL

1. ELECTRIC HEATING COIL LEAVING AIR TEMPERATURE SENSOR (HCLT) ALWAYS CONTROLS HEATER TO MAINTAIN A MINIMUM TEMPERATURE OF 50°F (ADJ).
2. UPON A DROP IN THE RETURN AIR TEMPERATURE AS SENSED BY THE RETURN AIR TEMPERATURE SENSOR (RAT) BELOW 70°F, THE DISCHARGE AIR TEMPERATURE SENSOR (DAT) SHALL RESET (HCLT) BETWEEN 70°F AND 90°F AS REQUIRED TO MAINTAIN 70°F (ADJ.). THE REVERSE SHALL OCCUR ON A RISE IN DAT ABOVE HEATING SETPOINT.

OCCUPIED COOLING CONTROL

1. UPON A RISE IN THE RETURN AIR TEMPERATURE AS SENSED BY THE RETURN AIR TEMPERATURE SENSOR (RAT) ABOVE 72°F, THE DISCHARGE AIR TEMPERATURE SENSOR (DAT) SHALL RESET (HCLT) BETWEEN 55°F AND 60°F AS REQUIRED TO MAINTAIN 70°F (ADJ.). THE REVERSE SHALL OCCUR ON A RISE IN DAT ABOVE HEATING SETPOINT.
2. THE FIRST MEANS OF COOLING SHALL BE ACTIVATION OF THE ECONOMIZER. IF THE OUTSIDE AIR ENTHALPY IS BELOW THE RETURN ENTHALPY, THE OUTSIDE AND RETURN AIR DAMPERS SHALL BE PROPORTIONALLY MODULATED UP TO 100% OUTDOOR AIR TO MAINTAIN SPACE TEMPERATURE SETPOINT. DAT SHALL OVERRIDE, IF REQUIRED, TO LIMIT SUPPLY AIR TEMPERATURE TO 55°F MINIMUM DURING ECONOMIZER COOLING (LIMIT SHALL NOT RESULT IN REDUCTION OF THE MINIMUM OUTDOOR AIRFLOW). IF ADDITIONAL COOLING IS REQUIRED, THE CONDENSING UNIT'S COMPRESSORS SHALL BE STAGED ON AS REQUIRED. THE REVERSE SHALL OCCUR ON A DROP IN SPACE TEMPERATURE BELOW COOLING SETPOINT.
3. IF THE OUTSIDE AIR ENTHALPY RISES ABOVE THE RETURN AIR ENTHALPY THE ECONOMIZER SHALL BE POSITIONED TO PROVIDE MINIMUM OUTDOOR AIRFLOW AND THE CONDENSING UNIT STAGED TO MAINTAIN ROOM COOLING SETPOINT TEMPERATURE.

UNOCCUPIED CONTROL

1. IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE FALLS BELOW 56°F, THE UNIT SHALL START WITH RAD OPEN AND OAD CLOSED AND GAS HEATER SHALL BE CONTROLLED BY DAT TO SUPPLY 85°F-90°F AIR. WHEN ROOM TEMPERATURE RISES ABOVE 60°F, THE UNIT SHALL SHUT DOWN.
2. PROVIDE 2 HOUR UNOCCUPIED OVERRIDE TO START UNIT IN OCCUPIED MODE BASED ON A SIGNAL FROM THE MANUAL SWITCH.

BY-PASS DAMPER OPERATION

1. ON IN AN INCREASE IN DUCT STATIC PRESSURE AS SENSED BY THE DUCT STATIC PRESSURE SENSOR (DSP) THE BY-PASS DAMPER (BYD) SHALL OPEN TO INCREASE THE AMOUNT OF BY-PASS AIR. ON A DECREASE IN DUCT STAIC THE REVERSE SHALL OCCUR.

SAFETIES

1. THE FOLLOWING SAFETIES EACH WITH ITS OWN MANUAL RESET BUTTON, SHALL SHUT DOWN THE UNIT VIA HARDWARE BEFORE H-O-A.
 - 1.1. WHEN ANY SMOKE DETECTOR (SDET) IS ACTIVATED THE UNIT SHALL SHUT DOWN.
 - 1.2. WHEN THE TEMPERATURE IS LESS THAN 37°F AT ANY FREEZESTAT (FZ). THIS ALARM SHALL ALSO ENABLE THE ELECTRIC HEATER.

ALARMS

1. IF THE SUPPLY OR EXHAUST FAN FAILS OR IF ANY UNIT SAFETY IS TRIPPED, THE DDC CONTROLLER SHALL GIVE AN ALARM.
2. IF THE FILTER PRESSURE DROP EXCEEDS SETPOINT (INITIALLY 0.6") FOR 10 MINUTES, THE UNIT CONTROLLER SHALL INITIATE A LOCAL ALARM.

POWER INTERRUPTION

1. UNIT AND CONTROLS SHALL NOT BE WIRED TO STAND-BY POWER. PROVIDE AUTOMATIC RE-START AFTER NORMAL POWER FAILURE AND UPON RESUMPTION OF NORMAL POWER.

ZONE CONTROL

ROOM LEVEL

1. THE ROOM VAV DIFFUSERS SHALL MODULATE THE AIR FLOW (BETWEEN MAX AND MIN) IN UNISON AS REQUIRED TO MAINTAIN THE ROOM TEMPERATURE SETPOINT BASED ON THE ENTERING AIR TEMPERATURE TO THE DIFFUSERS.

ROOFTOP UNIT (HEAT PUMP) CONTROL SEQUENCES - RTU-5

HC009

N|V|5

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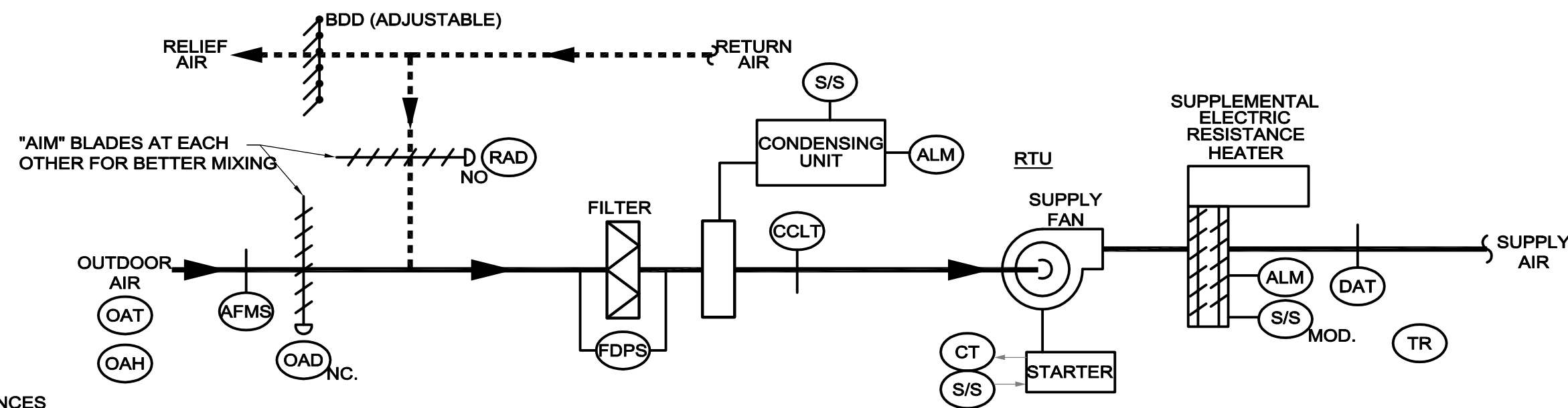
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**MECHANICAL
CONTROLS**



ROOFTOP UNIT CONTROL SEQUENCES

ROOF TOP UNIT CONTROLS

GENERAL

1. ROOFTOP UNIT AND EXHAUST FAN SHALL BE STARTED AND STOPPED VIA DDC CONTROLLER. COORDINATE OCCUPIED AND UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC.
2. LOCAL HAND-OFF-AUTOMATIC SWITCH (H-O-A) FOR FANS SHALL OVERRIDE DDC START/STOP (S/S) COMMANDS. ALL HARDWIRED SAFETIES SHALL BE ACTIVE IN BOTH "H" AND "A" POSITIONS.
3. ALL TEMPERATURES LISTED ARE FAHRENHEIT.
4. ALL TEMPERATURE SENSORS IN THE UNIT AND DUCTWORK SHALL BE AVERAGING TYPE EXCEPT FOR FREEZESTATS WHICH SHALL BE LOW POINT READING TYPE.
5. PROVIDE APPROPRIATE ANTI-RECYCLE TIME DELAYS AND SAFETIES ON COMPRESSOR AND GAS HEATER STAGING.

FAN CONTROL

1. WHILE IN UNOCCUPIED MODE (OR OFF ON SAFETY OR MANUAL DISCONNECT) THE SUPPLY AND EXHAUST FAN (EF) SHALL BE OFF WITH THE OUTSIDE AIR DAMPER (OAD) AND EXHAUST AIR DAMPER (EAD) CLOSED, THE CONDENSING UNIT AND ELECTRIC HEATER OFF, AND THE RETURN AIR DAMPER (RAD) OPEN.
2. WHEN STARTED IN OCCUPIED MODE, THE SUPPLY FAN SHALL START IN RECIRCULATION MODE, THEN THE OAD AND RAD SHALL OPEN TO THE MINIMUM OUTDOOR AIR POSITION AS CONTROLLED BY AIR FLOW MONITORING STATION (AFMS - SEE CO2 CONTROL), THE EAD SHALL OPEN, AND THE EXHAUST FAN (S) SHALL START.

OCCUPIED CARBON DIOXIDE CONTROL

1. THE ACTUAL MINIMUM OUTDOOR AIRFLOW SHALL VARY BETWEEN 40% AND 100% OF THE SCHEDULED MINIMUM OUTDOOR AIR VOLUME. NORMAL MINIMUM OUTDOOR AIR (OA) QUANTITY SHALL BE CONTROLLED BY THE OUTDOOR AIR AFMS TO 40% OF THE SCHEDULED MINIMUM OA. IF EITHER OF THE FOLLOWING OCCURS, THE OUTDOOR AIR AFMS SHALL SLOWLY MODULATE THE OAD AND RAD AS REQUIRED TO MAINTAIN THE MAXIMUM CO2 WITHIN 50 PPM OF THE LISTED LIMIT:
 - a. IF ANY VARIABLE OCCUPANCY SPACE CO2 SENSOR SERVED BY THE UNIT RISES ABOVE THE LIMIT OF 1200 PPM FOR 5 MINUTES.
 - b. IF THE RETURN AIR CO2 LEVEL AT SENSOR (C) RISES ABOVE LIMIT OF 1000 PPM.

OCCUPIED HEATING CONTROL

1. UPON A DROP IN ROOM TEMPERATURE BELOW THE ROOM HEATING SETPOINT OF 70°F, REFRIGERATION SYSTEM SHALL RUN AS 1ST STAGE OF HEAT AND ELECTRIC RESISTANCE COIL SHALL RUN AS SECOND STAGE OF HEAT TO MAINTAIN THE SPACE TEMPERATURE SETPOINT. THE REVERSE SHALL OCCUR ON A RISE IN SPACE TEMPERATURE.
2. DISCHARGE AIR TEMPERATURE SENSOR DAT SHALL STAGE THE REFRIGERATION SYSTEM & SUPPLEMENTAL ELECTRIC HEAT TO MAINTAIN A MINIMUM TEMPERATURE OF 50°F DURING THE HEATING SEASON.

OCCUPIED COOLING CONTROL

1. UPON A RISE IN ROOM TEMPERATURE ABOVE THE ROOM COOLING SETPOINT OF 75°F, THE COOLING CYCLE SHALL BE ACTIVATED.
2. THE FIRST MEANS OF COOLING SHALL BE ACTIVATION OF THE ECONOMIZER. IF THE OUTSIDE AIR ENTHALPY IS BELOW THE ROOM ENTHALPY, THE OUTSIDE AND RETURN AIR DAMPERS SHALL BE PROPORTIONALLY MODULATED UP TO 100% OUTDOOR AIR TO MAINTAIN SPACE TEMPERATURE SETPOINT. DAT SHALL OVERRIDE, IF REQUIRED, TO LIMIT SUPPLY AIR TEMPERATURE TO 55°F MINIMUM DURING ECONOMIZER COOLING (LIMIT SHALL NOT RESULT IN REDUCTION OF THE MINIMUM OUTDOOR AIRFLOW). IF ADDITIONAL COOLING IS REQUIRED, THE CONDENSING UNIT'S COMPRESSORS SHALL BE STAGED ON AS REQUIRED. FOR LOW LOAD OPERATION, HSB SHALL BE USED. THE REVERSE SHALL OCCUR ON A DROP IN SPACE TEMPERATURE BELOW COOLING SETPOINT.

3. IF THE OUTSIDE AIR ENTHALPY RISES ABOVE THE ROOM AIR ENTHALPY THE ECONOMIZER SHALL BE POSITIONED TO PROVIDE MINIMUM OUTDOOR AIRFLOW AND THE CONDENSING UNIT STAGED TO MAINTAIN ROOM COOLING SETPOINT TEMPERATURE. DAT SHALL LIMIT SUPPLY AIR TO 48°F MINIMUM, DURING MECHANICAL COOLING.

OCCUPIED DEHUMIDIFICATION CONTROL

1. IF ROOM RELATIVE HUMIDITY (RH) RISES ABOVE 62% FOR TEN MINUTES AS MEASURED BY HR, DEHUMIDIFICATION CYCLE SHALL BE ACTIVATED.
2. WHEN ACTIVATED, COOLING COIL LEAVING AIR TEMPERATURE SENSOR (CCLT) SHALL STAGE THE CONDENSING UNIT TO MAINTAIN 56°F. ROOM TEMPERATURE SENSOR TR SHALL STAGE RESISTANCE HEAT AS REQUIRED TO MAINTAIN HEATING SETPOINT OF 70°F.
3. WHEN RH FALLS BELOW 58% FOR TEN MINUTES, DEHUMIDIFICATION CYCLE SHALL END.

UNOCCUPIED CONTROL

1. IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE FALLS BELOW 56°F, THE UNIT SHALL START WITH RAD OPEN AND OAD CLOSED AND HEAT PUMP & RESISTANCE HEAT SHALL BE STAGED & MODULATED ON 0°F AIR. WHEN ROOM TEMPERATURE RISES ABOVE 60°F, THE UNIT SHALL SHUT DOWN. EF SHALL REMAIN OFF WITH EAD CLOSED.
2. BUTTON ON TR SHALL ALLOW 2-HOUR OVERRIDE FROM UNOCCUPIED TO OCCUPIED CONTROL.

WARM-UP CONTROL

1. DDC CONTROLLER SHALL PROVIDE OPTIMUM START CAPABILITY. IF SPACE TEMPERATURE IS BELOW 63°F, WARM-UP SHALL BE DONE WITH RAD OPEN, OAD CLOSED, AND HEAT PUMP & RESISTANCE HEAT STAGED ON DAT TO SUPPLY 90°F AIR. WHEN ROOM TEMPERATURE RISES ABOVE 69°F, OCCUPIED MODE SHALL START. EF SHALL REMAIN OFF WITH EAD CLOSED.

SAFETIES

1. THE FOLLOWING SAFETIES EACH WITH ITS OWN MANUAL RESET BUTTON, SHALL SHUT DOWN THE UNIT VIA HARDWARE BEFORE H-O-A.
 - a. ANY FREEZESTAT (FZ) SHALL SHUTDOWN THE UNIT WHENEVER THE TEMPERATURE IS LESS THAN 35°F.
 - b. WHEN ANY SMOKE DETECTOR (SDET) IS ACTIVATED THE UNIT SHALL SHUT DOWN.

ALARMS

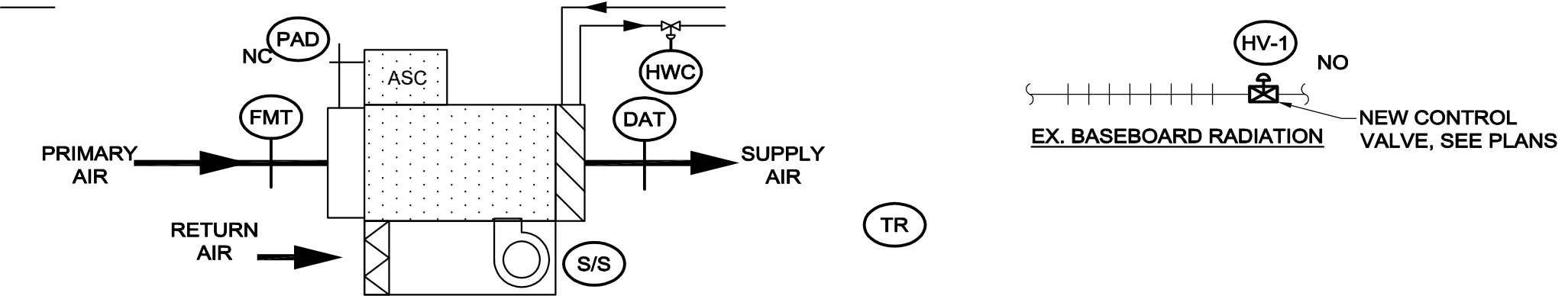
1. IF EITHER THE SUPPLY OR EXHAUST FAN (S) FAILS OR IF ANY SAFETY IS TRIPPED, THE DDC CONTROLLER SHALL GIVE A DETAILED ALARM SIGNAL TO THE FRONT END.
2. IF FILTER PRESSURE DROP EXCEEDS SETPOINT (INITIALLY 0.6") FOR 10 MINUTES, THE DDC CONTROLLER SHALL GIVE A DETAILED ALARM SIGNAL TO THE FRONT END.

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ROOFTOP UNIT CONTROL SEQUENCES RTU-6 (SINGLE ZONE)

HC002

FB



PARALLEL FAN POWERED BOX WITH HYDRONIC HEATING CONTROL SEQUENCES

GENERAL

1. FAN POWERED BOX SHALL BE CONTROLLED BY AN APPLICATION SPECIFIC CONTROLLER (ASC). COORDINATE OCCUPIED/UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC.
2. ALL TEMPERATURES LISTED ARE FAHRENHEIT AND SHALL BE ADJUSTABLE.
3. AIRFLOW SHALL BE MEASURED BY THE FLOW MEASURING TRANSMITTER (FMT) AND DISPLAYED ON THE GRAPHICS.
4. OCCUPIED HEATING SETPOINT SHALL BE 70°F. OCCUPIED COOLING SETPOINT SHALL BE 5°F WARMER THAN HEATING SETPOINT.
5. ROOM TEMPERATURES SHALL BE SET BY THE BUILDING AUTOMATION SYSTEM (BAS) AND CAPABLE OF LOCAL +/- 2°F ADJUSTMENT.
6. MINIMUM AND MAXIMUM PRIMARY AIRFLOWS ARE SHOWN ON DRAWINGS.

FAN CONTROL

1. WHILE IN UNOCCUPIED MODE, FAN SHALL BE OFF WITH THE PRIMARY AIR DAMPER (PAD) CLOSED AND THE ELECTRIC HEATING COIL (EHC) OFF.
2. WHEN BOX IS STARTED IN OCCUPIED MODE, THE PAD SHALL OPEN TO MINIMUM AIRFLOW.
3. THE FAN SHALL START AND RUN ONLY WHEN NEEDED FOR HEATING.

OCCUPIED HEATING CONTROL

1. UPON A CALL FOR HEATING FROM THE ROOM TEMPERATURE SENSOR (TR), THE PAD SHALL MODULATE TO ITS MINIMUM AIRFLOW AND THE UNIT FAN SHALL BE ENERGIZED TO PROVIDE WARM CEILING PLENUM AIR TO SPACE.
2. FB3.1 ONLY: UPON A FURTHER DROP IN SPACE TEMPERATURE THE HOT WATER COIL (HWC) VALVE SHALL MODULATE AS REQUIRED TO MAINTAIN THE HEATING SETPOINT. THE REVERSE SHALL OCCUR ON A RISE IN SPACE TEMPERATURE. THE FAN SHALL STOP ON AN ADJUSTABLE 2°F DIFFERENTIAL ABOVE HEATING SETPOINT.
3. FOR APPLICABLE UNITS WITH RADIATION: ON A CONTINUED DROP IN ROOM TEMPERATURE, BASEBOARD HEATING CONTROL VALVE (HV-1) SHALL MODULATE AS REQUIRED TO MAINTAIN HEATING SETPOINT. THE REVERSE SHALL OCCUR ON A RISE IN SPACE TEMPERATURE.

OCCUPIED COOLING CONTROL

1. UPON A CALL FOR COOLING FROM THE ROOM TEMPERATURE SENSOR (TR), THE PAD SHALL MODULATE BETWEEN MINIMUM AND MAXIMUM AIRFLOWS AS REQUIRED TO MAINTAIN THE COOLING SETPOINT WITH THE HWC VALVE CLOSED AND FAN OFF.

UNOCCUPIED HEATING/COOLING CONTROL

1. IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE FALLS BELOW 56°F, THE FB FAN SHALL START WITH THE PAD CLOSED. WHEN ROOM TEMPERATURE RISES ABOVE 60°F, THE FAN SHALL STOP.
2. FOR FB-3.1 ONLY: THE HWC VALVE SHALL BE MODULATED TO MAINTAIN A DISCHARGE AIR TEMPERATURE (DAT) BETWEEN 85 AND 90°F. WHEN ROOM TEMPERATURE RISES ABOVE 60°F, THE HWC SHALL CYCLE OFF AND, AFTER A 1-MINUTE DELAY, THE FAN SHALL STOP.
3. UNOCCUPIED COOLING CONTROL SHALL BE AVAILABLE. THE ASSOCIATED AIR HANDLERS SHALL START ON A CALL FOR COOLING FROM A ZONE (SEE AHU CONTROLS). THE BOX ASSOCIATED WITH THE ZONE CALLING SHALL OPEN ITS PAD FULLY AND SURROUNDING ZONES SHALL OPEN PADS TO MINIMUM POSITIONS TO ENSURE AHU MINIMUM AIRFLOW IS MET. WHEN THE ZONE IS SATISFIED, THE PARALLEL BOXES SHALL RETURN TO THEIR INACTIVE STATE.

UNOCCUPIED OVERRIDE

1. BUTTON ON TR SHALL ALLOW 2-HOUR (ADJ) OVERRIDE FROM UNOCCUPIED TO OCCUPIED CONTROL. WHEN ANY ROOM IS IN THIS OVERRIDE, THE DDC SYSTEM SHALL ENSURE THAT ENOUGH "UNOCCUPIED" ZONES ARE ALSO OVERRIDDEN SO THAT THE ASSOCIATED AIR HANDLER CAN OPERATE AT MINIMUM AIR FLOW IN THIS MODE.

WARM-UP CONTROL

1. PROVIDE OPTIMUM START CAPABILITY. IF ROOM TEMPERATURE IS BELOW 65°F, WARM-UP SHALL BE DONE WITH PAD CLOSED, FB FAN ON AND EHC STAGED TO MAINTAIN A DISCHARGE AIR TEMPERATURE (DAT) BETWEEN 85 AND 90°F. WHEN ROOM TEMPERATURE RISES ABOVE 69°F, OCCUPIED MODE SHALL START.

ALARMS

1. IF, DURING OCCUPIED MODE, THE ROOM TEMPERATURE SENSOR TR SENSES A TEMPERATURE MORE THAN 5°F ABOVE OR BELOW THE SETPOINT FOR 5 MINUTES, OR BELOW 50°F DURING UNOCCUPIED CONTROL, THE DDC SYSTEM SHALL GIVE A DETAILED ROOM "HIGH" OR "LOW" TEMPERATURE ALARM SIGNAL.

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PARALLEL FAN POWERED BOX CONTROL SEQUENCES

HC709

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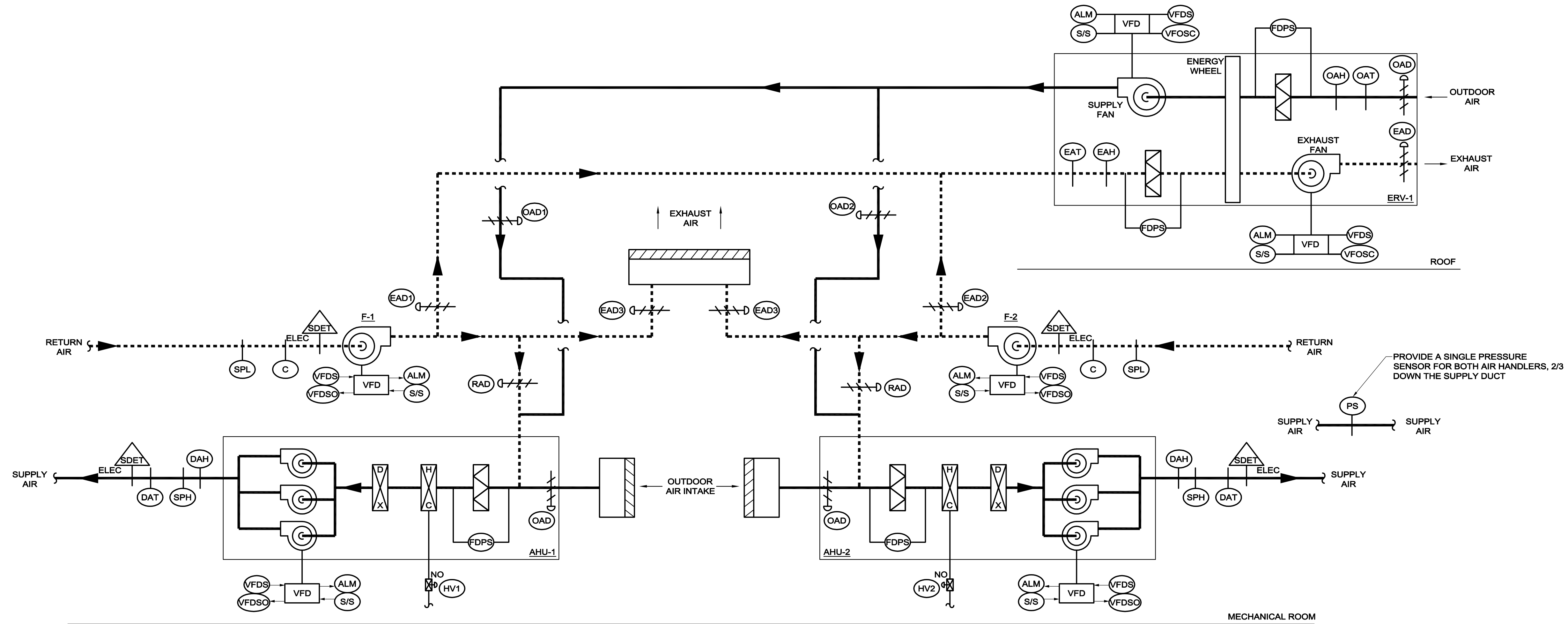
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MECHANICAL CONTROLS

M-6.2



GENERAL

- AIR HANDLING UNIT SHALL BE STARTED, STOPPED, AND CONTROLLED VIA DEDICATED FULLY PROGRAMMABLE DDC CONTROLLER. COORDINATE OCCUPIED AND UNOCCUPIED SCHEDULES WITH OWNER. ALL SETPOINTS SHALL BE ADJUSTABLE. ALL ACTUATORS SHALL BE ELECTRONIC. NO = NORMALLY (FAIL) CLOSED ON LOSS OF POWER. NC = NORMALLY (FAIL) OPEN ON LOSS OF POWER.
- LOCAL HAND-OFF-AUTOMATIC SWITCHES (H-O-A) FOR FANS SHALL OVERRIDE DDC START/STOP (S/S) COMMANDS. ALL HARDWIRED SAFETIES SHALL BE ACTIVE IN BOTH "H" AND "A" POSITIONS.
- ALL TEMPERATURES LISTED ARE FAHRENHEIT.
- ALL TEMPERATURE SENSORS IN THE UNIT AND DUCTWORK SHALL BE AVERAGING TYPE EXCEPT FOR FREEZESTATS WHICH SHALL BE LOW POINT READING TYPE.
- AHU-1 AND AHU-2 SHALL BE ACTIVATED AS ONE UNIT. THE BAS SHALL COMMAND BOTH FANS SIMULTANEOUSLY TO THE SAME SPEED.

FAN CONTROL

- WHILE IN UNOCCUPIED MODE (OR OFF ON SAFETY OR MANUAL DISCONNECT) AHU SUPPLY AND RETURN FANS SHALL BE OFF WITH ALL ASSOCIATED SUPPLY AIR AND RETURN AIR FLOOR SMOKE/FIRE DAMPERS (SFD) CLOSED, THE OUTSIDE AIR DAMPER (OAD), THE EXHAUST AIR DAMPER (EAD) AND THE COOLING COIL CONTROL VALVE (CV) CLOSED; THE RETURN AIR DAMPER (RAD) OPEN; AND THE HEATING COIL CONTROL VALVE (HV) CONTROLLED BY HEATING COIL LEAVING TEMPERATURE SENSOR (HCLT) TO MAINTAIN 50°F IN THE UNIT CASING.
- WHEN THE AHU SYSTEM IS STARTED, ALL ASSOCIATED SUPPLY AIR AND RETURN AIR FLOOR SMOKE/FIRE DAMPERS (SFD) SHALL OPEN, AND THEN AFTER 30 SECONDS, THE AHU FANS SHALL START IN RECIRCULATION MODE (100% RETURN AIR) AT MINIMUM SPEED WITH THE RETURN FAN STARTING FIRST BY 10 SECONDS.
- THE SUPPLY FAN VFDS SHALL SLOWLY INCREASE IN SPEED TO MAINTAIN SETPOINT OF REMOTE PRESSURE SENSOR (PS). INITIAL SETPOINT SHALL BE 1.0" W.G. WITH FINAL SETPOINT DETERMINED BY THE BALANCING CONTRACTOR TO BE AS LOW AS NEEDED TO PROVIDE FULL AIRFLOW TO THE MOST REMOTE TERMINAL BOXES WITH THEIR PRIMARY AIR DAMPERS AT LEAST 95% OPEN.
- THE RETURN FAN VFD SHALL TRACK THE SUPPLY FAN BY A FIXED DIFFERENTIAL AIRFLOW. THE DIFFERENTIAL AIRFLOW SHALL BE BASED ON THE RETURN AIRFLOW (AIRFLOW AT THE RETURN AIR FLOW MONITORING STATION) EQUALING THE SUPPLY AIR FLOW (BASED ON THE SUM OF ALL CONNECTED TERMINAL VOLUME BOXES) LESS THE NORMAL (NOT SCHEDULED) MINIMUM OUTDOOR AIRFLOW (SEE CO2 CONTROL). DURING OPERATION IN RECIRCULATION MODE (SUCH AS START-UP, UNOCCUPIED AND WARM-UP) THE DIFFERENTIAL AIRFLOW IS ZERO.
- AFTER START-UP, ONCE FAN OPERATION IS STABLE AND THE UNIT IS IN OCCUPIED OR OFF-HOURS UNOCCUPIED OVERRIDE MODE, THE OAD AND THE RAD SHALL SLOWLY OPEN TO MINIMUM OUTDOOR AIR POSITION AS CONTROLLED BY THE OUTDOOR AIR AFMS (SEE CO2 CONTROL). HEATING COIL LEAVING AIR TEMPERATURE SENSOR (HCLT) SHALL ALWAYS MAINTAIN A MINIMUM OF 50°F BY MODULATING HEATING CONTROL VALVE (HV).

OCCUPIED CARBON DIOXIDE CONTROL

- THE ACTUAL MINIMUM OUTDOOR AIRFLOW SHALL VARY BETWEEN 40% AND 100% OF THE SCHEDULED MINIMUM OUTDOOR AIR VOLUME. NORMAL MINIMUM OUTDOOR AIR (OA) QUANTITY SHALL BE CONTROLLED BY THE OUTDOOR AIR AFMS TO 40% OF THE SCHEDULED MINIMUM OA. IF EITHER OF THE FOLLOWING OCCURS, THE OUTDOOR AIR AFMS SHALL SLOWLY MODULATE THE ERV SUPPLY AND EXHAUST FAN VFD SPEED AS REQUIRED TO MAINTAIN THE MAXIMUM CO2 WITHIN 50 PPM OF THE LISTED LIMIT:
- IF ANY VARIABLE OCCUPANCY SPACE CO2 SENSOR (SEE TERMINAL UNIT CONTROLS) SERVED BY THE UNIT RISES ABOVE THE LIMIT OF 1200 PPM FOR 5 MINUTES.
- IF THE RETURN AIR CO2 LEVEL AT SENSOR (C) RISES ABOVE LIMIT OF 1000 PPM.

OCCUPIED HEATING CONTROL

- HEATING COIL LEAVING AIR TEMPERATURE SENSOR (HCLT) ALWAYS CONTROLS HV AND VRF TO MAINTAIN A MINIMUM TEMPERATURE OF 50°F (ADJ).
- UPON A DROP IN DISCHARGE AIR TEMPERATURE BELOW THE HEATING SETPOINT OF 54°F, THE DDC SYSTEM SHALL COMMAND THE VRF TO START IN HEATING MODE AS A FIRST STAGE OF HEAT. THE DDC SYSTEM SHALL SEND AN ANALOG OUTPUT TO THE VRF CONTROLLER. THE VRF SHALL VARY COMPRESSOR SPEED AND CAPACITY BASED ON THIS SIGNAL. WHEN THE VRF SIGNALS A DEFROST CYCLE TO THE DDC SYSTEM OR WHEN THE SUPPLY AIR TEMPERATURE SETPOINT HAS NOT BEEN REACHED AFTER 10 MINUTES (ADJUSTABLE) ON FULL SPEED THE DDC SYSTEM SHALL OPEN AND MODULATE THE HEATING VALVES AS A SECOND STAGE OF HEAT TO REACH SUPPLY AIR SETPOINT

OCCUPIED COOLING CONTROL

- UPON A RISE IN DAT ABOVE THE COOLING SETPOINT, THE COOLING CYCLE SHALL BE ACTIVATED. COOLING SETPOINT SHALL BE RESET TO AS WARM AS POSSIBLE (BETWEEN 55°F MINIMUM AND 60°F MAXIMUM) WITH THE FOLLOWING LIMITS:
 - NO ROOM TEMPERATURE (FOR ALL ASSOCIATED TERMINAL VOLUME BOXES) IS MORE THAN 1°F ABOVE COOLING SETPOINT.
 - THE DISCHARGE AIR DEWPOINT IS NO MORE THAN 57°F.
 - THE AHU SUPPLY AIR VOLUME IS NO MORE THAN 2% ABOVE THE SCHEDULED CFM (PER SUMMATION OF ALL TERMINAL VOLUME BOX AIRFLOWS).
- THE FIRST MEANS OF MAINTAINING DISCHARGE AIR TEMPERATURE SHALL BE ACTIVATION OF THE ECONOMIZER. IF THE OUTSIDE AIR ENTHALPY IS BELOW THE RETURN AIR ENTHALPY, THE EXHAUST, OUTDOOR AND RETURN AIR DAMPERS SHALL BE PROPORTIONALLY MODULATED UP TO 100% OUTDOOR AIR TO MAINTAIN SETPOINT AND THE ERV SHALL SHUT DOWN. DAT SHALL LIMIT SUPPLY AIR TEMPERATURE TO 55°F MINIMUM DURING THE COOLING SEASON (LIMIT SHALL NOT RESULT IN REDUCTION TO MINIMUM OUTDOOR AIRFLOW). IF ADDITIONAL COOLING IS REQUIRED, THE DDC SYSTEM SHALL SEND AN ANALOG CALL FOR COOLING SIGNAL TO THE VRF CONTROLLER AND THE VRF CONTROLLER SHALL MODULATE ITS COOLING BASED ON THIS SIGNAL. THE REVERSE SHALL OCCUR ON A DROP IN DAT BELOW COOLING SETPOINT. OA DAMPER SHALL MAINTAIN MINIMUM OA TO THE SPACE AND SHALL VARY MINIMUM BASED ON THE AFMS AND CO2 SENSORS.
- IF THE OUTSIDE AIR ENTHALPY RISES ABOVE THE RETURN AIR ENTHALPY THE ECONOMIZER SHALL BE POSITIONED TO PROVIDE MINIMUM OUTDOOR AIRFLOW AND CV SHALL BE MODULATED TO MAINTAIN COOLING SETPOINT TEMPERATURE. DAT SHALL LIMIT SUPPLY AIR TEMPERATURE TO 55°F MINIMUM DURING THE COOLING SEASON.

UNOCCUPIED CONTROL

- IF, WHEN THE UNIT IS OFF, THE ROOM TEMPERATURE AT ANY ASSOCIATED NON-FAN POWERED TERMINAL VOLUME BOX FALLS BELOW 54°F, THE AHU SYSTEM SHALL START AS STATED IN THE FAN CONTROL SECTION (IN RECIRCULATION MODE), THE DAT SHALL RESET VRF HEAT PUMP HEATING AND HCLT TO SUPPLY 90°F AIR. WHEN ALL ROOMS RISE ABOVE 59°F, THE UNIT SHALL SHUT DOWN.
- PROVIDE 2 HOUR UNOCCUPIED OVERRIDE TO START UNIT IN OCCUPIED MODE BASED ON SIGNAL FROM TERMINAL UNIT OVERRIDE BUTTON. IN THIS MODE THE CONTROLS SHALL ENSURE THAT ENOUGH "UNOCCUPIED" ZONES ARE ALSO OVERRIDDEN SO THAT THE UNIT OPERATES WITH AT LEAST 20% OF DESIGN AIR FLOW. RESET THE MINIMUM OUTDOOR AIRFLOW TO 20% OF SCHEDULED MINIMUM OUTDOOR AIRFLOW. MAINTAIN CO2 OVERRIDE WITH THIS NEW MINIMUM.

WARM-UP CONTROL

- DDC CONTROLLER SHALL PROVIDE OPTIMUM START CAPABILITY. IF THE ROOM TEMPERATURE AT ANY ASSOCIATED NON-FAN POWERED TERMINAL VOLUME BOX IS BELOW 63°F, WARM-UP SHALL BE DONE. THE AHU SYSTEM SHALL START AS STATED IN THE FAN CONTROL SECTION (IN RECIRCULATION MODE), AND DAT SHALL RESET VRF HEAT PUMP HEATING AND HCLT TO SUPPLY 90°F AIR. WHEN ALL ROOM TEMPERATURES RISE ABOVE 68°F, OCCUPIED MODE SHALL START.

SAFETIES

- THE FOLLOWING SAFETIES EACH WITH ITS OWN MANUAL RESET BUTTON, SHALL SHUT DOWN THE AHU VIA HARDWARE BEFORE H-O-A.
 - WHEN THE TEMPERATURE IS LESS THAN 37°F ANY FREEZESTAT (FZ). THIS ALARM SHALL ALSO OPEN HV.
 - WHEN ANY SMOKE DETECTOR (SDET) IS ACTIVATED.
 - WHEN THE PRESSURE AT STATIC PRESSURE HIGH LIMIT (SPH) RISES ABOVE 4 INCHES W.G.
 - WHEN THE PRESSURE AT STATIC PRESSURE LOW LIMIT (SPL) DROPS BELOW NEGATIVE 2 INCHES W.G.

ALARMS

- IF THE SUPPLY OR RETURN FAN FAILS OR IF ANY UNIT SAFETY IS TRIPPED, THE DDC CONTROLLER SHALL GIVE A DETAILED ALARM SIGNAL TO THE FRONT END.
- IF FILTER PRESSURE DROP EXCEEDS SETPOINT (INITIALLY 0.6") FOR 10 MINUTES, THE DDC CONTROLLER SHALL GIVE A DETAILED ALARM SIGNAL TO THE FRONT END.

STAND-BY POWER

- UNIT AND CONTROLS SHALL BE WIRED TO STAND-BY POWER. PROVIDE AUTOMATIC RE-START UPON POWER FAILURE AND UPON RETURN TO NORMAL POWER.

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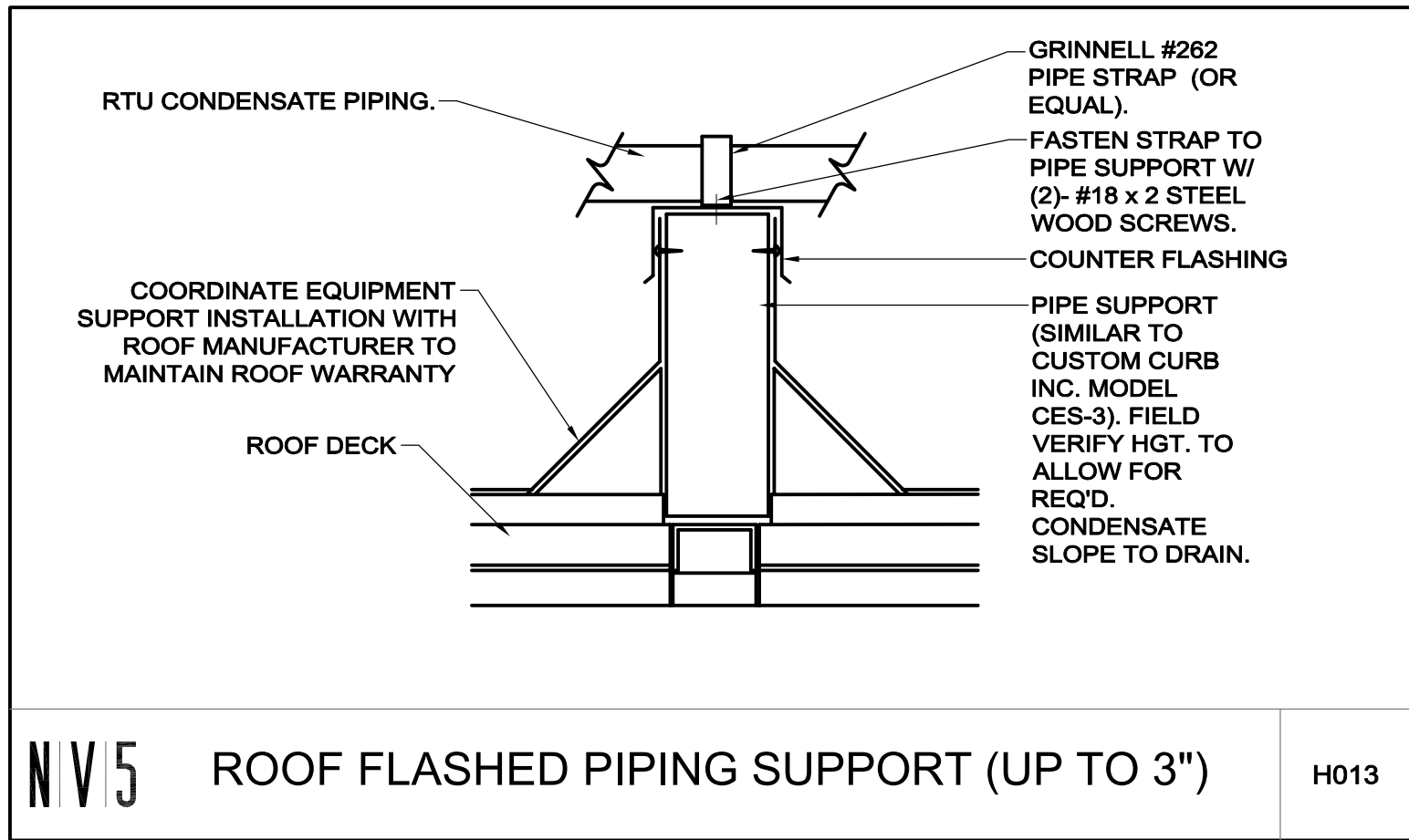
MECHANICAL CONTROLS

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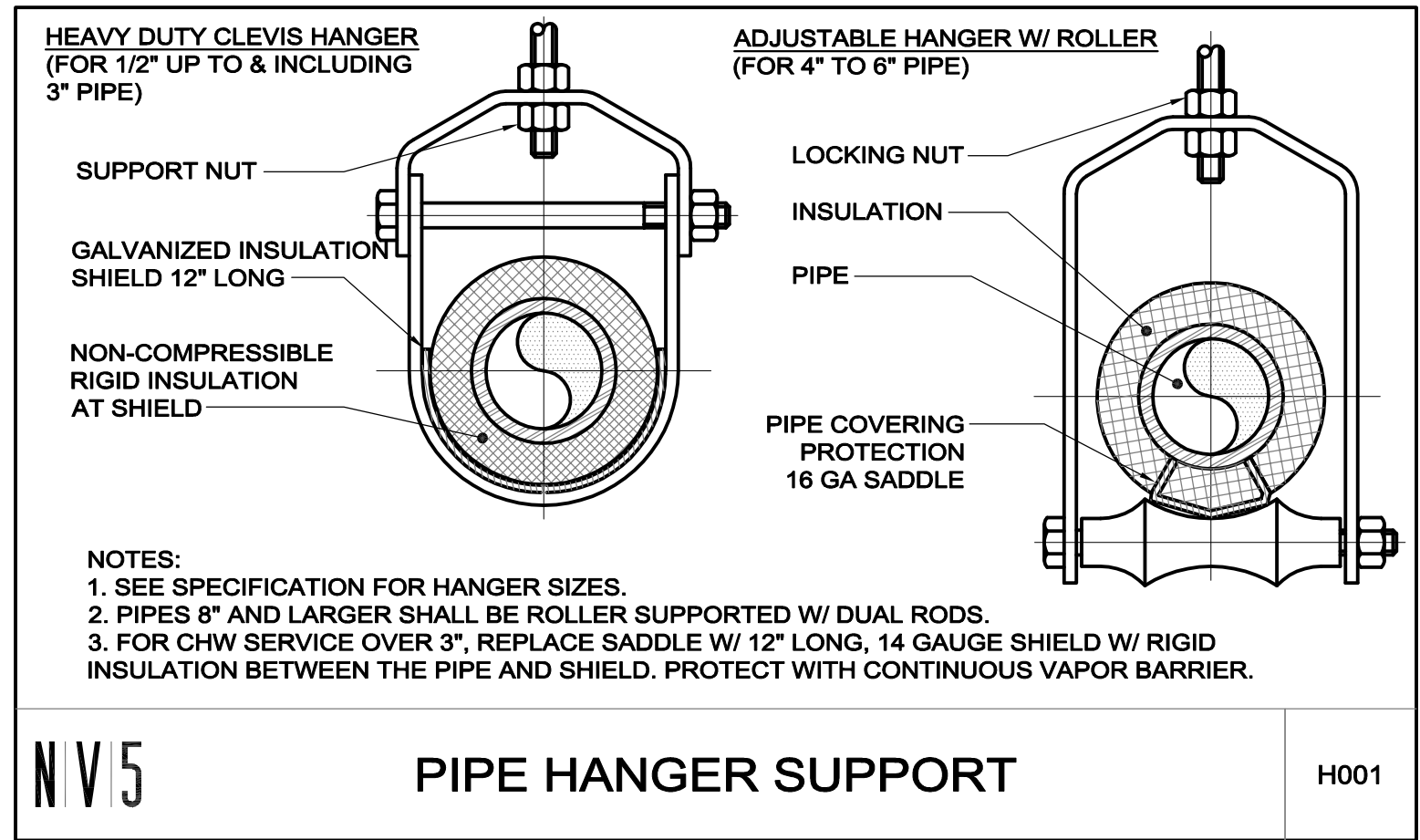
AHU-1 & AHU-2 CONTROL SEQUENCES (VAV, <15,000 CFM)

HC004

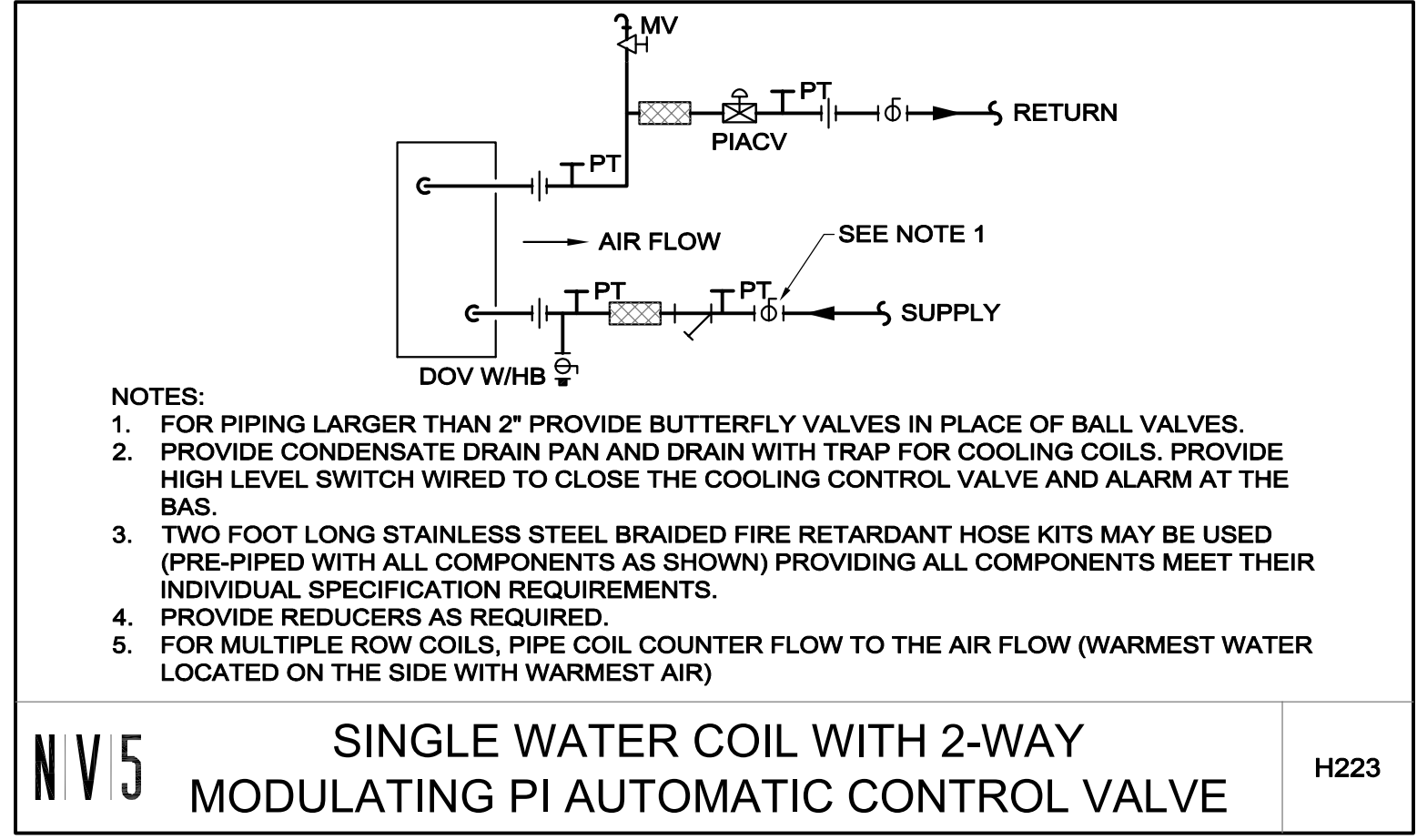
M-6.3



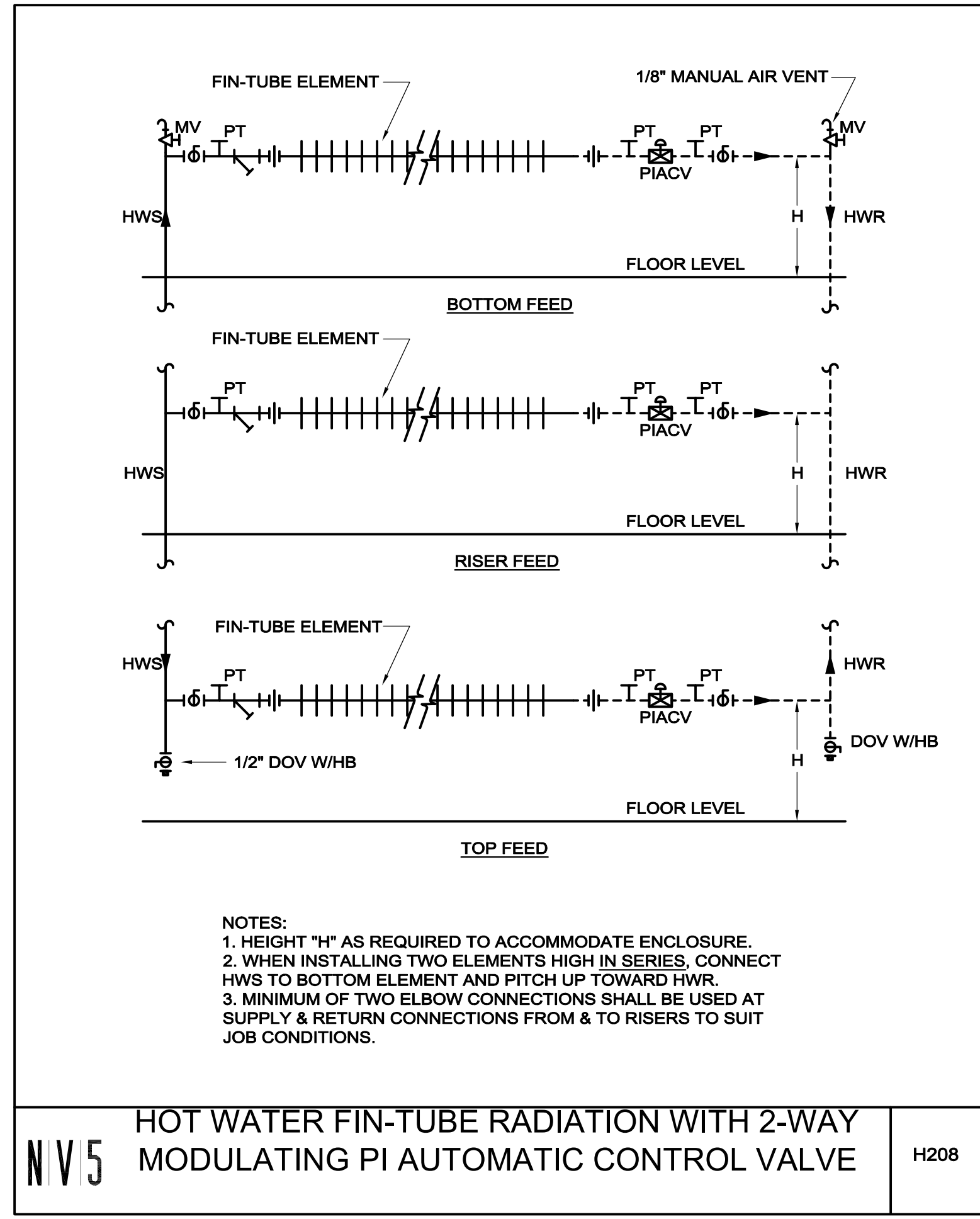
NV5 ROOF FLASHED PIPING SUPPORT (UP TO 3") H013



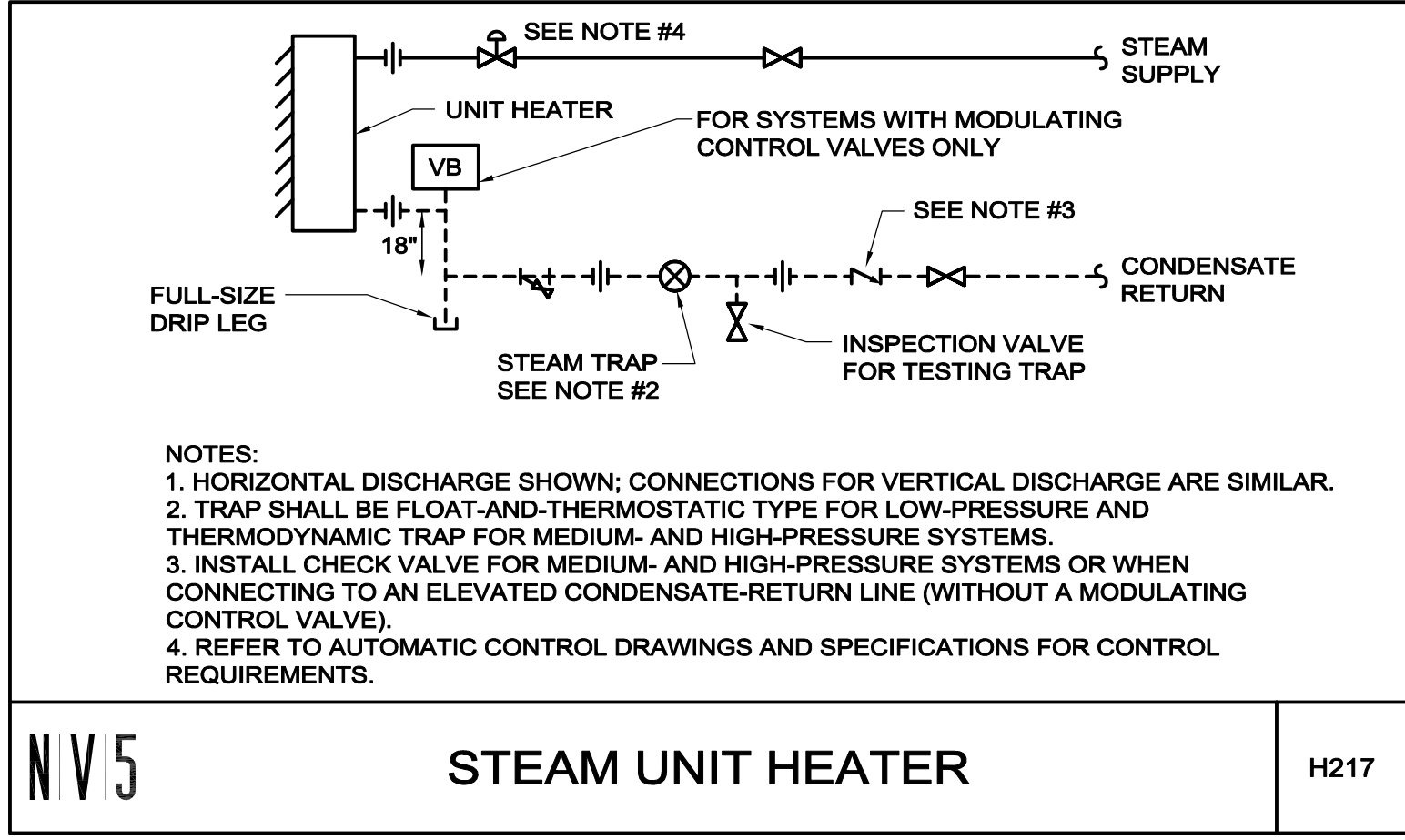
NV5 PIPE HANGER SUPPORT H001



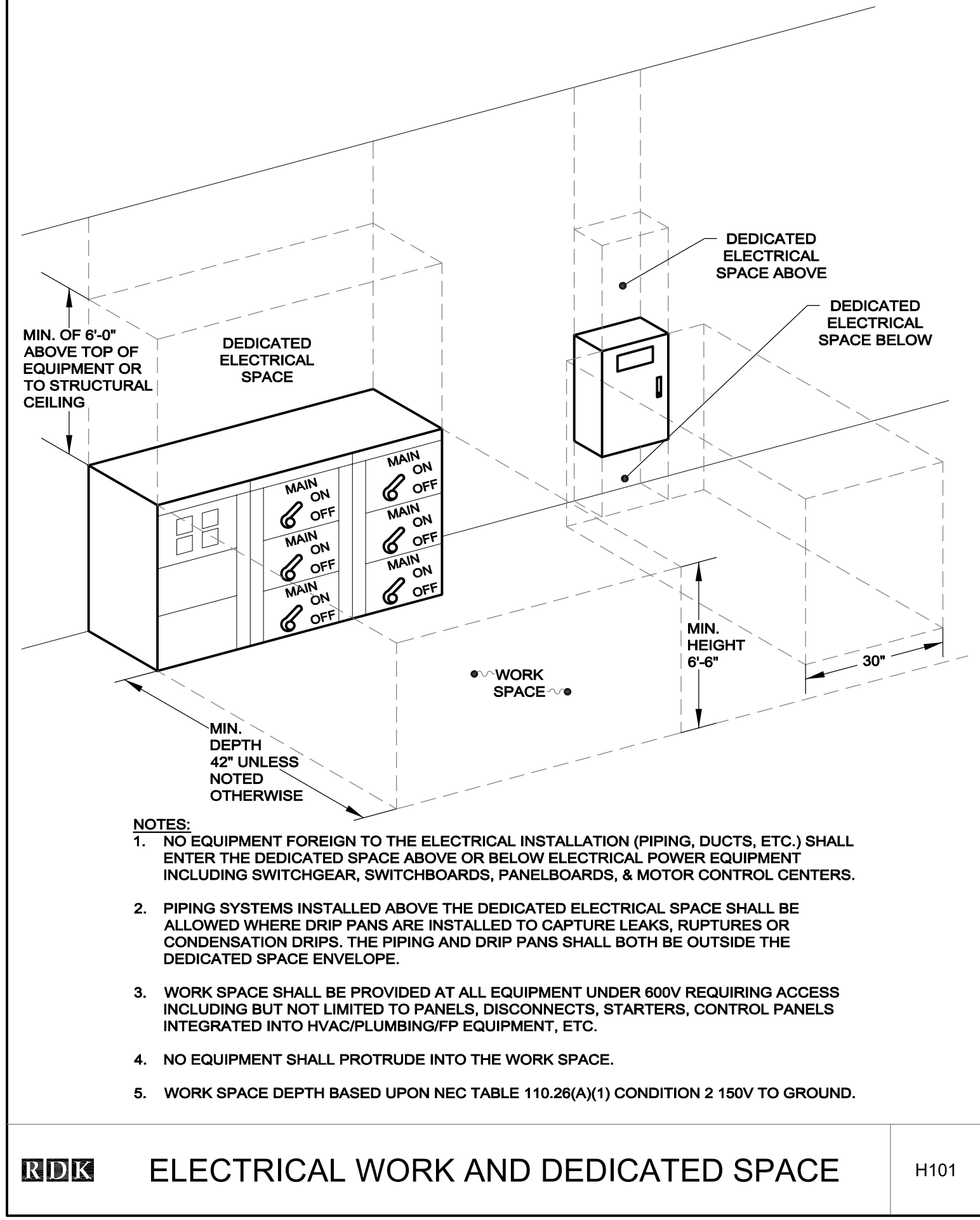
NV5 SINGLE WATER COIL WITH 2-WAY MODULATING PI AUTOMATIC CONTROL VALVE H223



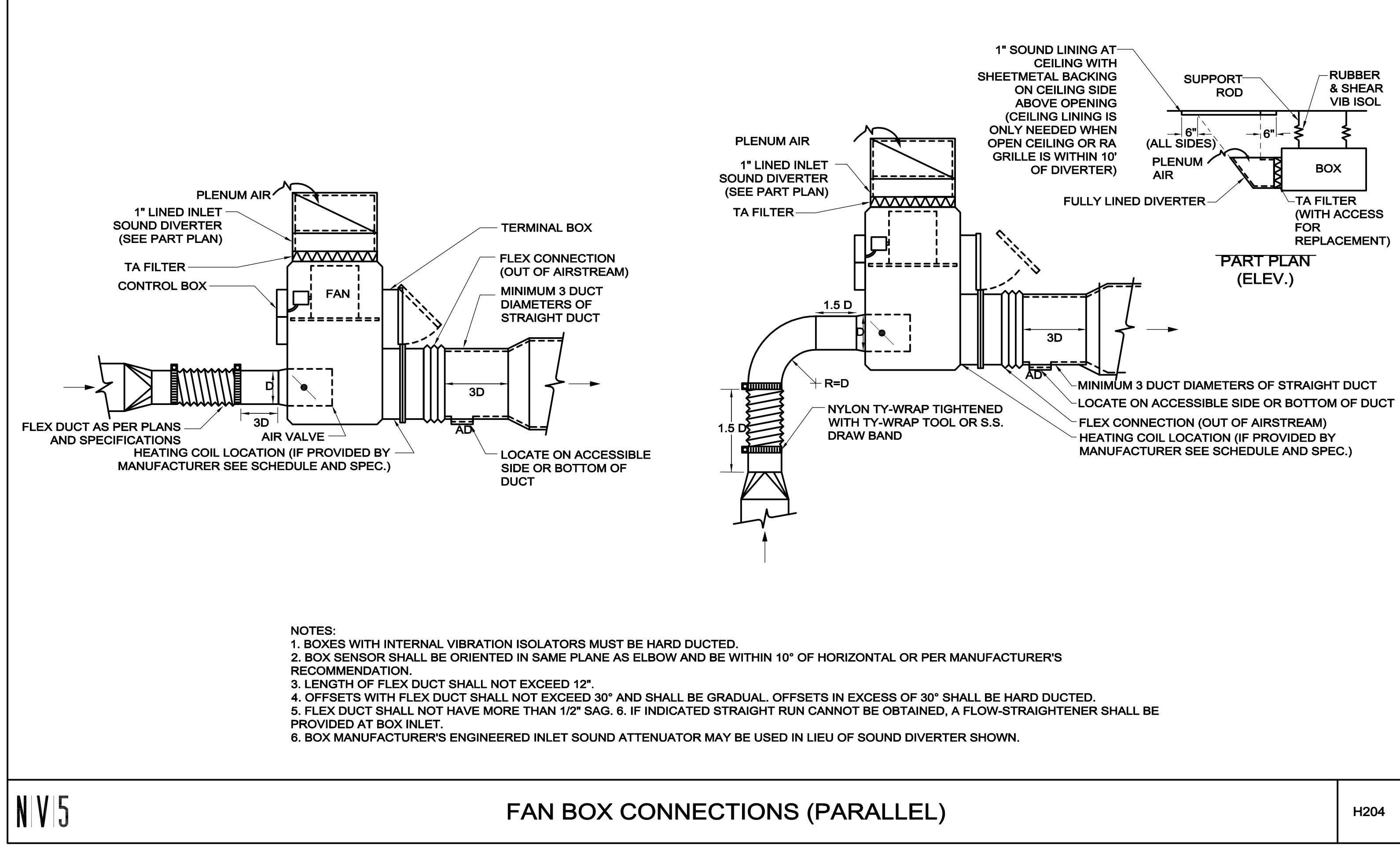
NV5 HOT WATER FIN-TUBE RADIATION WITH 2-WAY MODULATING PI AUTOMATIC CONTROL VALVE H208



NV5 STEAM UNIT HEATER H217



RDK ELECTRICAL WORK AND DEDICATED SPACE H101



NV5 FAN BOX CONNECTIONS (PARALLEL) H204

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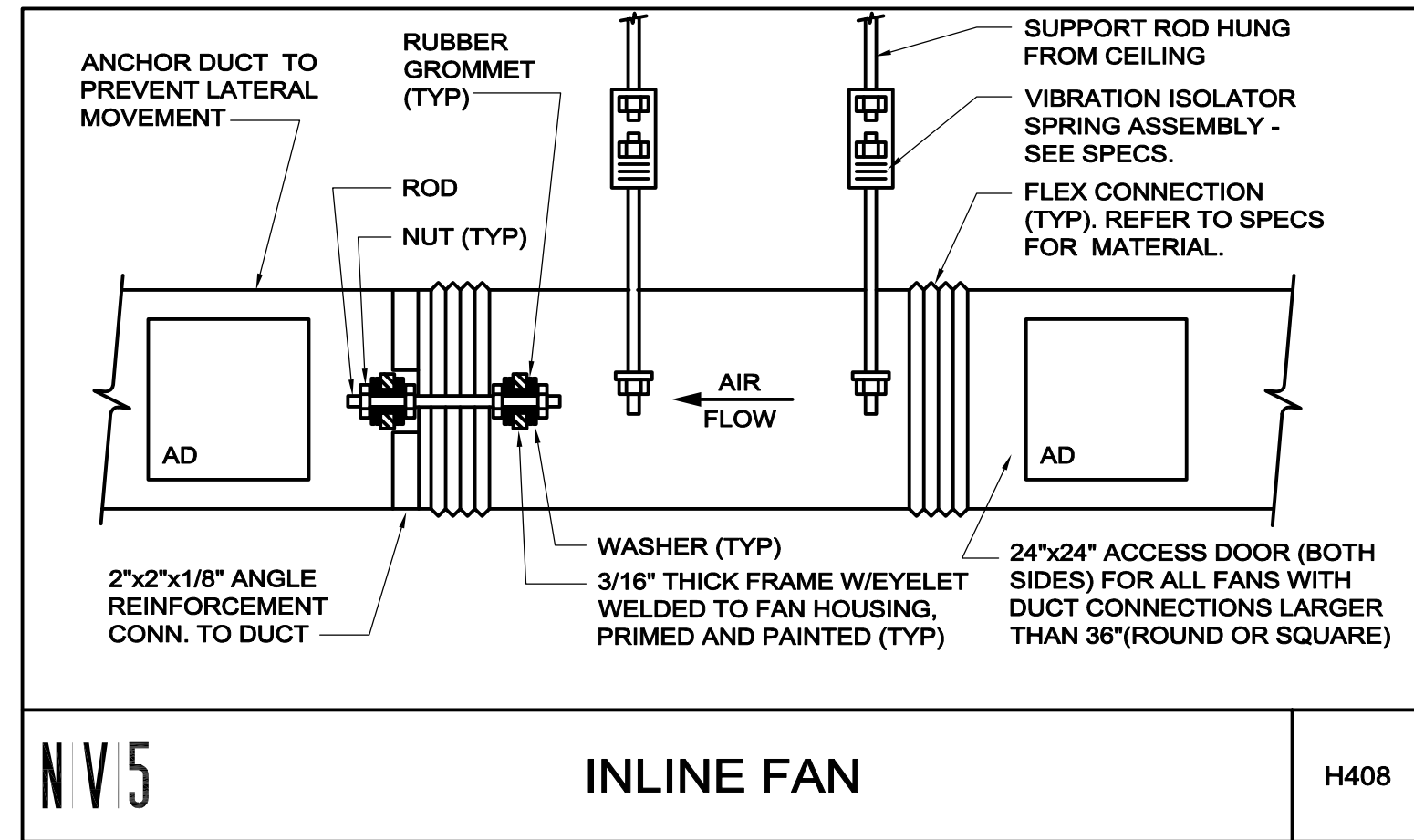
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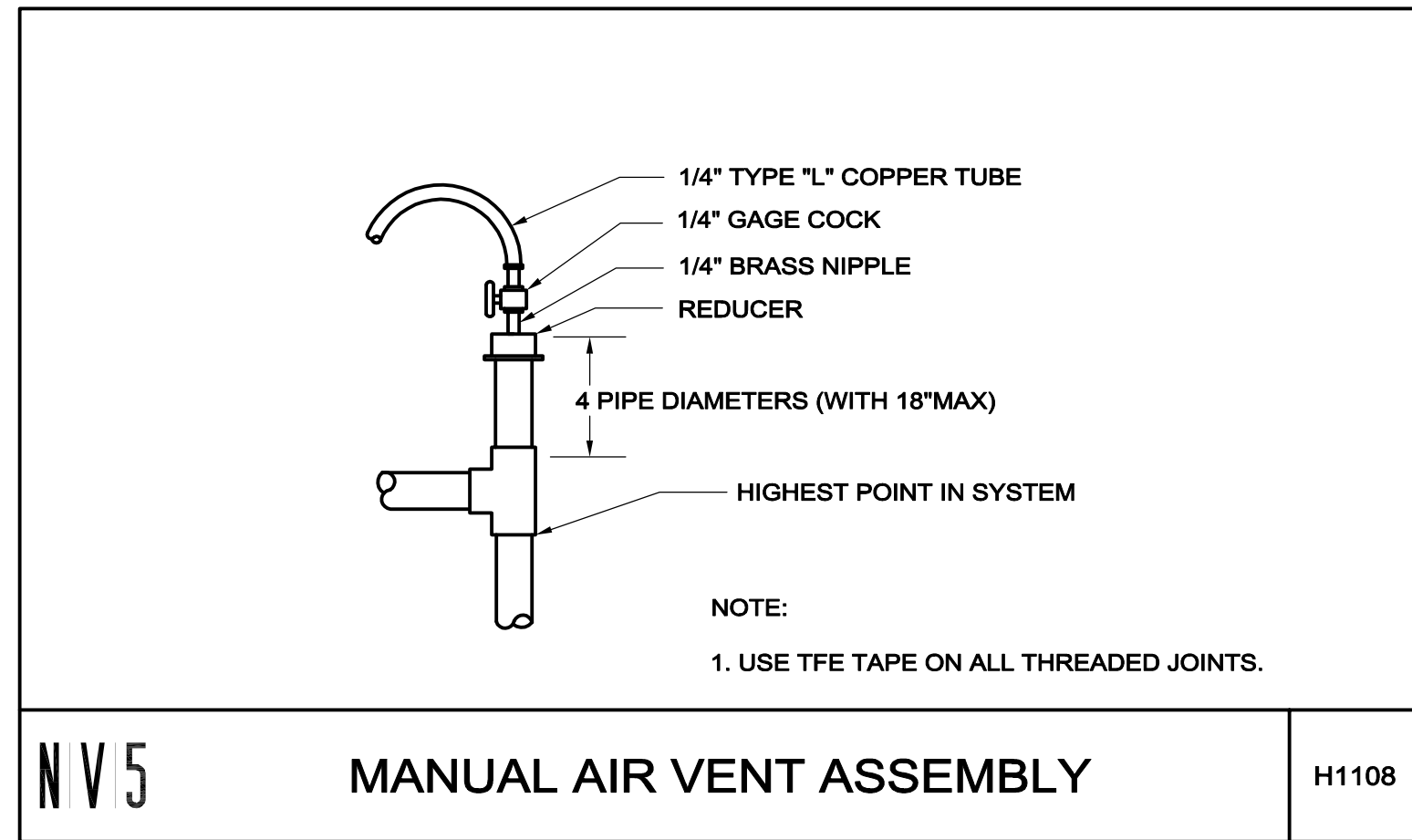
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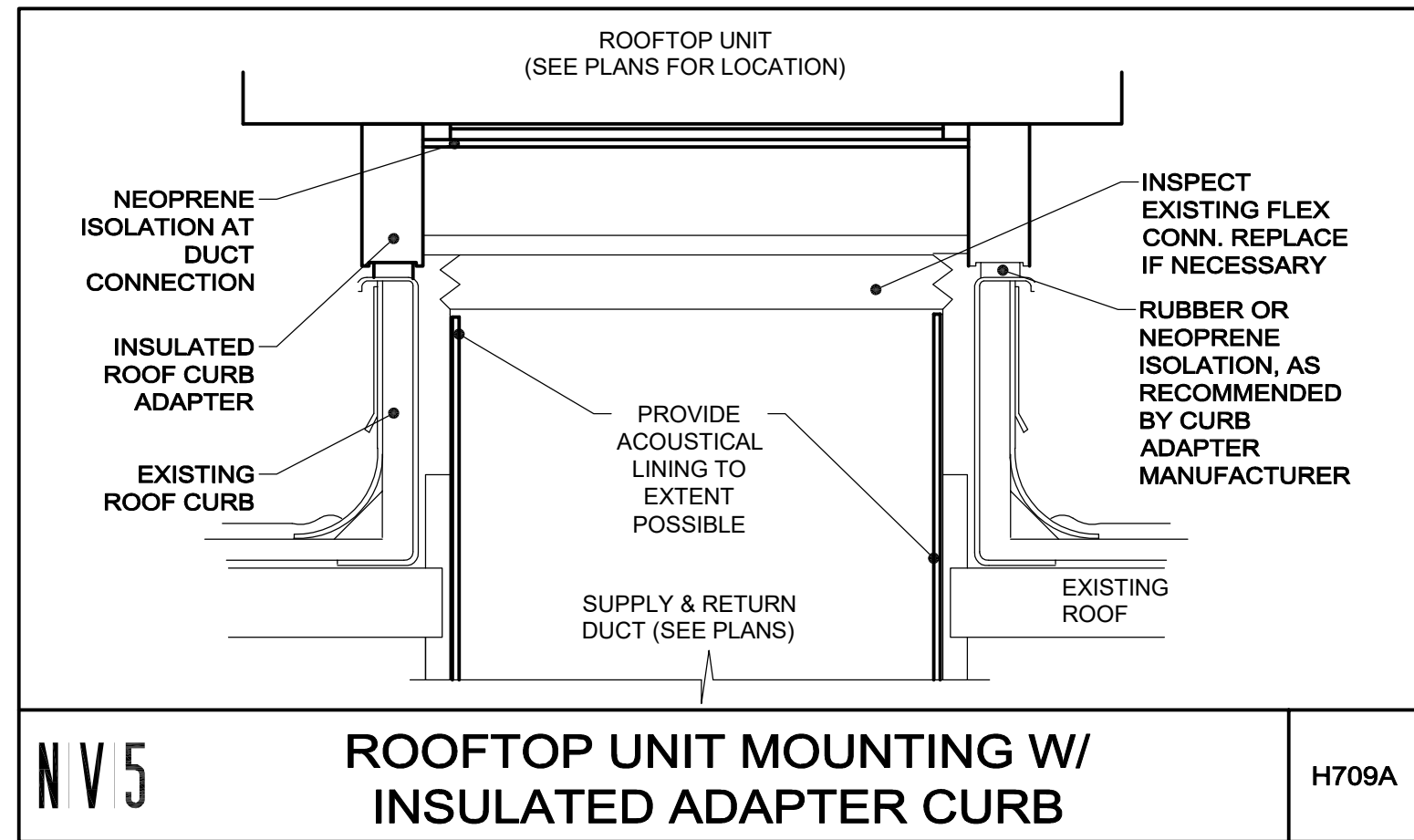
**MECHANICAL
DETAILS**



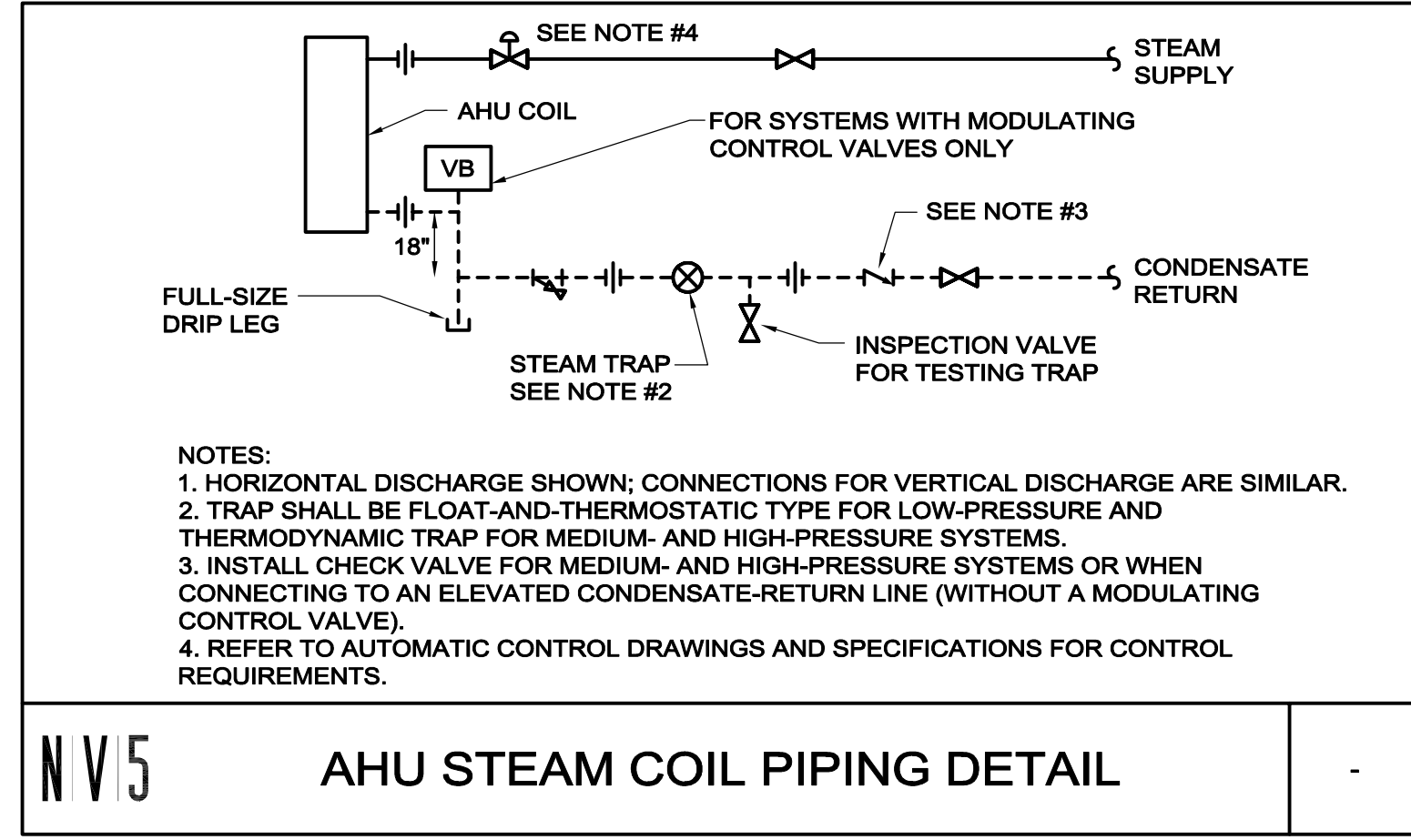
NV5 **INLINE FAN** H408



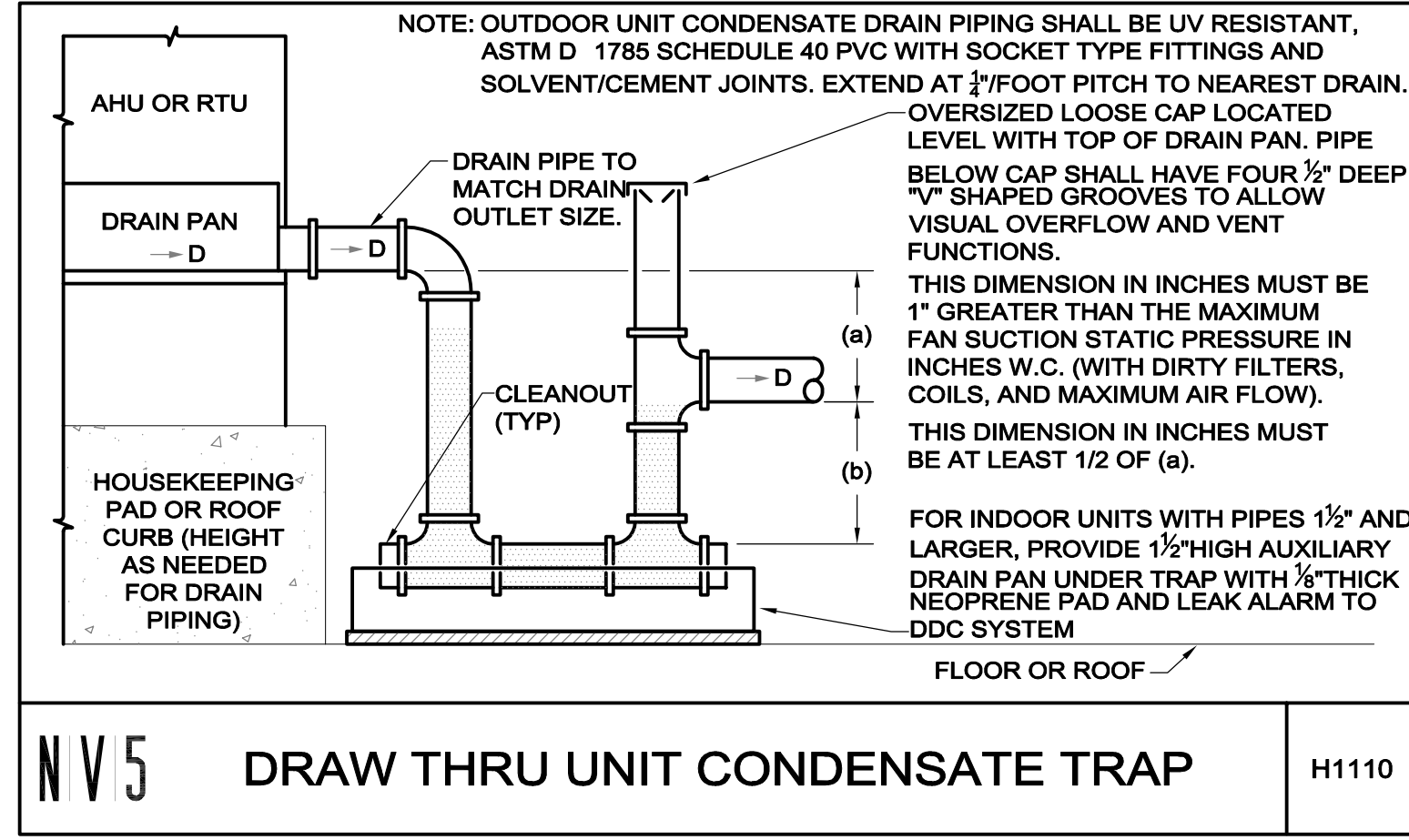
NV5 **MANUAL AIR VENT ASSEMBLY** H1108



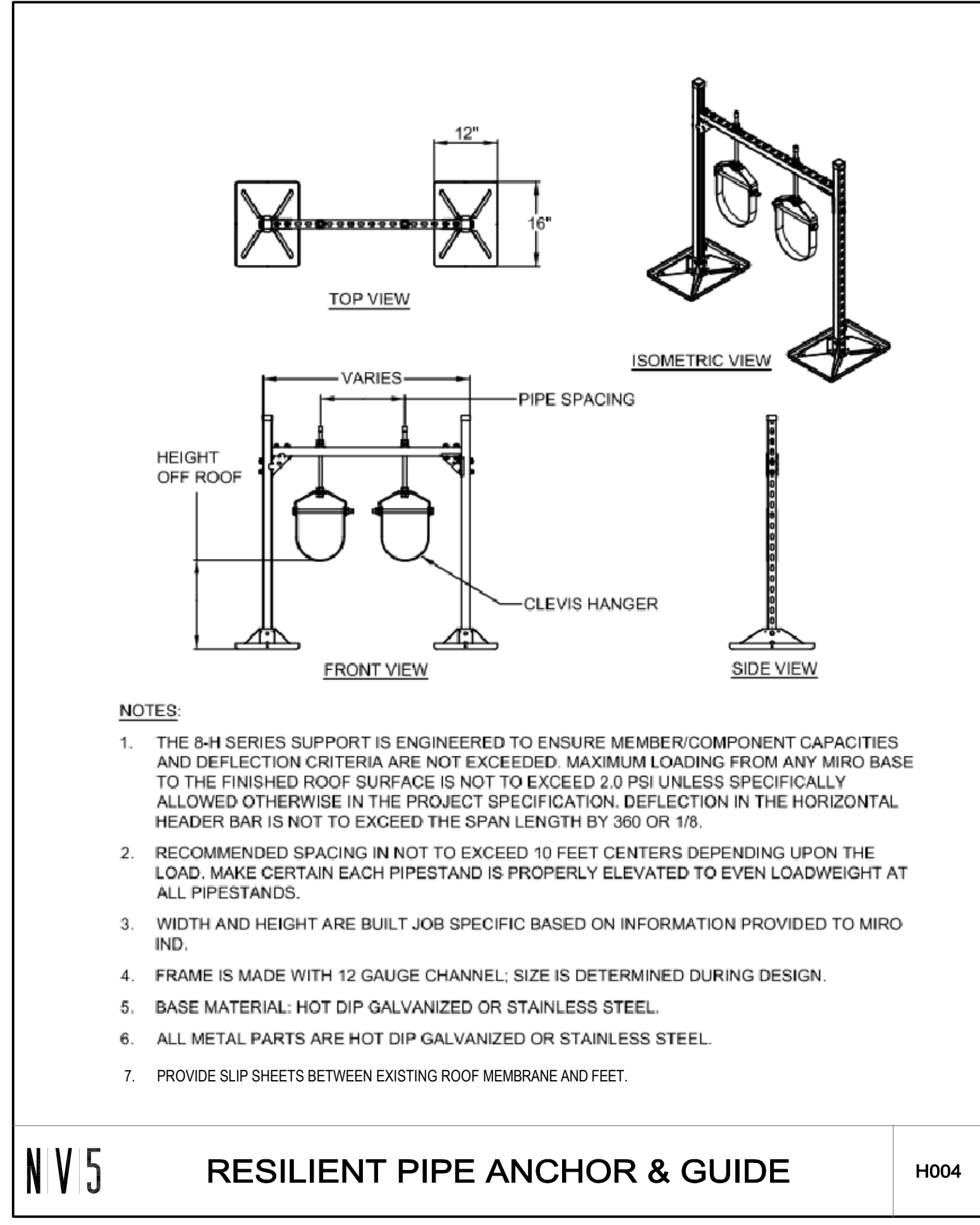
NV5 **ROOFTOP UNIT MOUNTING W/ INSULATED ADAPTER CURB** H709A



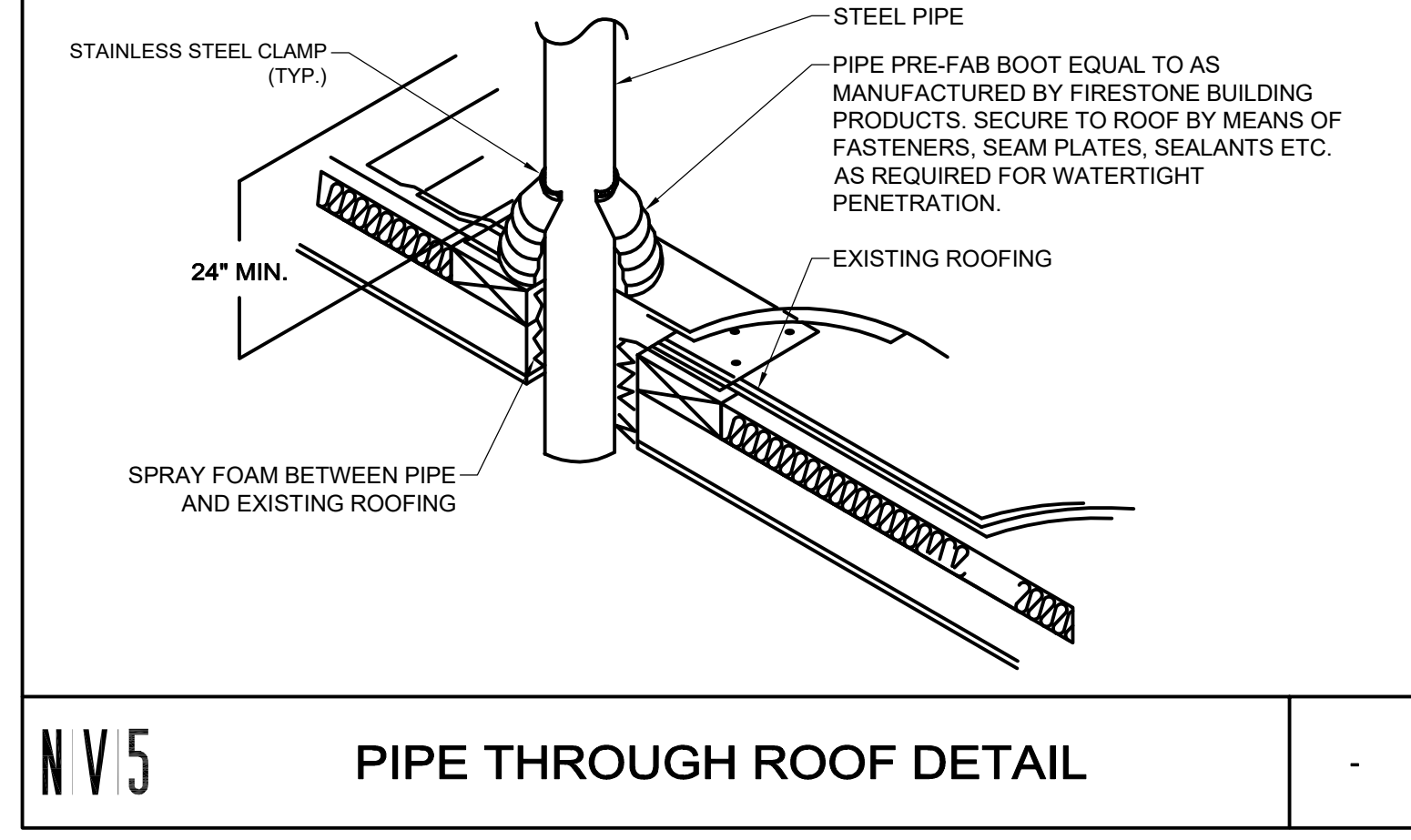
NV5 **AHU STEAM COIL PIPING DETAIL** -



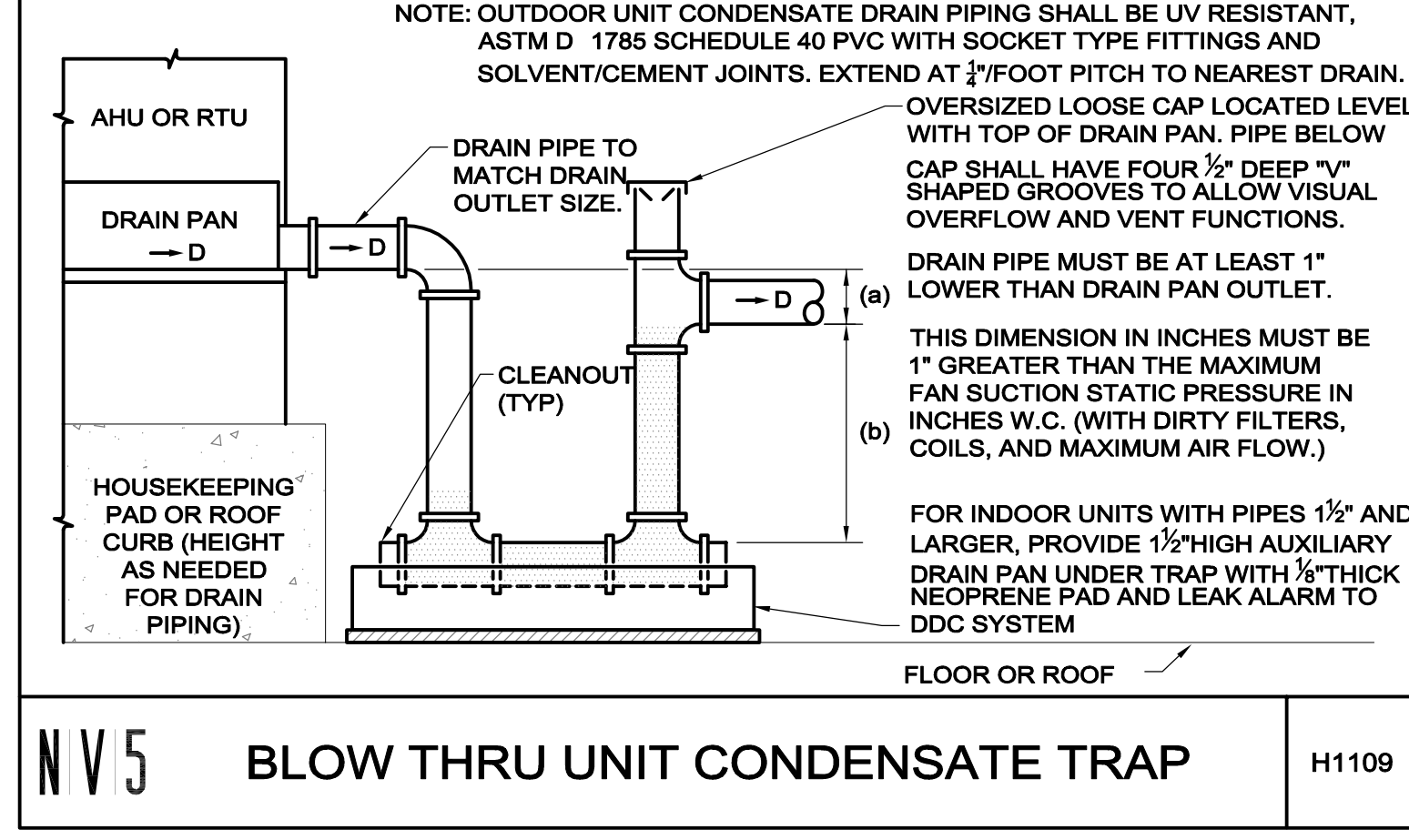
NV5 **DRAW THRU UNIT CONDENSATE TRAP** H1110



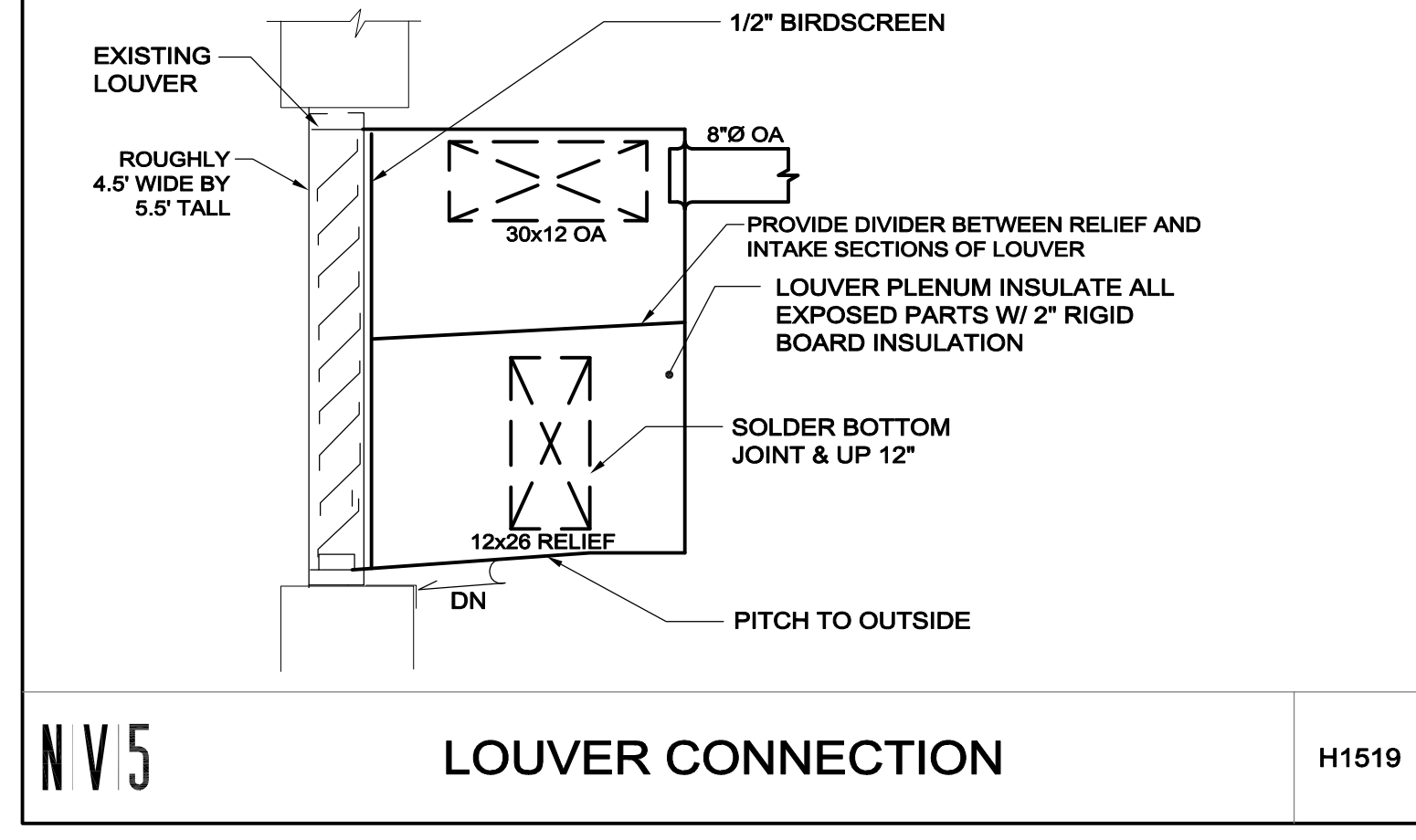
NV5 **RESILIENT PIPE ANCHOR & GUIDE** H004



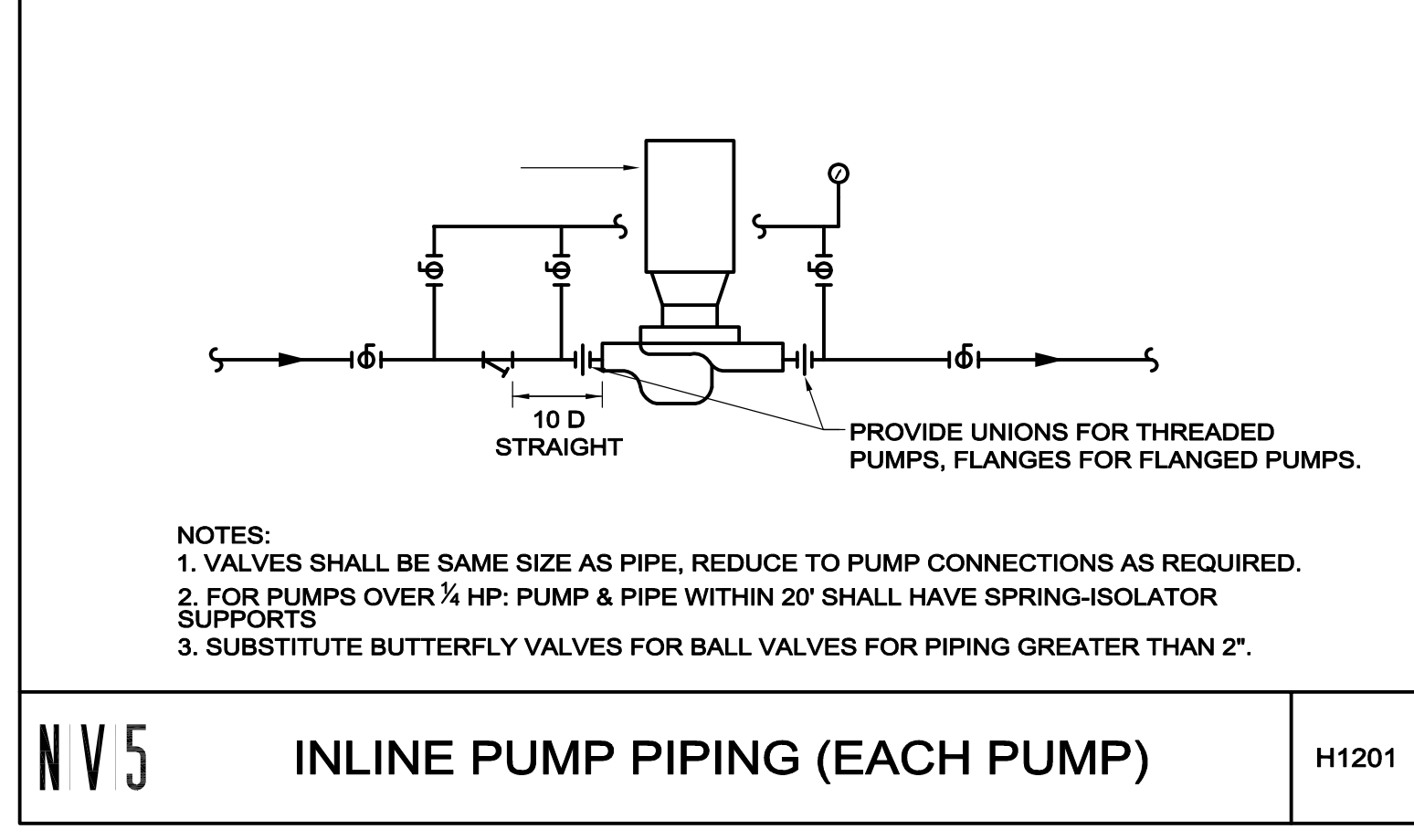
NV5 **PIPE THROUGH ROOF DETAIL** -



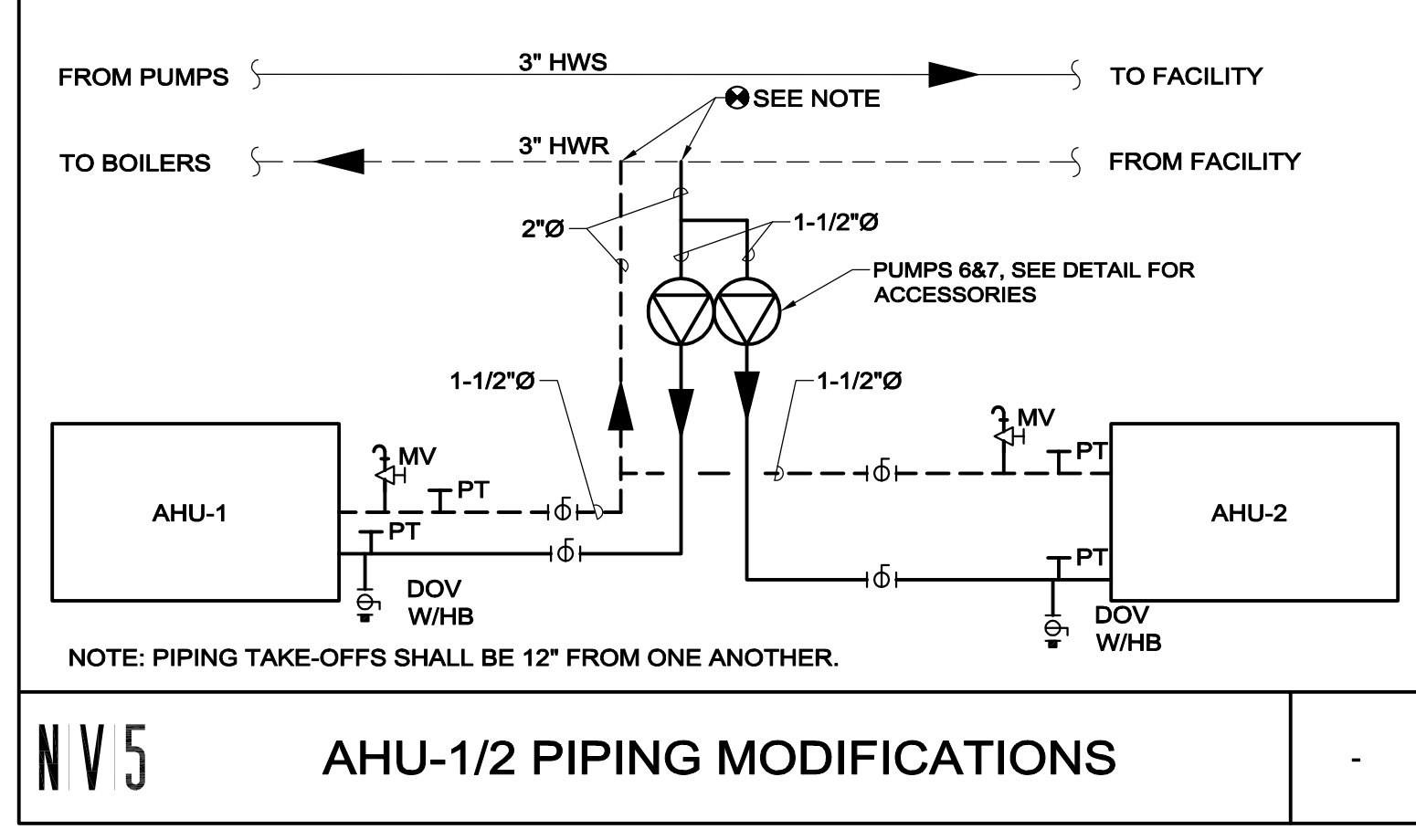
NV5 **BLOW THRU UNIT CONDENSATE TRAP** H1109



NV5 **LOUVER CONNECTION** H1519



NV5 **INLINE PUMP PIPING (EACH PUMP)** H1201



NV5 **AHU-1/2 PIPING MODIFICATIONS** -

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MECHANICAL DETAILS

PACKAGED ROOF TOP UNITS

ITEM	SERVICE	LOCATION	UNIT TOTAL CFM	MIN. OA CFM	NOM TONS	47 COP @ AHRI	HSPF @ AHRI	EER @ AHRI	IEER @ AHRI	SEER @ AHRI	SUPPLY FAN					EXHAUST FAN					REF.	EVAPORATOR - HEATING 10 DEG F AMBIENT					EVAPORATOR - COOLING - 95 DEG F AMBIENT					SUPPLEMENTAL HEAT				CONDENSER FANS		COMPRESSOR(S)		ELECTRICAL					OP. WEIGHT (LBS)	MFR & MODEL NO.	NOTE(S)	
											FAN TYPE	ESP (IN)	TSP (IN)	MAX BHP	MOTOR HP	FAN RPM	CFM	ESP	HP	QTY		EADB (DEG F)	TOTAL MBH	LADB	EADB (DEG F)	EAWB (DEG F)	TOT. MBH	SENS. MBH	ROWS/ FINS	LADB	LAWB	TYPE	EADB (DEG F)	INPUT MBH OR KW	TURN DOWN	LADB (DEG F)	QTY	FLA	NO.	TYPE	V	PH	HZ	MCA				MOCP
RTU-5	LOCAL HISTORY	ROOF	3600	410	10	3.42	-	11.7	18	-	DIRECT	2	3.1	2.87	4	1420	3600	1	4	1	R-410A	60	54.4	75.5	77	63.5	122	99	4-15	51.7	51.7	ELEC	60	36KW	SCR	91.5	2	4	2	INV. SCROLL	208	3	60	178	200	2431	DAIKIN DPS010A	SEE NOTES
RTU-6	PERIODICALS	ROOF	1500	190	4	3.94	8.8	11.4	-	14.3	DIRECT	2	3.1	1.65	4	2156	1500	1	2.3	1	R-410A	60	21.1	72	77	63.5	46.7	40.9	4-16	53.6	53.5	ELEC	60	18KW	SCR	95.4	1	0.9	1	INV. SCROLL	208	3	60	84.7	90	1359	DAIKIN DPS004A	SEE NOTES
RTU-7	PERIODICALS	ROOF	1500	140	4	3.94	8.8	11.4	-	14.3	DIRECT	2	3.1	1.65	4	2156	1500	1	2.3	1	R-410A	60	21.1	72	76.4	63	46.3	40.6	4-16	53.1	53.1	ELEC	60	12KW	SCR	86.6	1	0.9	1	INV. SCROLL	208	3	60	68.8	70	1409	DAIKIN DPS004A	SEE NOTES

- NOTES:
 1. PROVIDE VARIABLE SPEED SCROLL COMPRESSORS. FOR AHU-5 & AHU-7, PROVIDE WITH VFD FOR SUPPLY FAN TO RAMP FAN DOWN WHEN DIFFUSERS CLOSE.
 2. ISOLATED BLOWER(S), CONDENSER FAN MOTORS, AND COMPRESSORS
 3. FACTORY MOUNTED VFD ON SUPPLY BLOWER
 4. BACNET INTERFACE CARD
 5. PROVIDE WITH ECONOMIZER.
 6. WITH ADAPTER CURB TO EXISTING ROOF CURB
 7. HYBRID HEAT - UNIT SHALL OPERATE AS HEAT PUMP DOWN TO ADJUSTABLE CHANGEVER POINT OF 40 F AND SUPPLEMENTAL HEAT BELOW
 8. GAS HEAT STAGE TO OPERATE ON 3.5" WC MINIMUM INLET PRESSURE, 14" WC MAXIMUM INLET PRESSURE
 9. PROVIDE MERV 8 AND MERV 14 FILTERS

AIR HANDLERS

ITEM	SERVICE	LOCATION	ORIENTATION	UNIT TOTAL CFM	MINIMUM OUTDOOR AIR CFM	SUPPLY FAN					EVAPORATOR - HEATING 0 DEG F AMBIENT					EVAPORATOR - COOLING - 95 DEG F AMBIENT										HOT WATER COIL/STEAM COIL										ELECTRICAL					OPERATING WEIGHT (LBS)	MFR / MODEL NO.	NOTE(S)	
						FAN TYPE	ESP (IN)	TSP (IN)	MAX BHP	MOTOR HP	FAN RPM	EADB (DEG F)	SENS. MBH	CFM	LADB	EADB (DEG F)	EAWB (DEG F)	ROWS	FPI	CFM	TOTAL MBH	SENS. MBH	TONS	LADB	LAWB	MEDIA	ROWS	FPI	EADB (DEG F)	CFM	OUTPUT MBH	FLOW	EWT	STM PSI @ COIL	PD (FT)	LADB (%DF)	V	PH	HZ	MCA				MOCP
AHU-1	ADDITION	PENTHOUSE	VERTICAL	15000	2850	NOTE 1	2.5	4.4	5.3x3	6.7x3	2466	60	248	15000	75	78	65	8	8	15000	482	324	40	55	54	HW	1	11	60	15000	260	17 GPM	160	-	2.1	75	208	3	60	54.0	70	4005	DAIKIN CAH033GDCM	NOTES 1, 3, 4, 5, 6, 7, 8
AHU-2	ADDITION	PENTHOUSE	VERTICAL	15000	2850	NOTE 1	2.5	4.4	5.3x3	6.7x3	2466	60	248	15000	75	78	65	8	8	15000	482	324	40	55	54	HW	1	11	60	15000	260	17 GPM	160	-	2.1	75	208	3	60	54.0	70	4005	DAIKIN CAH033GDCM	NOTES 1, 3, 4, 5, 6, 7, 8
AHU-3	PUBLIC MEETING	BASEMENT	HORIZONTAL	2000	650	NOTE 2	1.0	1.6	0.9	3	1118	48	81	2000	85	80	66	3	12	2000	97	67	8	50	49	STM	1	10	48	2000	81	68 LB/HR	1 psi	1	-	85	208	3	60	10.5	15	634	DAIKIN BCHD0401	NOTES 2, 3, 4, 7, 9
AHU-4	TECHNICAL SERVICES	BASEMENT	HORIZONTAL	1550	120	NOTE 2	1.0	1.7	0.9	2x0.5	1383	46	66	1550	85	76	64	3	12	1550	52	38	4	53	53	STM	1	10	56	1550	49	68 LB/HR	1 psi	1	-	85	208	1	60	9.4	15	573	DAIKIN BCHD0201	NOTES 2, 3, 4, 7, 9

- NOTES:
 1. DIRECT DRIVE 3 MOTOR PLENUM FAN ARRAY
 2. DIRECT DRIVE PLENUM
 3. FACTORY MOUNTED VFD ON SUPPLY FAN(S)
 4. BACNET INTERFACE CARD
 5. MIXING BOX, MERV 13 FILTER RACK, DX COIL, HOT WATER COIL IN BOTTOM TUNNEL, SUPPLY FAN IN TOP TUNNEL.
 6. COIL ENTERING CONDITIONS REFLECT ERV CONTRIBUTION
 7. UNIT SHALL OPERATE AS HEAT PUMP AND SHALL UTILIZE STEAM OR HOT WATER COIL AS SUPPLEMENTAL HEAT
 8. ENTHALPY ECONOMIZER, INTERLOCK SUCH THAT ERV IS IDLE WHEN UNIT IS IN UNOCCUPIED OR ECONOMIZER MODE, AND RUNS OTHERWISE.
 9. PROVIDE FIELD FABRICATED MIXING BOX, FACTORY FILTER RACK, VRF COIL, STEAM COIL.

VRF HEAT PUMP OUTDOOR UNITS

ITEM	LOCATION	SERVICE	NOM. TONS @ AHRI	MIN EER @ AHRI	MIN IEER @ AHRI	EER2	MIN COP @ 47 DEG F	MIN COP @ 17 DEG F	HSPF 2	MIN COP @ 5 DEG F	REFRIG-ERANT	ELECTRICAL DATA						OPERATING WEIGHT (LBS)	MANUFACTURER / MODEL NUMBER	NOTES			
												V	PH	HZ	CIRCUIT A MCA	CIRCUIT A MOCP	CIRCUIT B MCA				CIRCUIT B MOCP	CIRCUIT C MCA	CIRCUIT C MOCP
ACC-1	ROOF	AHU-1	34.0	9.6	16.4	NA	3.25	2.07	NA	NA	R410a	208	3	60	36.3	45	55.1	60	55.1	60	1915	DAIKIN / RXY Q 408 XATJA	SEE NOTES
ACC-2	ROOF	AHU-2	34.0	9.6	16.4	NA	3.25	2.07	NA	NA	R410a	208	3	60	36.3	45	55.1	60	55.1	60	1915	DAIKIN / RXY Q 408 XATJA	SEE NOTES
ACC-3	GRADE	AHU-3	8.0	12.8	24.8	NA	NA	NA	NA	NA	R410a	208	3	60	34.1	35	NA	NA	NA	NA	683	DAIKIN / RXY Q 96 AATJA	SEE NOTES
ACC-4	GRADE	AHU-4	5.0	NA	NA	8.5	NA	NA	8.50	NA	R410a	208	1	60	29.1	35	NA	NA	NA	NA	224	DAIKIN / RXT Q 60 TBVJUA	SEE NOTES

- NOTES:
 1. REFER TO SPECIFICATIONS, DETAILS AND CONTROL DRAWINGS FOR FURTHER INFORMATION.
 2. DISCONNECT BY DIV. 26
 3. PROVIDE WITH SNOW/HAIL GUARDS, WIND BAFFLES AND BASEPAN HEATERS. MOUNT CONDENSERS AS INDICATED ON DRAWINGS (STANDS OR DUNNAGE).
 4. PROVIDE WITH BACNET CARD AND SERVER LICENSE FOR BAS INTEGRATION.
 5. PROVIDE REFRIGERANT PIPING SIZED PER MANUFACTURER'S RECOMMENDATIONS BASED ON PROPOSED FIELD ROUTING. PROVIDE ANY ADDITIONAL REFRIGERANT CHARGE REQUIRED.

OUTDOOR AIR DESIGN TEMPERATURES

	DRY BULB (DEG F)	WET BULB (DEG F)
SUMMER	91	73
WINTER	7	5

NOTES:
 1. PER ASHRAE FUNDAMENTALS FOR BOSTON, MA

FAN SCHEDULE

TAG	LOCATION	SERVICE	CFM	STYLE	FAN RPM	DRIVE	S.P. (IN.)	MOTOR RPM	BRAKE HP	MOTOR HP	VOLTS	PHASE	HERTZ	FLA	MCA	MOCP	OPERATING WEIGHT (LBS)	MANUFACTURER	MODEL NUMBER	REMARKS
F-1	MECH MEZZ	AHU-1	15000	INLINE, CENT.	794	BELT	2	1245	7.33	7.5	208	3	60	24.2	-	-	701	GREENHECK	QEI-27	NOTES 1-4
F-2	MECH MEZZ	AHU-2	15000	INLINE, CENT.	794	BELT	2	1245	7.33	7.5	208	3	60	24.2	-	-	701	GREENHECK	QEI-27	NOTES 1-4,6
EF-7	GROUND FLR	AHU-3	1700	INLINE, CENT.	1153	DIRECT	0.5	1153	0.31	3/4	208	1	60	5.4	7	15	97	GREENHECK	SQ-140-VG	NOTES1,3,4,5

- NOTES:
 1. REFER TO PLANS, SPECIFICATIONS AND CONTROL DRAWINGS FOR FURTHER INFORMATION.
 2. MOTOR SHALL BE INVERTER DUTY RATED FOR CONNECTION TO A VFD. PROVIDE BEARING SHAFT RING FOR SHAFT GROUNDING. PROVIDE WITH VFD.
 3. HANG WITH WITH VIBRATION ISOLATORS.
 4. DISCONNECT BY DIV 26.
 5. PROVIDE ECM FAN WITH VARIABLE SPEED INPUT SIGNAL AND FLEXIBLE CONNECTIONS.
 6. PROVIDE F-2 IN THE VERTICAL CONFIGURATION WITH FIELD FABRICATED SUPPORTS AND SPRING ISOLATORS.



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MECHANICAL SCHEDULES



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MECHANICAL SCHEDULES

PIPE INSULATION (IECC - 2021 AND ASHRAE 90.1 2019 COMPLIANT)							
MINIMUM INSULATION THICKNESS IN INCHES OF INDOOR PIPE SIZES (SEE NOTES BELOW)							
PIPING SYSTEM TYPES	FLUID TEMP RANG (DEG F)	<1"	1" & 1-1/4"	1-1/2" - 3"	4" - 6"	8" & UP	K-FACTOR (BTU-INCH/DEG F-HR-SF) AT AVG. TEMP (DEG F)
UNCONDITIONED SPACE (SHAFT OR CEILING WITH DUCTED RETURN AIR)	R-6	2.5	2.5	2.5	3	3	0.27-0.30 @ 150 F
RETURN AIR PLENUM	R-4	1.5	1.5	2	2	2	0.25-0.29 @ 125 F
EXPOSED IN MECHANICAL ROOM	R-6	0.5	1	1	1	1.5	0.20 - 0.27 @ 75 F

NOTES:
1. FOR MINIMUM THICKNESS OF ALTERNATIVE INSULATION TYPES OUTSIDE THE STATED CONDUCTIVITY RANGE, SEE TEST METHOD FOR STEADY STATE HEAT TRANSFER PROPERTIES OF HORIZONTAL PIPE INSULATIONS, ASTM C 335-95, AND THE STATE ENERGY CODE.
2. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.

VRF EXPANSION VALVE AND CONTROLLER							
TAG	SERVICE	LOCATION	ELECTRICAL DATA				NOTE(S)
			V	PH	HZ	MAX AMPS	
EV-1	AHU-1	MECH PENTHOUSE	208	1	60	<1A	SEE NOTES
EV-2	AHU-1	MECH PENTHOUSE	208	1	60	<1A	SEE NOTES
EV-3	AHU-2	MECH PENTHOUSE	208	1	60	<1A	SEE NOTES
EV-4	AHU-2	MECH PENTHOUSE	208	1	60	<1A	SEE NOTES
EV-5	AHU-3	GROUND FLR MECH	208	1	60	<1A	SEE NOTES
EV-6	AHU-4	GROUND FLR MECH	208	1	60	<1A	SEE NOTES

NOTES:
1. INSTALL CONTROLLER AND EXPANSION VALVE IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS
2. WIRE AND MOUNT THE INCLUDED THERMISTORS
3. DISCONNECT AND ELECTRICAL CONNECTION BY DIV. 26

ENERGY RECOVERY VENTILATOR SCHEDULE																																
TAG	DESCRIPTION	COMPONENT	FAN DATA								ELEC DATA					THERMAL DATA							FILTER DATA				NOTES					
			SUPPLY CFM	EXHAUS T CFM	ESP	TSP	FAN RPM	FAN BHP	FAN MOTOR HP	MOTOR NOM. RPM	MCA	MOCP	VOLTS	PHASE	HERTZ	EOA DB (DEG F)	EOA WB (DEG F)	EEA DB (DEG F)	EEA WB (DEG F)	SENS MBH	TOTAL MBH	SA LVG DB	SA LVG WB	MAX FPM	MERV	CLEAN PD		DIRTY PD	TYPE			
ERV-1	OUTDOOR, CONSTANT VOLUME, 2" FOAM PANEL CONSTRUCTION, WHEEL TYPE ENERGY RECOVERY, PACKAGED ENERGY RECOVERY VENTILATOR, 1922 LBS OPERATING WEIGHT PLUS CURB	OUTDOOR AIR FILTER	5400	3600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	2" THROW AWAY				
		EXHAUST AIR FILTER			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	2" THROW AWAY			
		ENERGY RECOVERY WHEEL WINTER			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
		ENERGY RECOVERY WHEEL SUMER			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		EXHAUST FAN (FC BELT DRIVE) W/ VFD			0.63	0.81	781	3.51	5	1750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		SUPPLY FAN (FC BELT DRIVE) W/ VFD			0.63	1.25	1038	1.28	1.5	1750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SINGLE POINT POWER CONNECTION			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
					-	-	-	-	-	-	29.8	45	208	3	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

NOTES:
1. END INTAKE END DISCHARGE FOR SUPPLY AND EXHAUST
2. PREMIUM EFFICIENCY, OPEN DRIP PROOF FAN MOTORS
3. BASIS OF DESIGN: VALENT MODEL #VXE-312-74E-0-2-D1
4. WITH DOWNTURN WEATHERHOOD ON SA AND OA OPENINGS
5. WITH INSULATED LOW LEAK DAMPERS ON INTAKE AND EXHAUST

MINIMUM DUCT INSULATION R-VALUES (IECC - 2021 AND ASHRAE 90.1 2019 COMPLIANT)					
LOCATION	SUPPLY	RETURN	RAW OUTDOOR AIR	EXHAUST	
				WITH ENERGY RECOVERY	WITHOUT ENERGY RECOVERY
UNCONDITIONED SPACE (SHAFT OR CEILING WITH DUCTED RETURN AIR)	R-6	R-6	R-6	R-6	R-6*
RETURN AIR PLENUM	R-4	-0-	R-6	R-6 (ONLY IF ABOVE ROOF)	R-6* (ONLY IF ABOVE ROOF)
EXPOSED IN MECHANICAL ROOM	R-6	R-6	R-6	R-6	R-6*
EXPOSED IN ZONE SERVED (**ONLY DUCTS THAT PROVIDE COOLING)	R-4**	-0-	R-6	-0-	-0-

* R-VALUE SHOWN IS ONLY IF AREA OF BUILDING BEING ECXHAUSTED I HUMIDIFIED. IF NOT HUMIDIFIED, NO INSULATION (-0-) UNLESS FIRE WRAP OR LINING IS NEEDED

DUCT LINING SCOPE: ACOUSTIC DUCT LINING OF THE TYPE AND THICKNESS SPECIFIED SHALL BE INSTALLED ON ALL SUPPLY, RETURN, AND EXHAUST DUCTWORK WITHIN 20 FEET OF ALL TYPES OF AIR HANDLING UNITS (INCLUDING RTU, ERU, FCU, MUA, ETC., AND ALL BRANCHES WITHIN 20') ALL FANS (INCLUDING BRANCHES), ALL LOW PRESSURE DUCTWORK DOWNSTREAM OF ALL TYPES OF SUPPLY VOLUME BOXES (CV, VAV, FPAV, ETC.), AND WHERE DETAILED OR SHOWN ON DRAWINGS. LINING SHALL NOT BE USED ON DUCTWORK SERVING SURGICAL SUITES, DELIVERY ROOMS, INTENSIVE CARE UNITS AND ISOLATION AREAS OF HOSPITALS AND MEDICAL FACILITIES OR ON KITCHEN AND FUME HOOD EXHAUST AND WET/HUMID EXHAUST SUCH AS DISHWASHER, CLOTHES DRYER, AND SHOWER SYSTEMS.

NOTES: (SEE SPECIFICATIONS FOR R-VALUES OF VARIOUS DUCT INSULATION AND LINERS).
1. R-VALUES SHOWN MAY BE OBTAINED BY ADDING THE R-VALUES OF BOTH THE LINING (WHERE SHOWN OR USED) AND EXTERNAL DUCT INSULATION.
2. R-VALUES SHOWN ARE AS INSTALLED. USE R-VALUES FOR 25% COMPRESSION FOR NON-RIGID INSULATION.
3. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.

DUCTWORK PRESSURE CLASS AND SEAL CLASS					
PRESSURE CLASS	STATIC PRESSURE CLASS	SMACNA SEAL CLASS	SMACNA LEAKAGE CLASS		MAXIMUM DESIGN VELOCITY
			RECTANGULAR	ROUND	
4"	4" POS. OR NEG.	A	6	3	3000
3"	3" POS. OR NEG.	A	6	3	2500
2"	2" POS. OR NEG.	A	6	3	2000

UNLESS OTHERWISE SPECIFIED OR SHOWN ON DRAWINGS, USE THE FOLLOWING PRESSURE CLASSIFICATIONS FOR THE TYPES OF DUCTWORK LISTED BELOW

4" (POS) CLASS	ALL SUPPLY DUCTWORK BETWEEN THE DISCHARGE OF AIR SUPPLY UNITS TO THE INLETS OF SUPPLY TERMINAL VOLUME BOXES.
3"	ALL SUCTION AND DISCHARGE FUME HOOD, KITCHEN EXHAUST DUCTWORK AND FOR MEDIUM PRESSURE EXHAUST AND RETURN SYSTEMS, ALL DUCTWORK BETWEEN AIR EXHAUST AND RETURN UNITS TO OUTLETS OF EXHAUST AND RETURN TERMINAL VOLUME BOXES.
2"	ALL OTHER DUCTWORK

NOTES:
1. CONTRACTOR SHALL LEAK TEST (SUBMIT REPORT) A MINIMUM OF 25% OF THE SURFACE AREA FOR ALL DUCTWORK ABOVE PRESSURE CLASS 3" AND 100% OF ALL DUCTWORK LOCATED OUTDOORS.
2. FOR NEGATIVE PRESSURE OVER 3"W.G., REFER TO SMACNA ROUND AND RECTANGULAR INDUSTRIAL DUCT CONSTRUCTION STANDARDS FOR JOINT AND INTERMEDIATE REINFORCEMENT REQUIREMENTS.
3. FOR ROUND DUCTWORK, NEGATIVE PRESSURE OVER 2"W.G., REFER TO SMACNA ROUND INDUSTRIAL DUCT CONSTRUCTION STANDARDS AND BUILD TO NEGATIVE RATING SPECIFIED (-4"W.G. MIN.).
4. LEAKAGE CLASS AND THE ASSOCIATED DUCT SEALING FOR DUCTWORK SERVING LABORATORIES, HOSPITAL OPERATING ROOMS, AND CLEAN ROOMS SHALL ALLOW FOR 1/2 THE LEAKAGE LISTED.
5. REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.

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PUMP SCHEDULE

TAG	LOCATION	SERVICE	TYPE	GPM	FLUID TEMP (°F)	HEAD (FT)	INLET (IN)	IMP. DIA (IN)	OUTLET (IN)	BRAKE HP	MOTOR HP	MOTOR RPM	VOLTS	PHASE	HERTZ	MANUFACTURER	MODEL NUMBER	NOTES
P-6	MECH MEZZ	AHU-1	INLINE ECM	18	160	12	1.25	-	1.25	-	1/6	2764	115	1	60	B&G	ECOCIRC 36-45	SEE NOTES
P-7	MECH MEZZ	AHU-2	INLINE ECM	18	160	12	1.25	-	1.25	-	1/6	2764	115	1	60	B&G	ECOCIRC 36-45	SEE NOTES

NOTES:
 1. REFER TO DETAILS AND CONTROL DRAWINGS FOR FURTHER INFORMATION.
 2. PUMP SHALL BE VARIABLE SPEED WITH INTEGRAL LOGIC/DRIVE AND CONTROLLED BY THE BAS.
 3. DISCONNECT BY DIV. 26

HYDRONIC HORIZONTAL UNIT HEATER SCHEDULE

TAG	LOCATION	TYPE	CFM	ELECTRICAL DATA				THERMAL DATA						WEIGHT (LBS)	MANUFACTURER	MODEL NUMBER	NOTES	
				HP	VOLTS	PHASE	HERTZ	EADB	LADB	TOTAL MBH	EFT (°F)	LFT (°F)	GPM					WPD (FT)
UH-1	2ND FLOOR PLENUM	HORIZONTAL	700	1/20	120	1	60	55	101	35.2	180	160	3.5	0.11	41.0	TRANE	UHSB06011	1, 2, 3, 4
UH-2	2ND FLOOR PLENUM	HORIZONTAL	700	1/20	120	1	60	55	101	35.2	180	160	3.5	0.11	41.0	TRANE	UHSB06011	1, 2, 3, 4
UH-3	2ND FLOOR PLENUM	HORIZONTAL	700	1/20	120	1	60	55	101	35.2	180	160	3.5	0.11	41.0	TRANE	UHSB06011	1, 2, 3, 4
UH-4	PENTHOUSE	HORIZONTAL	1100	1/12	120	1	60	55	102	56.3	180	160	5.6	0.19	49.0	TRANE	UHSB09611	1, 2, 3, 4

NOTES:
 1. REFER TO SPECIFICATIONS, DETAILS AND CONTROL DRAWINGS FOR FURTHER INFORMATION.
 2. DISCONNECT BY DIV. 26.
 3. PROVIDE WITH LINE VOLTAGE THERMOSTAT AND AQUASTAT.
 4. HANG FROM STRUCTURE ABOVE.

HEAT PUMP MINI-SPLIT SYSTEM SCHEDULE

INDOOR UNIT														OUTDOOR UNIT											
ITEM	LOCATION	SERVICE	FAN TOTAL CFM	COOLING PERFORMANCE					HEATING PERFORMANCE			OPERATING WEIGHT (LBS)	MANUFACTURER / MODEL NUMBER	ITEM	LOCATION	NOMINAL TONS	OPERATING WEIGHT (LBS)	ELECTRICAL DATA					MANUFACTURER/ MODEL NUMBER	REMARKS	
				TOTAL MBH	SENS. MBH	REF.	EAT DB (°F)	EAT WB (°F)	AMBIENT AIR TEMP (°F)	EAT	TOTAL MBH							AMBIENT AIR TEMP	MCA	MOCP	VOLTS	PHASE			HERTZ
FCU-1	2ND FLOOR	STORAGE	430	10.9	9.0	R-410a	80	67	95	70	8.6	17	22	DAIKIN FTX12AXVJU	HP-1	ROOF	1.0	64	8.7	15	208	1	60	DAIKIN RX12AXVJU	SEE NOTES
FCU-2	1ST FLOOR	SERVER	430	8.9	8.0	R-410a	80	67	95	70	5.7	17	20	DAIKIN FTX09AXVJU	HP-2	ROOF	0.75	57	8.7	15	208	1	60	DAIKIN RX09AXVJU	SEE NOTES

NOTES:
 1. PROVIDE WIND BAFFLE AND FIELD PROGRAMMING FOR LOW AMBIENT COOLING.
 2. REFRIGERANT PIPE SIZING TO BE SELECTED AND CONFIRMED BY THE MANUFACTURER'S REPRESENTATIVE.
 3. PROVIDE BAS TEMPERATURE SENSOR TO START STOP EQUIPMENT OR MANUFACTURER'S THERMOSTAT WITH BAS INTEGRATION HARDWARE.
 4. INDOOR UNIT POWERED BY OUTDOOR UNIT

PARALLEL FAN POWERED TERMINAL (PFPT) BOX SCHEDULE (ADD-ALTERNATE)

TAG	CFM RANGE	NECK SIZE (IN)	TYPE	MAX COOL CFM	MIN COOL CFM	MAX HEAT CFM	FAN MOTOR HP	FAN ESP (IN)	FAN CFM	LINING THICKNESS	MAX RADIATE D NC	MAX DISCHARGE NC	COIL EAT (DEG F)	COIL LAT (DEG F)	COIL EWT (DEG F)	COIL LWT (DEG F)	COIL MBH	COIL GPM	MAX COIL WATER PD (FT)	VOLTS	PHASE	HERTZ	MCA	MOCP	MANUFACTURER	MODEL NUMBER	NOTES
FB-1	0-360	8	PARALLEL FLOW	340	55	360	1/2	0.25	150	1"	28	17	-	-	-	-	-	-	-	120	1	60	9.6	15	TITUS	DTQP	SEE NOTES
FB-2	361-600	8	PARALLEL FLOW	600	100	600	1/2	0.25	250	1"	31	20	-	-	-	-	-	-	-	120	1	60	9.6	15	TITUS	DTQP	SEE NOTES
FB-3	601-950	10	PARALLEL FLOW	950	160	950	1/2	0.25	340	1"	34	20	-	-	-	-	-	-	-	120	1	60	9.6	15	TITUS	DTQP	SEE NOTES
FB-3.1	601-950	10	PARALLEL FLOW	850	160	950	1/2	0.25	275	1"	32	20	70	84.7	180	147.9	9.6	0.6	0.09	120	1	60	9.6	15	TITUS	DTQP	SEE NOTES
FB-4	951-1500	12	PARALLEL FLOW	1190	270	1500	1/2	0.25	480	1"	32	22	-	-	-	-	-	-	-	120	1	60	9.6	15	TITUS	DTQP	SEE NOTES
FB-5	1501-1760	14	PARALLEL FLOW	1760	600	1760	1	0.25	630	1"	34	23	-	-	-	-	-	-	-	120	1	60	16	25	TITUS	DTQP	SEE NOTES

NOTES:
 1. PFPT REPLACEMENT IS AN ADD-ALTERNATE
 2. WITH ECM MOTOR, INLET & DISCHARGE ATTENUATORS
 3. WITH VIBRATION ISOLATORS

REGISTER GRILLE AND DIFFUSER SCHEDULE

TAG	SERVICE	TYPE	FACE SIZE	NECK SIZE	AIR PATTERN	MATERIAL	MANUFACTURER	MODEL NUMBER	NOTES
SD	CEILING SUPPLY	LOUVERED FACE	24x24	SEE PLANS	4-WAY	ALUMINUM	TITUS	TDV-AA	1 THRU 4
SE	CEILING SUPPLY	PLAQUE DIFFUSER	24x24	SEE PLANS	4-WAY	STEEL	TITUS	T3SQ-2	1 THRU 4,6
SF	SIDEWALL SUPPLY	GRILLE	SEE PLANS	SEE PLANS	2-WAY	STEEL	TITUS	T3SW	1 THRU 6
RE	RETURN GRILLE	PERFORATED	24x24	22x22	NA	STEEL	TITUS	PAR	1 THRU 4

NOTES:
 1. REFER TO ARCHITECTURAL REFLECTED CEILING PLAN FOR MOUNTING TYPE
 2. DEVICES IN GRID CEILINGS SHALL BE 24"x24" LAY-IN TYPE UNLESS NOTED OTHERWISE
 3. DEVICES IN SHEETROCK CEILINGS SHALL BE SURFACE MOUNTED
 4. ALL COLOR AND FINISH SHALL BE SELECTED AND APPROVED BY ARCHITECT
 5. WHEN MOUNTED SIDEWALL, FACE BLADES SHALL BE IN HORIZONTAL
 6. DIFFUSER SHALL BE LOW VOLTAGE, VAV DIFFUSER.



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HVAC Replacement at:

WALTHAM PUBLIC LIBRARY
 735 Main Street
 Waltham, MA 02451

SCALE: NO SCALE

DATE: 2024-01-31

REVISIONS:

2023-10-17: SD PLUS

2023-12-22: DD PLUS

2024-01-31: CD'S

DRAWN BY: NG

MECHANICAL SCHEDULES

ELECTRICAL DEMOLITION NOTES

- REFER TO THE ARCHITECTURAL AND MECHANICAL DRAWINGS FOR THE EXTENT OF THE DEMOLITION SCOPE OF WORK AND AREA. THE DEMOLITION PLANS INDICATE THE GENERAL INTENT AND ARE NOT INTENDED TO SHOW ALL ITEMS TO BE REMOVED OR RETAINED. THE ELECTRICAL SCOPE MAY EXTEND BEYOND THE AREA DEFINED BY THE ARCHITECTURAL DEMOLITION LIMITS TO FULLY COMPLY WITH VARIOUS REQUIREMENTS OF THE CONTRACT DOCUMENTS.
- THE ELECTRICAL DEMOLITION PLANS ARE NOT INTENDED TO SHOW ALL ITEMS TO BE REMOVED OR RETAINED. NOTIFY THE OWNER'S REPRESENTATIVE IMMEDIATELY OF ANY UNANTICIPATED HIDDEN CONDITIONS ENCOUNTERED DURING THE DEMOLITION.
- PERFORM ELECTRICAL DEMOLITION WORK AS SHOWN ON THE DRAWINGS AND AS SPECIFIED IN COOPERATION WITH THE OTHER TRADES AND AS SCHEDULED AND APPROVED BY THE OWNER'S REPRESENTATIVE. DISCONNECT AND MAKE SAFE ALL ELECTRICAL EQUIPMENT IDENTIFIED FOR REMOVAL ON THE ELECTRICAL AND HVAC PLANS.
- THE LOCATIONS OF EXISTING EQUIPMENT INCLUDING PIPING, DUCTWORK, EQUIPMENT, CONDUITS, ETC ARE SHOWN IN AN APPROXIMATE WAY ONLY. VISIT THE SITE PRIOR TO SUBMISSION OF THE BIDS AND COMMENCEMENT OF WORK TO BECOME FAMILIAR WITH THE ACTUAL CONDITIONS AND EXTENT OF THE WORK.
- POWER OUTAGES CAUSED BY DEMOLITION THAT AFFECT OTHER AREAS SHALL BE HELD TO A MINIMUM. SHUTDOWNS SHALL BE COORDINATED WITH USERS AND THE OWNER, NIGHT, WEEKEND, AND/OR HOLIDAY TIME REQUIRED TO PERFORM ELECTRICAL DEMOLITION WORK OR NEW ELECTRICAL WORK SHALL BE CARRIED AS PART OF THE CONTRACT COST.
- CIRCUIT TRACE AND LABEL ALL EXISTING BRANCH CIRCUITS AND FEEDERS WITHIN THE AREA OF DEMOLITION SCOPE PRIOR TO DE-ENERGIZING AND DISCONNECTION. THERE SHALL BE NO INTERRUPTION OF SERVICES OUTSIDE THE DEMOLITION AREA WITHOUT APPROVAL FROM THE OWNER'S REPRESENTATIVE.
- DE-ENERGIZE AND REMOVE ALL CONDUCTORS AND RACEWAYS TO THEIR POINTS OF ORIGIN WITHIN THE AREA OF DEMOLITION SCOPE. ITEMS IDENTIFIED FOR DEMOLITION SHALL NOT BE ABANDONED IN PLACE. RACEWAYS THAT ENTER MASONRY WALLS AND FLOORS SHALL BE CUT FLUSH AT THE SURFACE FOR PATCHING BY OTHERS. ALL CIRCUIT BREAKERS ASSOCIATED WITH THE DEMOLITION SCOPE SHALL BE DE-ENERGIZED AND LABELED SPARE.
- PROMPTLY REPAIR ANY DAMAGE CAUSED DURING/BY THE EXECUTION OF WORK. DAMAGE INCLUDES BUT IS NOT LIMITED TO DESTRUCTION OF ITEMS INTENDED TO REMAIN OR TO BE SALVAGED.
- EXERCISE CARE WITH EQUIPMENT THAT IS TO BE RELOCATED OR TURNED OVER TO THE OWNER. EXAMINE THE EQUIPMENT BEFORE REMOVAL IN THE PRESENCE OF THE OWNER'S REPRESENTATIVE TO DETERMINE ITS CONDITION. DELIVER OWNER-RETAINED EQUIPMENT TO AN ON-SITE LOCATION DESIGNATED BY THE OWNER AND OBTAIN ACKNOWLEDGMENT OF RECEIPT IN ORIGINAL CONDITION.
- ALL ITEMS REMOVED SHALL BE OFFERED TO THE OWNER FOR SALVAGE. IF THE OWNER DOES NOT TAKE POSSESSION, DISPOSE OF THE ITEMS IN A SAFE AND LEGAL MANNER. ALL ITEMS CLASSIFIED AS HAZARDOUS SHALL BE DISPOSED AS HAZARDOUS WASTES AND A UNIFORM HAZARDOUS WASTE MANIFEST SHALL BE PROVIDED TO THE OWNER.
- ENSURE THE SAFE PASSAGE OF PERSONS IN AND AROUND THE BUILDING DURING DEMOLITION. PREVENT INJURY TO PERSONS AND DAMAGE TO PROPERTY. PROVIDE ADEQUATE SHORING AND BRACING TO PREVENT COLLAPSE. IMMEDIATELY REPAIR DAMAGED PROPERTY TO THE CONDITION BEFORE BEING DAMAGED. TAKE EFFECTIVE MEASURES TO PREVENT WINDBLOWN DUST.
- THE EXISTING FIRE ALARM SYSTEM SHALL REMAIN FULLY FUNCTIONAL DURING THE ENTIRE DEMOLITION AND CONSTRUCTION PERIOD. REUSE OF EXISTING FIRE ALARM SYSTEM RACEWAYS SHALL NOT BE ALLOWED. ALL REQUIRED SYSTEM SHUTDOWNS SHALL BE COORDINATED WITH AND APPROVED BY THE OWNER'S REPRESENTATIVE AND THE AUTHORITY HAVING JURISDICTION. DEMOLITION OF THE EXISTING SYSTEM SHALL NOT COMMENCE UNTIL THE NEW SYSTEM HAS BEEN COMPLETELY INSTALLED, TESTED AND APPROVED BY THE AUTHORITY HAVING JURISDICTION.
- CREATE AND SUBMIT IMPAIRMENT PLANS TO THE OWNER AND AHJ IF ANY PORTION OF THE EXISTING FIRE ALARM SYSTEM IS TAKEN OUT OF SERVICE DURING THE EXECUTION OF THE PROJECT.

WIRING DEVICE LEGEND

	DUPLEX RECEPTACLE, GROUNDING TYPE, RATED 20A, 125V
	"C" - INDICATES CIRCUIT NUMBER
	"GFI" - INDICATES INTEGRAL GROUND FAULT CIRCUIT INTERRUPTER
	"IG" - INDICATES ISOLATED GROUND TYPE
	"WP" - INDICATES WEATHERPROOF
	JUNCTION BOX
	PULL BOX

BRANCH CIRCUIT & FEEDER LEGEND

	BRANCH CIRCUIT OR FEEDER CONCEALED IN FINISHED AREAS
	BRANCH CIRCUIT OR FEEDER, CONCEALED IN OR UNDER FLOOR SLAB
	BRANCH CIRCUIT OR FEEDER TURNING UP TOWARDS OBSERVER
	BRANCH CIRCUIT OR FEEDER TURNING DOWN AWAY FROM OBSERVER
	CONDUIT STUBBED ABOVE CEILING
	BRANCH CIRCUIT HOME RUN TICKS INDICATE QUANTITY OF CONDUCTORS, GROUND CONDUCTORS ARE NOT INDICATED. NO TICKS INDICATES 2#12 & 1#120 IN 3/4" MINIMUM. R22A-1.3.3 INDICATES PANEL AND CIRCUIT DESIGNATION FROM WHICH HOMERUN SHALL ORIGINATE. EACH CIRCUIT SHALL BE 20A-1P (20AMP SINGLE POLE) UNLESS NOTED OTHERWISE.

POWER DISTRIBUTION

	208Y120 VOLT PANELBOARD, SURFACE MOUNTED REFER TO PANELBOARD SCHEDULE
	208Y120 VOLT PANELBOARD, RECESSED MOUNTED REFER TO PANELBOARD SCHEDULE
	UTILITY METER AND SOCKET

MOTOR & CONTROLS LEGEND

	MANUAL MOTOR STARTING SWITCH WITH THERMAL OVERLOAD PROTECTION
	MAGNETIC MOTOR STARTER, REFER TO MAGNETIC MOTOR STARTER & VFD SCHEDULE FOR TYPE, SIZE AND ENCLOSURE
	COMBINATION FUSED DISCONNECT MAGNETIC MOTOR STARTER. REFER TO MAGNETIC MOTOR STARTER AND VFD SCHEDULE FOR TYPE, SIZE AND ENCLOSURE
	VARIABLE SPEED DRIVE
	MOTOR, NUMERICAL INDICATES HORSEPOWER "H" - INDICATES HORSEPOWER RATING
	DISCONNECT SWITCH RATED 30AMP, 3-POLE, IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED "3P" - INDICATES NEMA TYPE 3R ENCLOSURE "2P" - INDICATES 2 POLE SINGLE PHASE DISCONNECT "60AP" - INDICATES 60AMP SWITCH FUSED DISCONNECT SWITCH 3-POLE, IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED. "3P" - INDICATES NEMA TYPE 3R ENCLOSURE "60AP" - INDICATES 60AMP SWITCH "50AP" - INDICATES 50AMP FUSES
	ENCLOSED CIRCUIT BREAKER IN NEMA TYPE 1 ENCLOSURE, UNLESS OTHERWISE NOTED "100AP" - INDICATES 100AMP, 3-POLE FRAME CIRCUIT BREAKER "90AT" - INDICATES 90AMP TRIP
	EQUIPMENT TAG, TOP ALPHANUMERIC CORRESPONDS TO EQUIPMENT ID REFER TO MECHANICAL SCHEDULE

EXISTING EQUIPMENT LEGEND

	EXISTING EQUIPMENT TO REMAIN
	EXISTING EQUIPMENT TO BE REMOVED
	EXISTING EQUIPMENT TO BE RELOCATED
	NEW LOCATION OF EXISTING RELOCATED EQUIPMENT
	EXISTING EQUIPMENT TO BE REMOVED AND NEW EQUIPMENT TO BE INSTALLED ON EXISTING BRANCH/FREEDER
	EXISTING EQUIPMENT FOR INFORMATION ONLY - INDICATED BY SYMBOL WITH LIGHT AND OUT OF FUNCTION LINE TYPE
	EXISTING EQUIPMENT TO BE REWORKED - INDICATED BY SYMBOL WITH DASHED AND IN FUNCTION LINE TYPE

LIGHTING FIXTURE LEGEND

	LIGHTING FIXTURE (SEE LIGHTING FIXTURE SCHEDULE)
	"RF" - INDICATES LIGHTING FIXTURE TYPE
	"Z" - INDICATES CIRCUIT NUMBER
	"S" - INDICATES SWITCH CONTROL
	LIGHTING FIXTURE WALL MOUNTED

SWITCH LEGEND

	SINGLE POLE SWITCH, RATED 20A, 120/277V
	"L" - LOWER CASE LETTER INDICATES FIXTURE SWITCH CONTROL
	SINGLE POLE SWITCH, WEATHERPROOF

ABBREVIATIONS

AMP	AMPERE	KWH	KILOWATT HOURS
AC	ALTERNATING CURRENT	LTG	LIGHTING
ADA	AMERICAN WITH DISABILITIES ACT	MCB	MAIN CIRCUIT BREAKER
AF	AMPERE FRAME	MEC	MASSACHUSETTS ELECTRICAL CODE
AFB	ABOVE FINISHED FLOOR	MG	MOTOR/GENERATOR SET
AFG	ABOVE FINISHED GRADE	MH	MANHOLE
AIC	AMPERE INTERRUPTING CAPACITY	MLO	MAIN LUGS ONLY
AL	ALUMINUM	MTD	MOUNTED
AT	AMPERE TRIP	MTG	MOUNTING
ATS	AUTOMATIC TRANSFER SWITCH	NC	NORMALLY CLOSED CONTACT
AWG	AMERICAN WIRE GAUGE	NEC	NATIONAL ELECTRICAL CODE
B	BURIED	NO	NORMALLY OPEN CONTACT
C	CONDUIT	NTS	NOT TO SCALE
CA	CABLE	#	NUMBER
CATV	CABLE TELEVISION	OPD	OVER CURRENT PROTECTION DEVICE
CCTV	CLOSED CIRCUIT TELEVISION SYSTEM	POS	PROVIDED UNDER OTHER SECTIONS
CB	CIRCUIT BREAKER	PVC	POLYVINYL CHLORIDE
CKT	CIRCUITS	PWR	POWER
CPU	CENTRAL PROCESSING UNIT	RGS	RIGID GALVANIZED STEEL
CL	CENTERLINE	RMS	ROOT MEAN SQUARE VALUE
dB	DECIBEL	RPM	REVOLUTIONS PER MINUTE
DC	DIRECT CURRENT	SPD	SURGE PROTECTIVE DEVICE
DWG	DRAWING	SN	SOLID NEUTRAL
EC	ELECTRICAL CONTRACTOR	SWBD	SWITCHBOARD
EMT	ELECTRIC METALLIC TUBING	TB	TERMINAL BLOCK
FDR	FEEDER	TEL	TELEPHONE
FLMT	FLEXIBLE LIQUID TIGHT METALLIC TUBING	TERMIN	TERMINAL
FREQ	FREQUENCY	TSP	TWISTED SHIELDED-PAIR
GEC	GROUNDING ELECTRODE CONDUCTOR	TVSB	TRANSIENT VOLTAGE SURGE SUPPRESSOR
GFI	GROUND FAULT INTERRUPTING	TYP	TYPICAL
GND	GROUND	UG	UNDERGROUND
HH	HANDHOLE	UNO	UNLESS NOTED OTHERWISE
HP	HORSEPOWER	UPS	UNINTERRUPTIBLE POWER SUPPLY
HVAC	HEATING, VENTILATING AND AIR CONDITIONING	UTP	UNSHIELDED TWISTED-PAIR
HZ	HERTZ	V	VOLTS
IG	ISOLATED GROUND	VA	VOLT-AMPERE
JB	JUNCTION BOX	VSD	VARIABLE SPEED DRIVE
KVA	KILOVOLT-AMPERE	W	WATTS
KW	KILOWATT	WP	WEATHERPROOF



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CITY OF WALTHAM

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SCALE: NO SCALE

DATE: 2024-01-31

REVISIONS:

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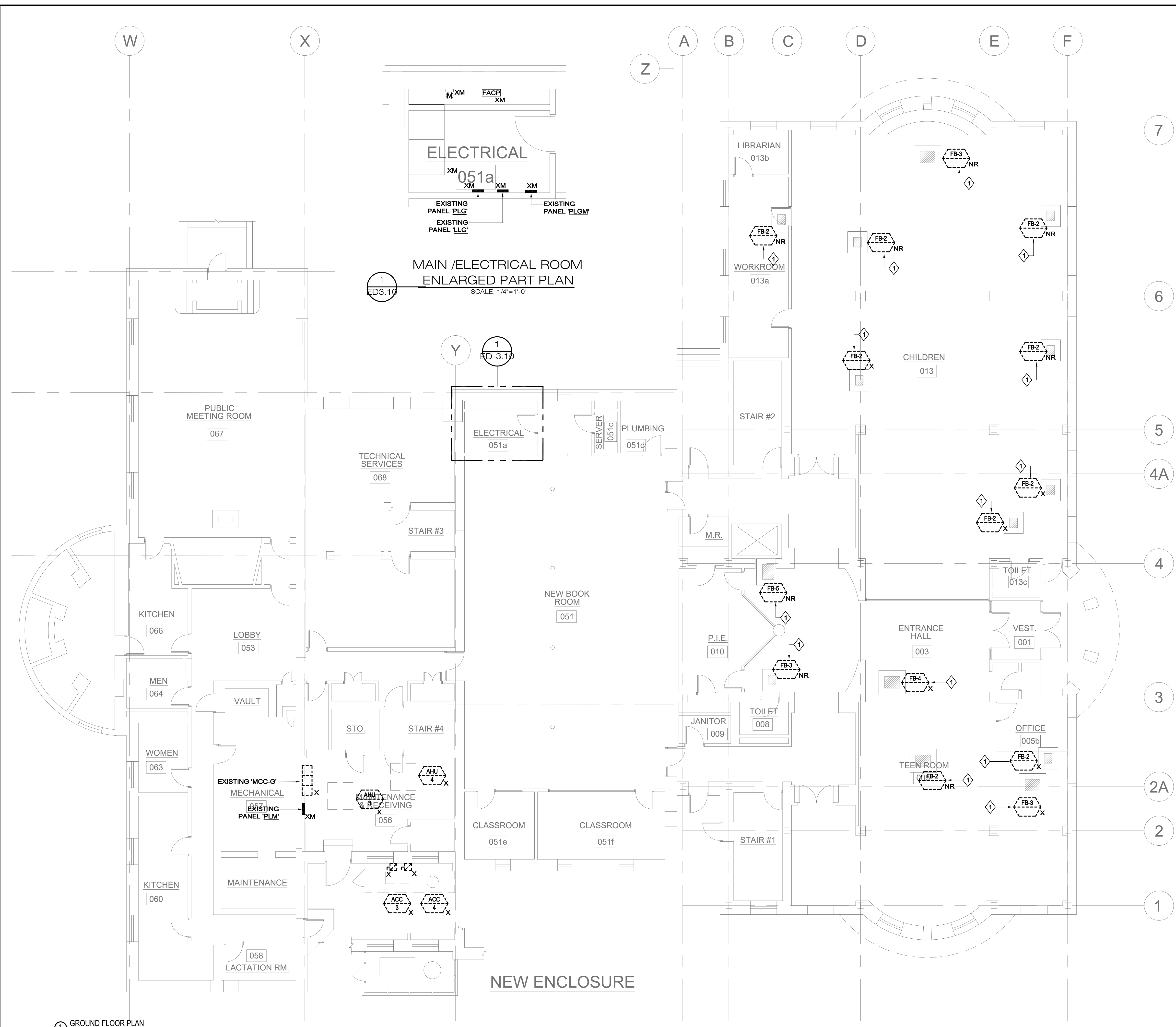
2023-12-22: DD PLUS

2024-01-31: CD'S

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ELECTRICAL LEGEND NOTES AND ABBREVIATIONS

W:\BLD3\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164 DD-2.1 ELECTRICAL POWER GROUND FLOOR DEMO PLAN.dwg [PAPER] January 31, 2024 - 10:09pm jshamh



NOTES:
 1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS, GENERAL NOTES AND DEMOLITION NOTES.

KEYNOTES	
	SCOPE OF WORK SHALL BE CARRIED UNDER ADD ALTERNATE #1

NOTES:
 1 REFER TO SPECIFICATIONS AND DETAILS FOR ADDITIONAL INFORMATION.

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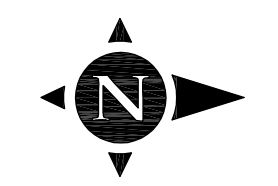
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2024-01-31: CD'S
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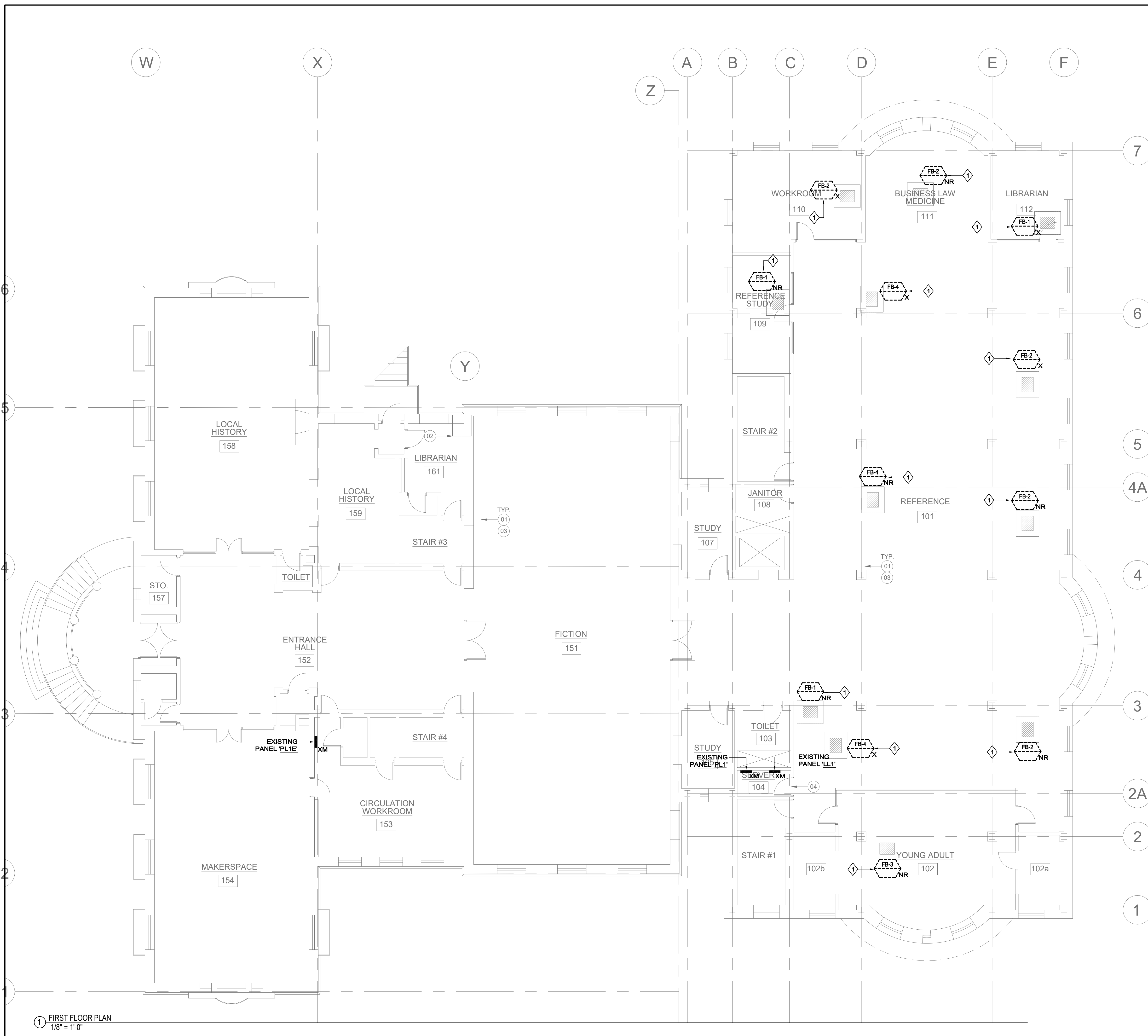
ELECTRICAL POWER GROUND FLOOR DEMO PLAN

1 GROUND FLOOR PLAN
1/8" = 1'-0"



ED-2.1

W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164-ED-2.2 ELECTRICAL POWER FIRST FLOOR DEMO PLAN.dwg [PAPER] January 31, 2024 - 10:08am joah.amh



NOTES:

1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS, GENERAL NOTES AND DEMOLITION NOTES.

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

DATE: 2024-01-31

REVISIONS:

2023-10-17: SD PLUS

2023-12-22: DD PLUS

2024-01-31: CD'S

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ELECTRICAL POWER FIRST FLOOR DEMO PLAN

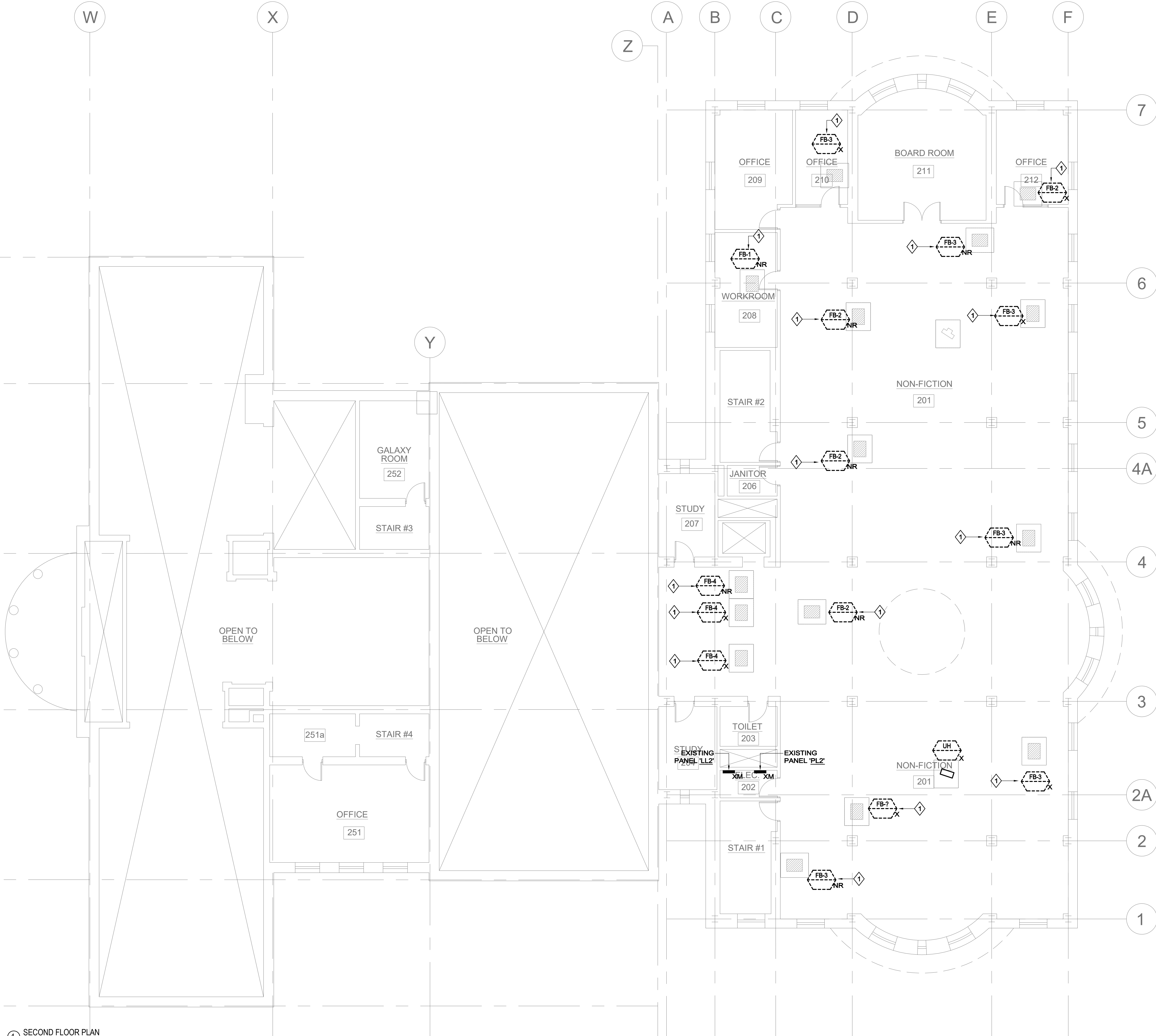
1 FIRST FLOOR PLAN
1/8" = 1'-0"



1/8" = 1'-0"
0 8' 16'

ED-2.2

W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164_DD-2.3 ELECTRICAL POWER SECOND FLOOR DEMO PLAN.dwg [PAPER] January 31, 2024 - 10:09pm jsh.smh



NOTES:
 1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS, GENERAL NOTES AND DEMOLITION NOTES.

KEYNOTES	
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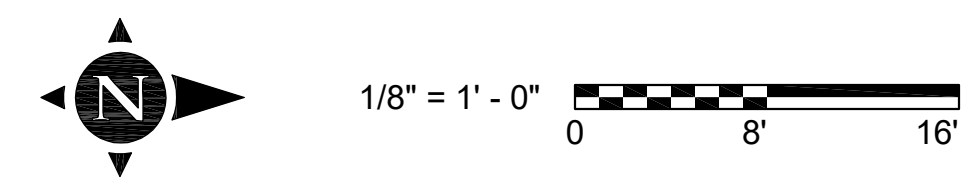
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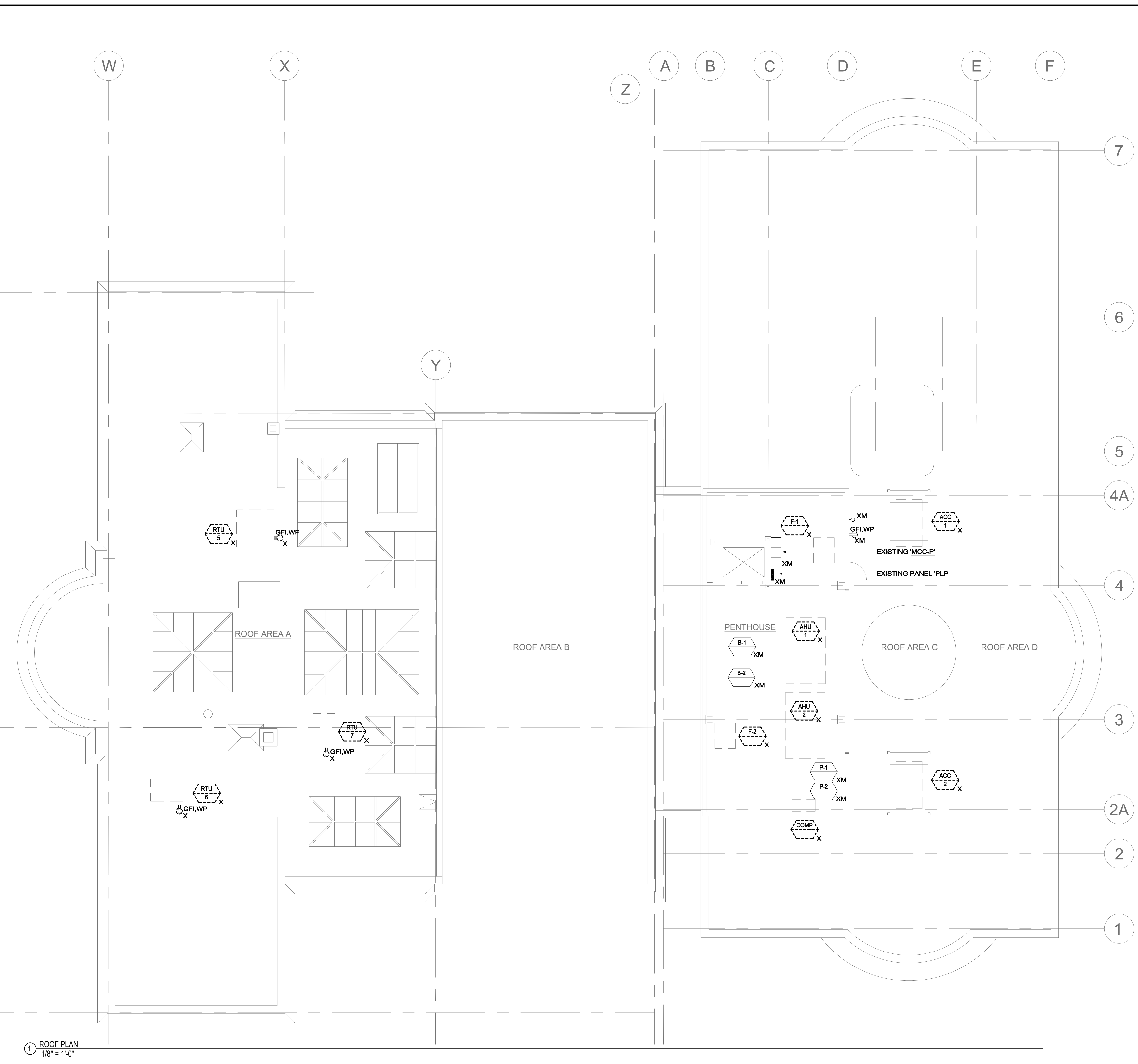
SCALE: 1/8" = 1'-0"
DATE: 2024-01-31
REVISIONS:
2023-10-17: SD PLUS
2023-12-22: DD PLUS
2024-01-31: CD'S
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ELECTRICAL POWER SECOND FLOOR DEMO PLAN

① SECOND FLOOR PLAN
1/8" = 1'-0"



W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164-ED-2.4 ELECTRICAL POWER ROOF DEMO PLAN.dwg [PAPER] January 31, 2024 - 10:00am jstamrnh



NOTES:
1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS, GENERAL NOTES AND DEMOLITION NOTES.



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

DATE: 2024-01-31

REVISIONS:

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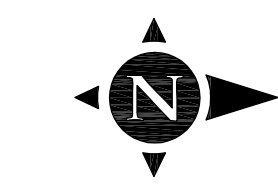
2023-12-22: DD PLUS

2024-01-31: CD'S

DRAWN BY: MVM

**ELECTRICAL
POWER
ROOF DEMO
PLAN**

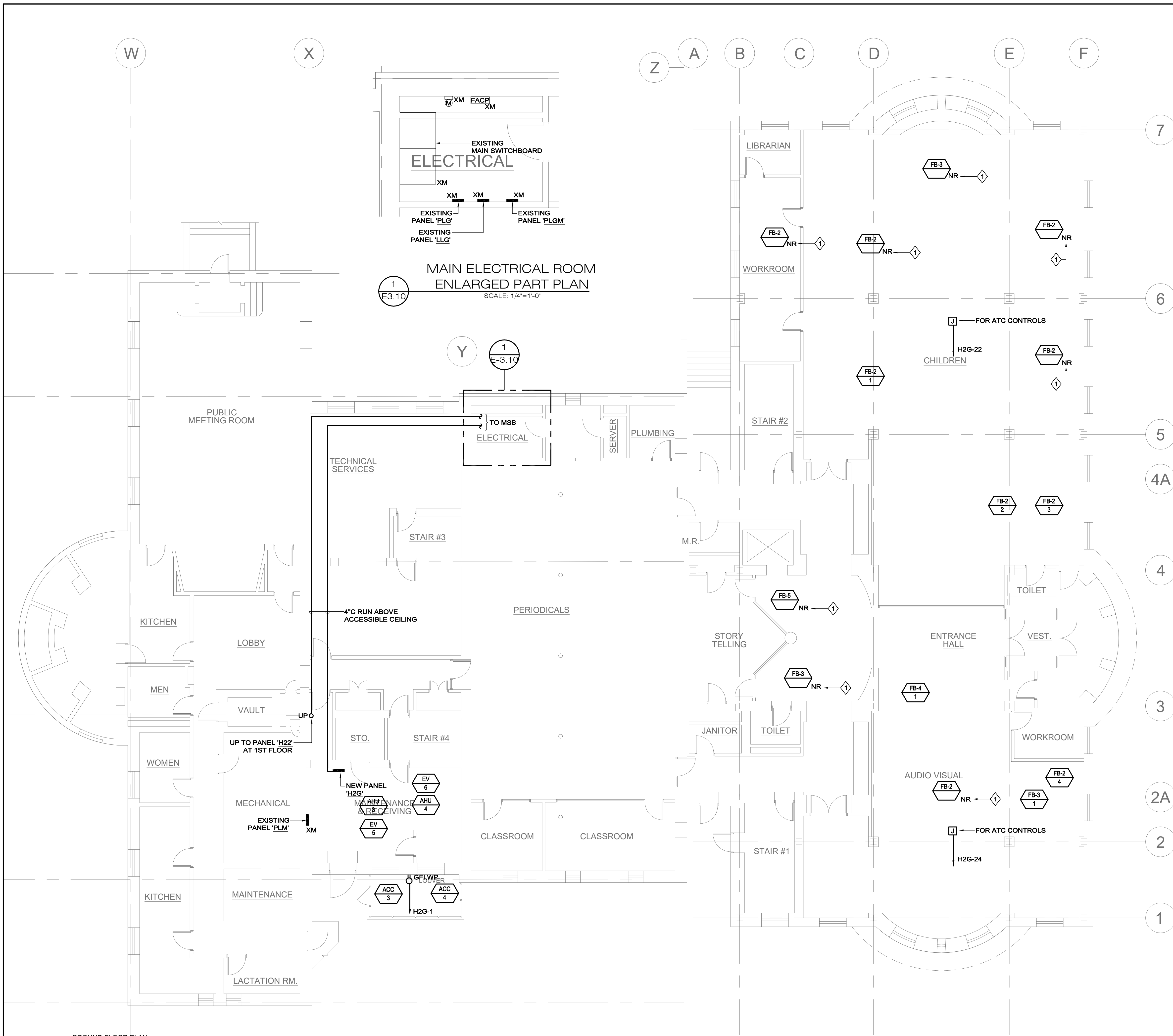
1 ROOF PLAN
1/8" = 1'-0"



1/8" = 1'-0"
0 8' 16'

ED-2.4

W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164 E-2.1 ELECTRICAL POWER GROUND FLOOR NEW WORK PLAN.dwg [paper] January 31, 2024 - 10:10pm joan.ambin



1
E3.10
MAIN ELECTRICAL ROOM
ENLARGED PART PLAN
SCALE: 1/4" = 1'-0"

POWER NOTES:

1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
2. REFER TO ARCHITECTURAL DRAWINGS FOR ASSOCIATED NOTES, MOUNTING DETAILS, HEIGHTS AND EXACT LOCATIONS OF ALL DEVICES.
3. CIRCUIT NUMBERS DENOTE CIRCUITING INTENT. EXACT NUMBER DESIGNATIONS SHALL BE DETERMINED IN THE FIELD AND REFLECTED ON THE AS BUILT DRAWINGS. INTERCONNECTING BRANCH WIRING SHALL BE SIZED EQUAL TO THE HOMERUN UNLESS NOTED OTHERWISE.
4. VOLTAGE DROP HAS BEEN CONSIDERED IN THE DESIGN OF ALL BRANCH CIRCUITRY AND FEEDER SIZES BASED ON EQUIPMENT LAYOUTS AND SHORTEST CONDUCTOR/RACEWAY ROUTING. THE ELECTRICAL CONTRACTOR SHALL BE RESPONSIBLE FOR DEVIATIONS TAKEN THAT WILL INCREASE CONDUCTOR/RACEWAY LENGTHS. BRANCH CIRCUITS LONGER THAN 75' FOR 120V FROM PANEL TO LAST OUTLET SHALL BE INCREASED A MINIMUM OF ONE SIZE ABOVE THAT SPECIFIED TO LIMIT VOLTAGE DROP TO LESS THAN 3%. FEEDERS SHALL FOLLOW SIMILAR GUIDELINES AND BE LIMITED TO A 2% DROP.
5. POWER BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT FROM THE PANEL TO THE FIRST DEVICE AND/OR WHERE EXPOSED. POWER BRANCH CIRCUITRY MAY BE TYPE MC CABLE WHERE CONCEALED ABOVE SUSPENDED CEILINGS AND IN METAL STUD WALLS.
6. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING POWER DEVICES TO REMAIN.
7. PANELBOARDS AND DISCONNECT SWITCHES SHALL BE FIELD MARKED TO WARN QUALIFIED PERSONS OF POTENTIAL ELECTRIC ARC FLASH HAZARDS. THE MARKING SHALL BE LOCATED SO AS TO BE CLEARLY VISIBLE TO QUALIFIED PERSONS BEFORE EXAMINATION, ADJUSTMENT, SERVICING, OR MAINTENANCE OF THE EQUIPMENT.

KEYNOTES

①	PROVIDE NEW 30AS/15AF DISCONNECT SWITCH AND RECONNECT/EXTEND RELATED BRANCH CIRCUIT WIRING TO NEW UNIT AS REQUIRED. SCOPE OF WORK SHALL BE CARRIED UNDER ADD ALTERNATE #1
②	REFER TO MECHANICAL EQUIPMENT SCHEDULE ON DRAWING E-9.00. SCOPE OF WORK SHALL BE CARRIED UNDER ADD ALTERNATE #1

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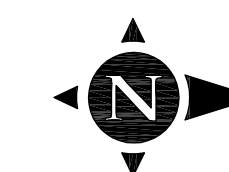
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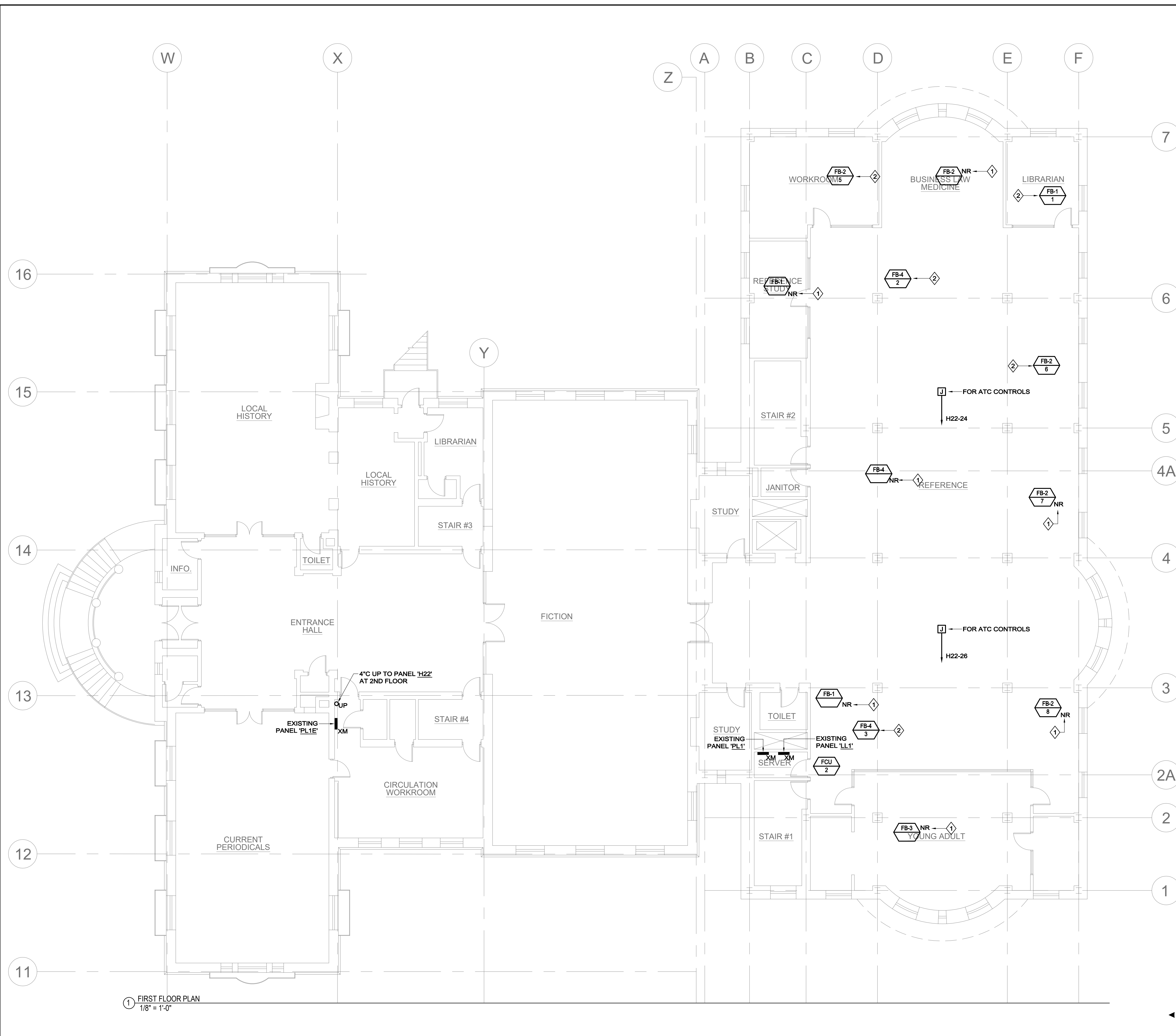
**ELECTRICAL
POWER
GROUND FLOOR
NEW WORK PLAN**

① GROUND FLOOR PLAN
1/8" = 1'-0"



1/8" = 1'-0"
0 8' 16'

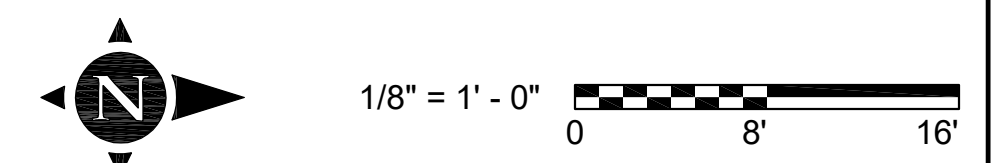
W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164 E-2.2 ELECTRICAL POWER FIRST FLOOR NEW WORK PLAN.dwg [PAPER] January 31, 2024 - 10:10pm josh.amlin



① FIRST FLOOR PLAN
1/8" = 1'-0"

- POWER NOTES:**
- REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
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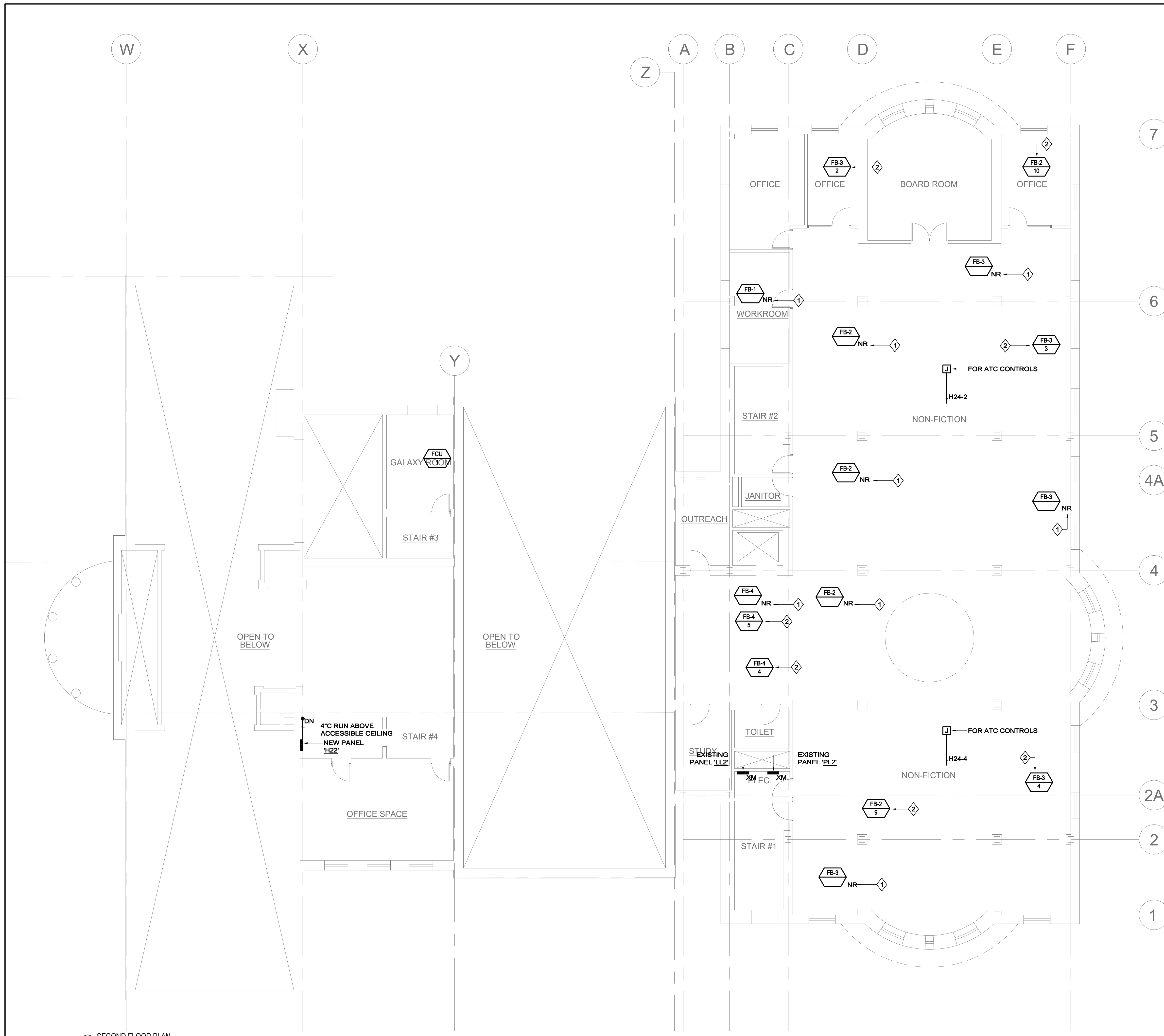
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**ELECTRICAL
POWER
FIRST FLOOR
NEW WORK PLAN**

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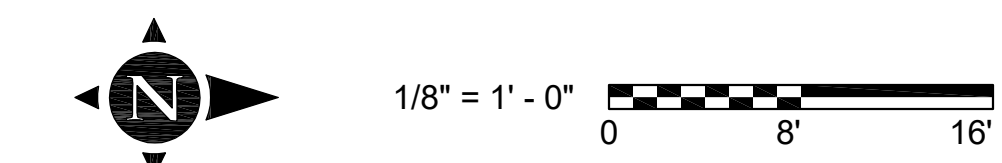


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1 SECOND FLOOR PLAN
1/8" = 1'-0"



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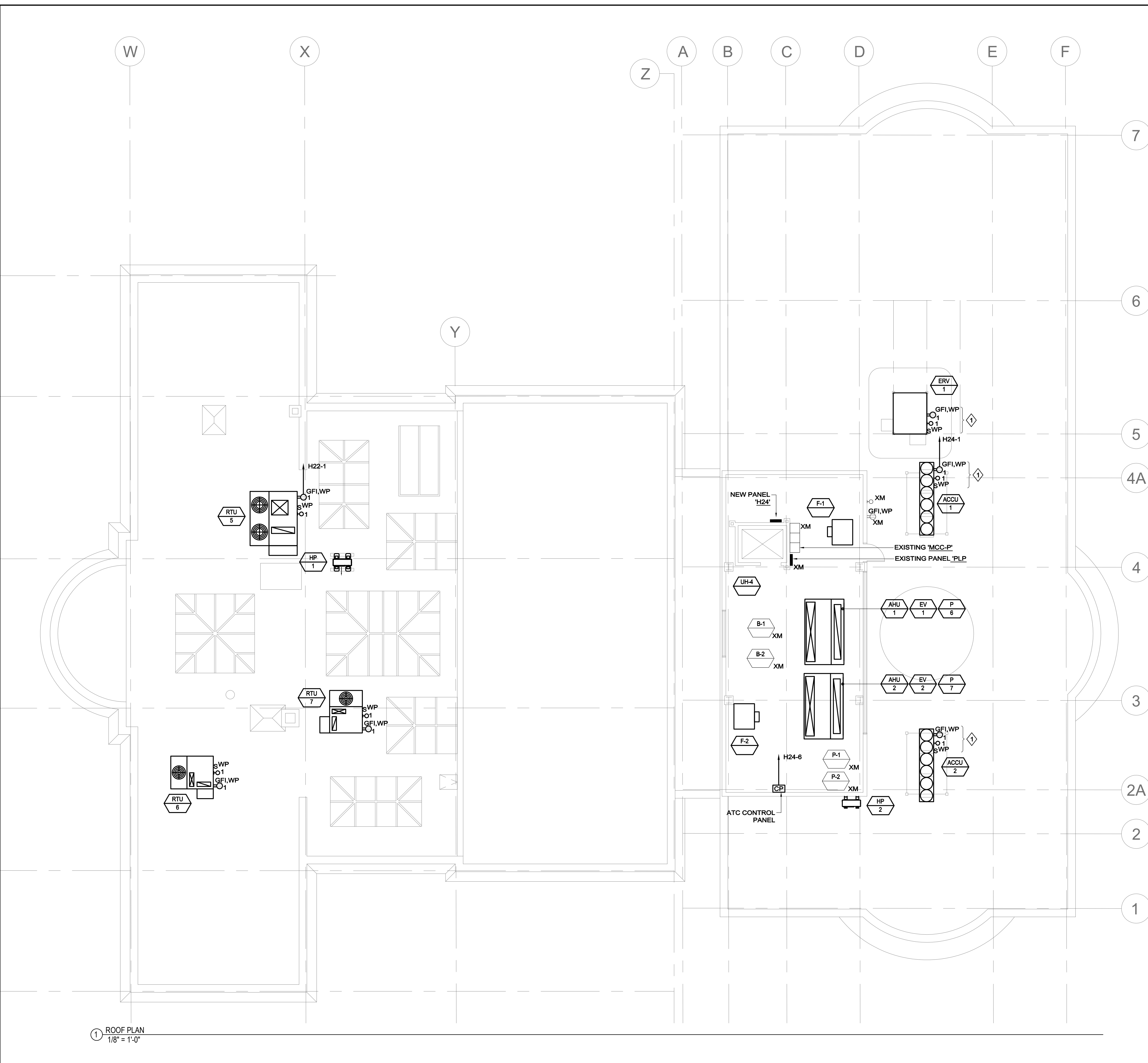
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**ELECTRICAL
POWER
SECOND FLOOR
NEW WORK PLAN**

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KEYNOTES	
1	SEE DETAIL E203 ON DRAWING E-8.0 FOR ADDITIONAL INFORMATION.
NOTES:	
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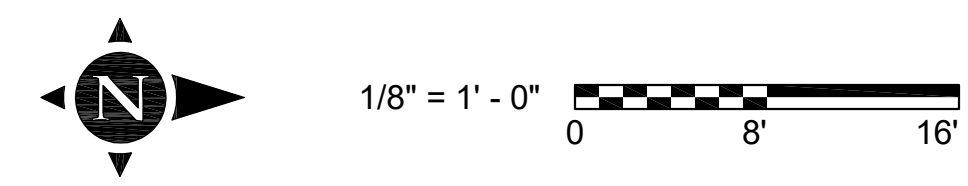
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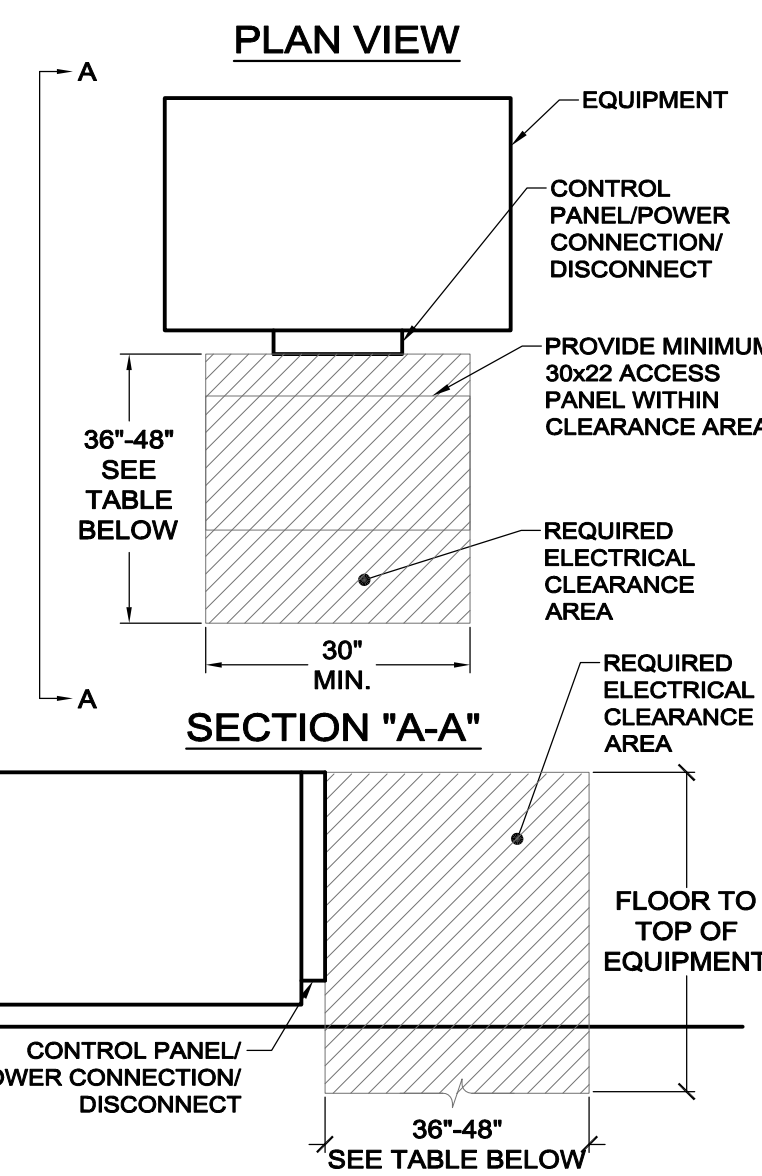
**ELECTRICAL
 POWER
 ROOF NEW
 WORK PLAN**

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



NOTES:

1. DETAIL APPLIES TO ALL MECHANICAL EQUIPMENT LOCATED ABOVE A CEILING THAT REQUIRES POWER, INCLUDING CONTROL POWER. EQUIPMENT INCLUDES, BUT IS NOT LIMITED TO, FAN POWERED BOXES, VAV BOXES, FANS, FAN COIL UNITS, HEAT PUMPS, CRAC UNITS, DX SPLIT SYSTEMS, DUCT HEATERS, ETC.
2. ELECTRICAL CLEARANCE AREA (INCLUDING WITHIN CEILING) MUST BE FREE FROM LIGHTS, SPRINKLER HEADS, FIRE ALARM DEVICES, SPEAKERS, PIPING, DUCTWORK, BEAMS AND OTHER OBSTRUCTIONS.
3. THE HEIGHT OF THE ELECTRICAL CLEARANCE SHALL BE AS REQUIRED TO INSTALL AND PERFORM MAINTENANCE ON THE EQUIPMENT. MINIMUM HEIGHT SHALL BE FROM FLOOR TO TOP OF EQUIPMENT.
4. REFER TO SPECIFIC MANUFACTURER PRODUCT DATA FOR ADDITIONAL ACCESS AND CLEARANCE REQUIREMENTS FOR FANS, COMPRESSORS, VALVES, DAMPERS, FILTERS, ETC. PROVIDE ACCESS PANELS AS REQUIRED.
5. COORDINATE WITH ALL TRADES TO PROVIDE THESE MINIMUM REQUIRED CLEARANCES.



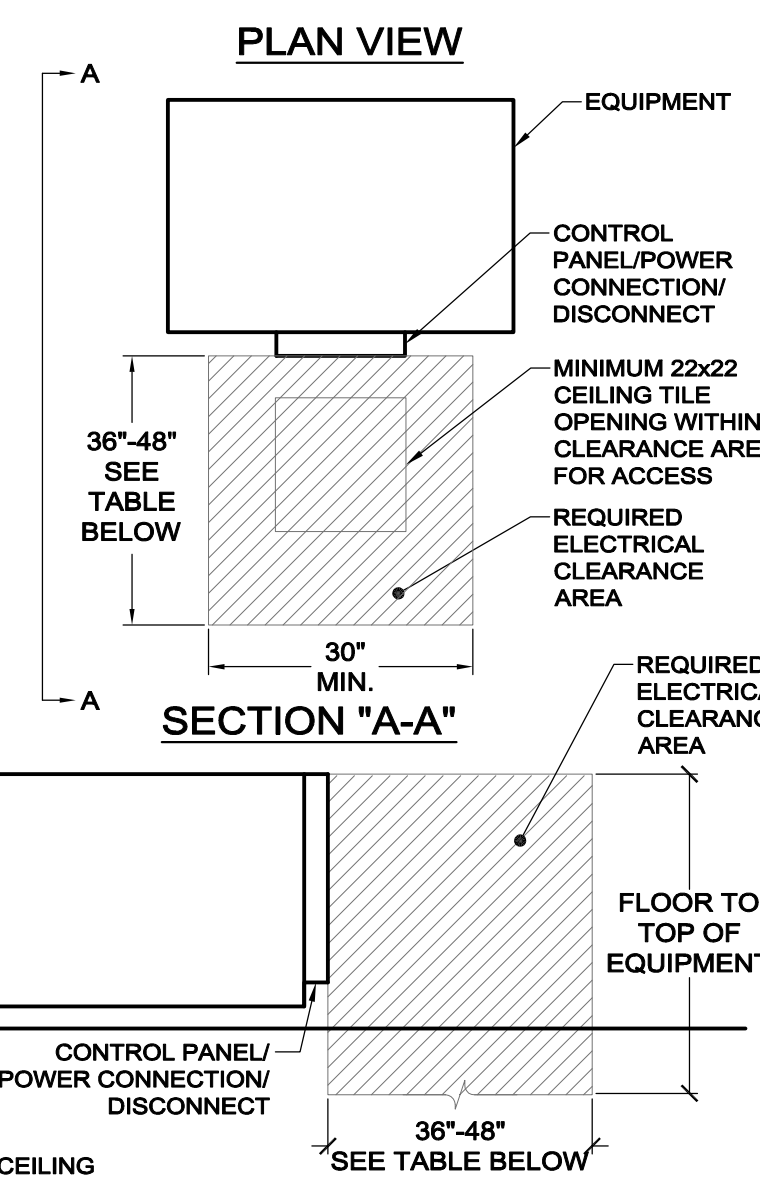
MINIMUM ELECTRICAL CLEARANCES (NEC 2017 COMPLIANCE)			
VOLTAGE TO GROUND (SINGLE PHASE VOLTAGE)	CONDITION 1	CONDITION 2	CONDITION 3
0-150	36"	36"	36"
151-600	36"	42"	48"

CONDITION 1 - EXPOSED LIVE PARTS ON ONE SIDE OF THE WORKING SPACE AND NO LIVE OR GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE, OR EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORKING SPACE THAT ARE EFFECTIVELY GUARDED BY INSULATING MATERIALS.
 CONDITION 2 - EXPOSED LIVE PARTS ON ONE SIDE OF THE WORKING SPACE AND GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE. CONCRETE, BRICK, OR TILE WALLS SHALL BE CONSIDERED AS GROUNDED.
 CONDITION 3 - EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORKING SPACE
 NOTE: CLEARANCE WIDTH SHALL BE 30" OR THE WIDTH OF THE CONTROL PANEL/POWER CONNECTION, WHICHEVER IS GREATER

NV5 ELECTRICAL CLEARANCE MECHANICAL EQUIPMENT GWB CEILING E215

NOTES:

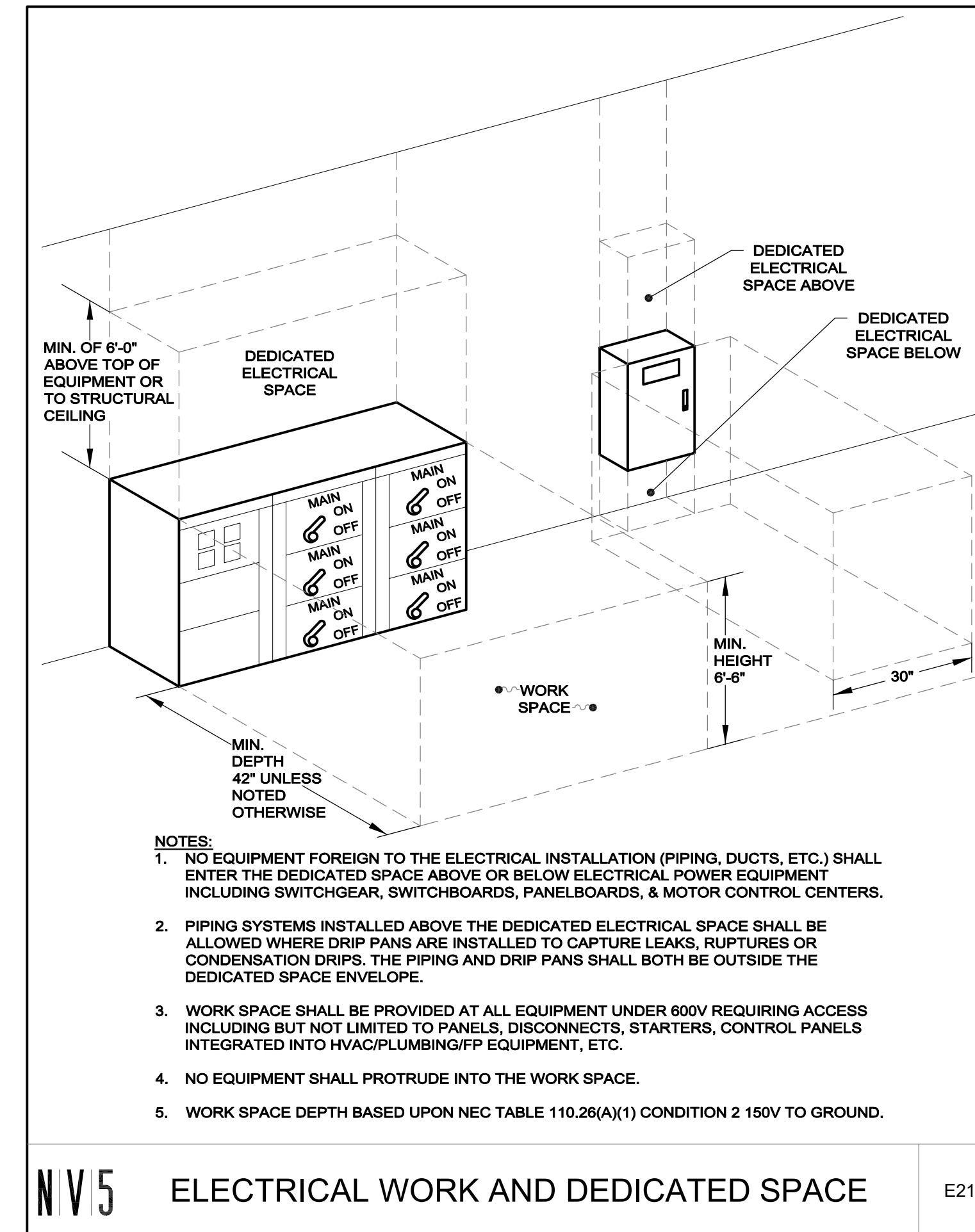
1. DETAIL APPLIES TO ALL MECHANICAL EQUIPMENT LOCATED ABOVE A CEILING THAT REQUIRES POWER, INCLUDING CONTROL POWER. EQUIPMENT INCLUDES, BUT IS NOT LIMITED TO, FAN POWERED BOXES, VAV BOXES, FANS, FAN COIL UNITS, HEAT PUMPS, CRAC UNITS, DX SPLIT SYSTEMS, DUCT HEATERS, ETC.
2. ELECTRICAL CLEARANCE AREA (INCLUDING WITHIN CEILING) MUST BE FREE FROM LIGHTS, SPRINKLER HEADS, FIRE ALARM DEVICES, SPEAKERS, PIPING, DUCTWORK, BEAMS AND OTHER OBSTRUCTIONS.
3. THE HEIGHT OF THE ELECTRICAL CLEARANCE SHALL BE AS REQUIRED TO INSTALL AND PERFORM MAINTENANCE ON THE EQUIPMENT. MINIMUM HEIGHT SHALL BE FROM FLOOR TO TOP OF EQUIPMENT.
4. REFER TO SPECIFIC MANUFACTURER PRODUCT DATA FOR ADDITIONAL ACCESS AND CLEARANCE REQUIREMENTS FOR FANS, COMPRESSORS, VALVES, DAMPERS, FILTERS, ETC. COORDINATE CEILING MOUNTED DEVICE LOCATIONS AS REQUIRED
5. COORDINATE WITH ALL TRADES TO PROVIDE THESE MINIMUM REQUIRED CLEARANCES.



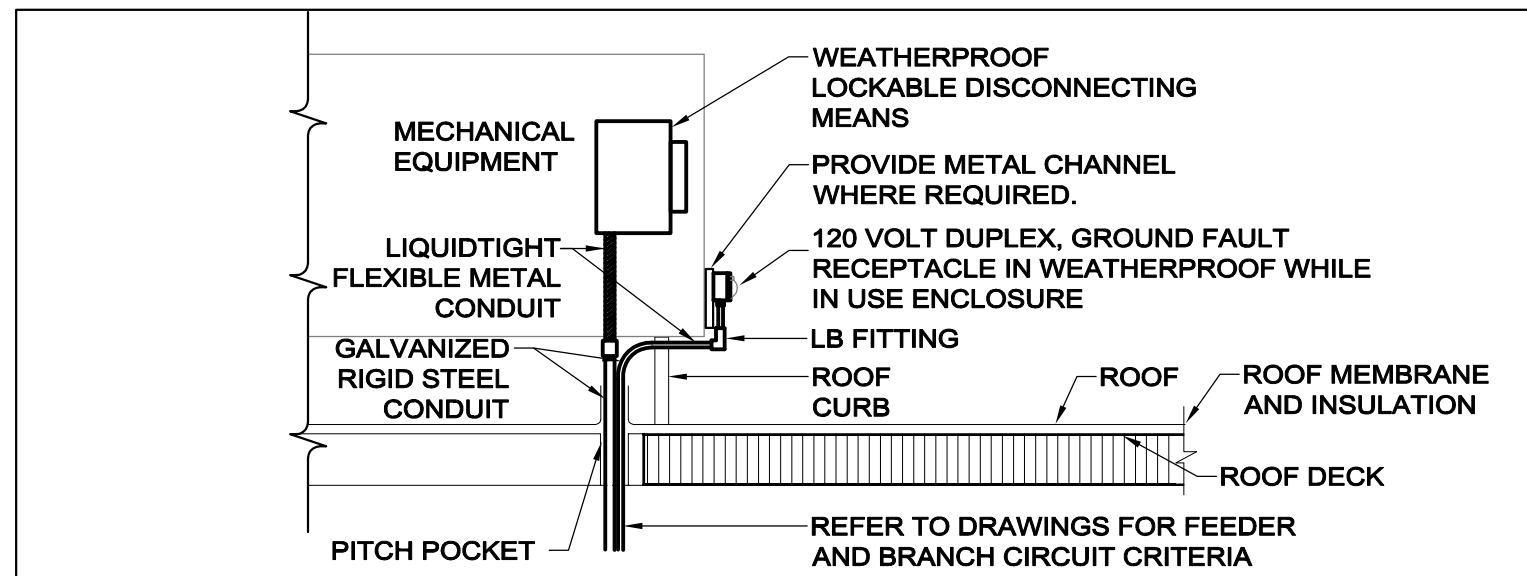
MINIMUM ELECTRICAL CLEARANCES (NEC 2017 COMPLIANCE)			
VOLTAGE TO GROUND (SINGLE PHASE VOLTAGE)	CONDITION 1	CONDITION 2	CONDITION 3
0-150	36"	36"	36"
151-600	36"	42"	48"

CONDITION 1 - EXPOSED LIVE PARTS ON ONE SIDE OF THE WORKING SPACE AND NO LIVE OR GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE, OR EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORKING SPACE THAT ARE EFFECTIVELY GUARDED BY INSULATING MATERIALS.
 CONDITION 2 - EXPOSED LIVE PARTS ON ONE SIDE OF THE WORKING SPACE AND GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE. CONCRETE, BRICK, OR TILE WALLS SHALL BE CONSIDERED AS GROUNDED.
 CONDITION 3 - EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORKING SPACE
 NOTE: CLEARANCE WIDTH SHALL BE 30" OR THE WIDTH OF THE CONTROL PANEL/POWER CONNECTION, WHICHEVER IS GREATER

NV5 ELECTRICAL CLEARANCE MECHANICAL EQUIPMENT ATC CEILING E216

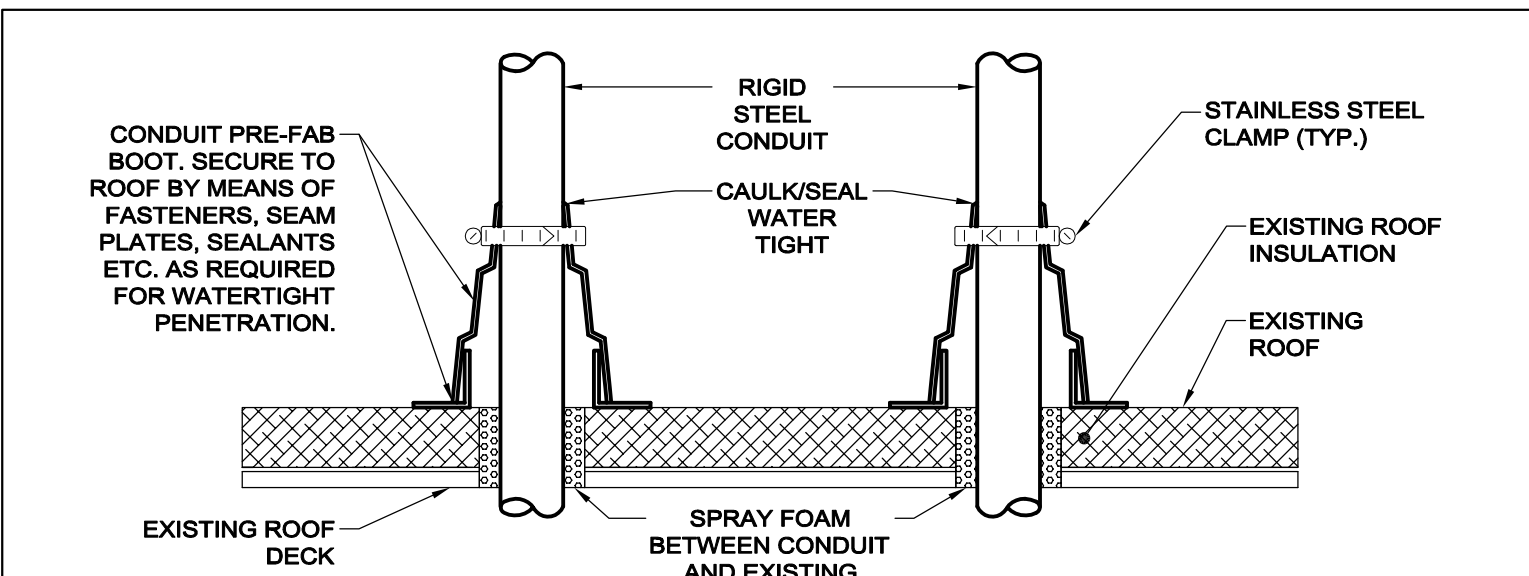


NV5 ELECTRICAL WORK AND DEDICATED SPACE E213



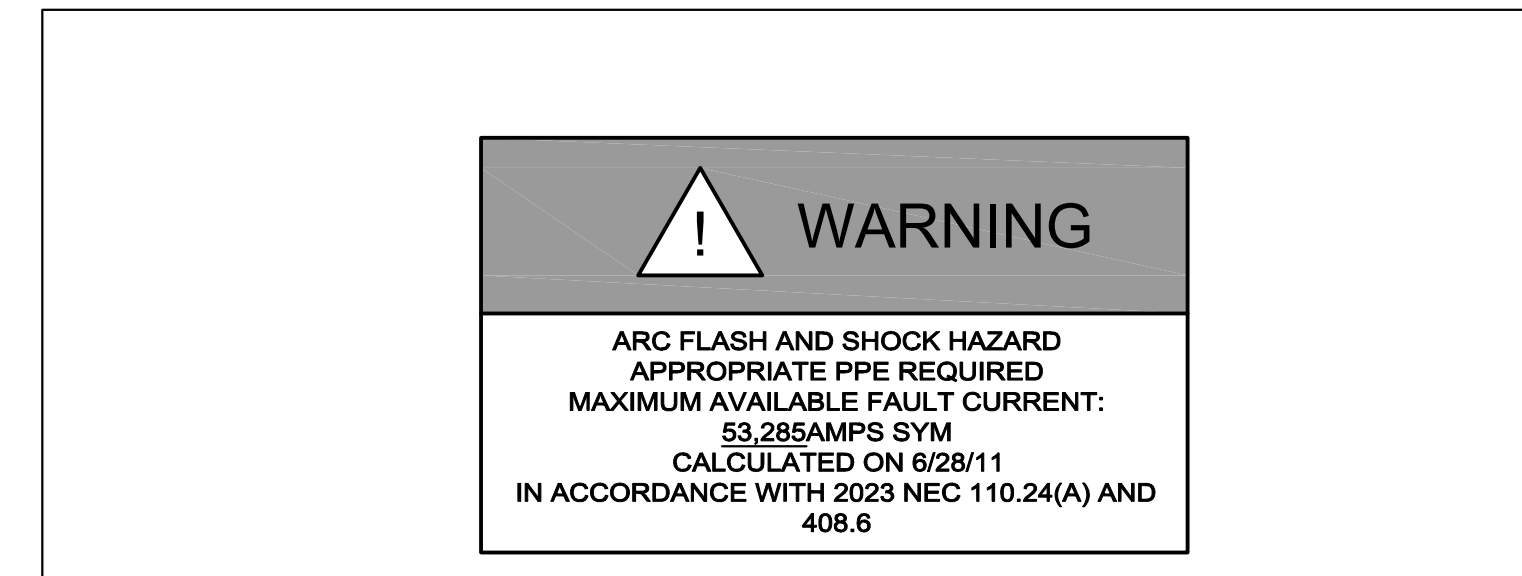
- NOTES:**
1. LOCATION OF RECEPTACLE AND DISCONNECT SWITCH IS REPRESENTATIVE AND SHALL BE INSTALLED PER MECHANICAL EQUIPMENT MANUFACTURER'S RECOMMENDATIONS.
 2. MAINTAIN WORK SPACE IN ACCORDANCE WITH NEC 110.26.
 3. REFER TO POWER PLAN FOR EXACT RACEWAY AND MOUNTING MATERIAL REQUIREMENTS.

NV5 ROOF TOP MECHANICAL EQUIPMENT RECEPTACLE DETAIL E203



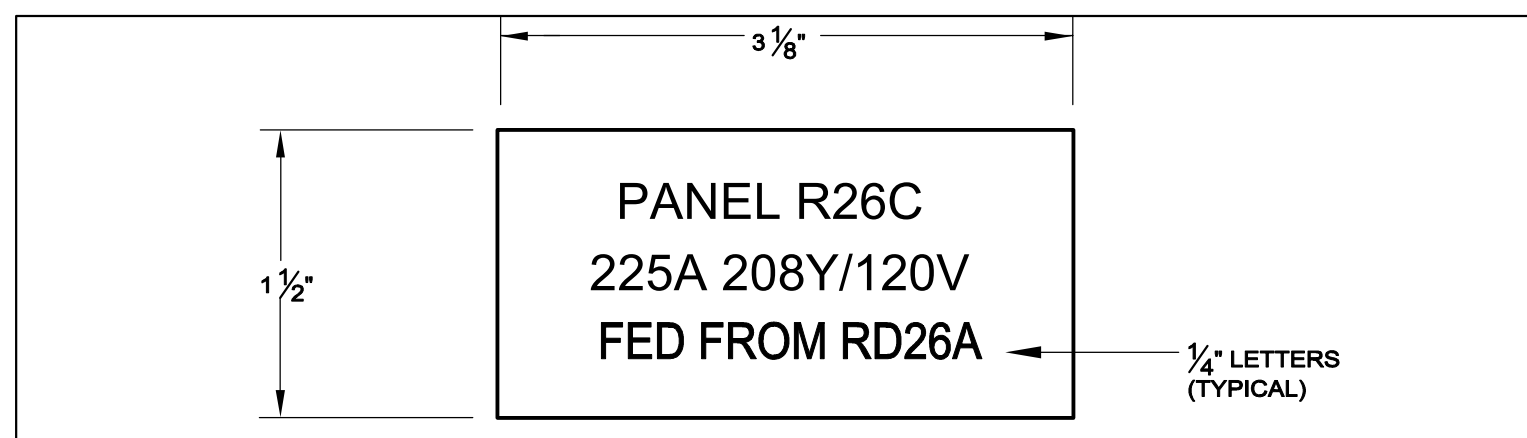
- NOTES:**
1. ROOFING MODIFICATIONS/PENETRATIONS SHALL BE IN ACCORDANCE WITH THE ROOFING MANUFACTURER'S SPECIFICATIONS AND DETAILS TO MAINTAIN THE ROOFING SYSTEM WARRANTY. COORDINATE ALL ROOFING WORK WITH THE OWNER AND/OR ASSOCIATED CONTRACTOR.
 2. WHERE POSSIBLE UTILIZE EXISTING ROOF PENETRATIONS.

NV5 CONDUIT THRU ROOF DECK E210R



- NOTES:**
1. REFER TO SPECIFICATIONS FOR ADDITIONAL NAMEPLATE REQUIREMENTS.
 2. PROVIDE ON THE MDP, SWITCHBOARD, SWITCHGEAR, AND PANELBOARDS.

NV5 FLASH PROTECTION WARNING LABEL WITH AVAILABLE FAULT VALUE E305B



- NOTES:**
1. REFER TO SPECIFICATIONS FOR ADDITIONAL NAMEPLATE REQUIREMENTS.
 2. NAMEPLATE TO BE 1/16" THICK PLASTIC WITH BLACK CENTER LAMINATION. FACE SHALL BE WHITE, ENGRAVED LETTERS SHALL BE BLACK.
 3. SECURE NAMEPLATE TO SURFACES WITH HIGH STRENGTH ADHESIVE CEMENT. UTILIZE MECHANICAL FASTENERS FOR ALL EXTERIOR LOCATIONS.
 4. TYPICAL FOR MOUNTING ON "SWITCHBOARDS", "PANELBOARDS", "STARTERS", "DISCONNECTS", AND "TRANSFORMERS".

NV5 TYPICAL ENGRAVED PLASTIC NAMEPLATE DETAIL E303

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Waltham, MA 02452

HVAC Replacement at:
WALTHAM PUBLIC LIBRARY
735 Main Street
Waltham, MA 02451

SCALE: NO SCALE
DATE: 2024-01-31
REVISIONS:
2023-10-17: SD PLUS
2023-12-22: DD PLUS
2024-01-31: CD'S
DRAWN BY: MVM

ELECTRICAL DETAILS

MECHANICAL EQUIPMENT SCHEDULE																														
LOAD TAG	STARTER LOCATION	LOAD					STARTER											POWER SOURCE		CONNECTION						BRANCH CIRCUIT	REMARKS			
		HP	FLA	KVA	VOLT	PH	NEMA SIZE	TYPE	OVERCURRENT			PB	HOA	INDICATING LIGHTS			AUXILIARY		PANEL	C/B	FLEX	JB	REC	DISC						
									CB	RK1 FUSE	MCP			R	G	A	CPT	NO						NC	AS			AF	NEMA	
AHU-1	NOTE 8		43	15.6	208	3													H24-9	70A/3P	X				100	70	1	3#4+#8G-1 1/2"C	NOTE 11	
AHU-2	NOTE 8		43	15.6	208	3													H24-15	70A/3P	X				100	70	1	3#4+#8G-1 1/2"C	NOTE 11	
AHU-3	NOTE 8		4.8	1.7	208	3													H2G-3	15A/3P					30	15	1	3#12+#12G-3/4"C	NOTE 11	
AHU-4	NOTE 8		7.5	2.7	208	1													H2G-9	15A/2P					30	15	1	2#12+#12G-3/4"C	NOTE 11	
ACC-1	NOTE 8		29	10.4	208	3													MSB	250A/3P	X				60	60	3R	3#6+#10G-3/4"C	NOTE 11,13	
	NOTE 8		44	15.8	208	3												X								60	60	3R	3#6+#10G-3/4"C	NOTE 11,13
ACC-2	NOTE 8		44	15.8	208	3													MSB	250A/3P	X				60	60	3R	3#6+#10G-3/4"C	NOTE 11,13	
	NOTE 8		29	10.4	208	3												X								60	60	3R	3#6+#10G-3/4"C	NOTE 11,13
ACC-3	NOTE 8		44	15.8	208	3													H2G-15	60A/3P	X				60	60	3R	3#6+#10G-3/4"C	NOTE 11,13	
	NOTE 8		29	10.4	208	3												X								60	60	3R	3#6+#10G-3/4"C	NOTE 11
ACC-4	NOTE 8		23	8.4	208	3													H2G-21	35A/3P	X				60	35	3R	3#8+#10G-3/4"C	NOTE 11	
F-1	AT UNIT	7.5	24.2	8.7	208	3													H24-21	60A/3P	X				60	60	1	3#8+#10G-3/4"C	NOTE 11	
F-2	AT UNIT	7.5	24.2	8.7	208	3													H24-27	60A/3P	X				60	60	1	3#8+#10G-3/4"C	NOTE 11	
EF-7	AT UNIT	3/4	7.6	1.6	208	1	00												H2G-2	15A/2P	X				30	15	3R	2#12+#12G-3/4"C		
FB-1.1	NOTE 8		9.8	1.2	120	1													H22-16	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.1	NOTE 8		9.8	1.2	120	1													H2G-10	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.2	NOTE 8		9.8	1.2	120	1													H2G-12	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.3	NOTE 8		9.8	1.2	120	1													H2G-14	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.4	NOTE 8		9.8	1.2	120	1													H2G-16	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.5	NOTE 8		9.8	1.2	120	1													H22-8	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.6	NOTE 8		9.8	1.2	120	1													H22-10	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.7	NOTE 8		9.8	1.2	120	1													H22-12	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.8	NOTE 8		9.8	1.2	120	1													H22-14	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.9	NOTE 8		9.8	1.2	120	1													H24-26	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-2.10	NOTE 8		9.8	1.2	120	1													H24-28	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-3.1	NOTE 8		9.8	1.2	120	1													H2G-18	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-3.2	NOTE 8		9.8	1.2	120	1													H24-30	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-3.3	NOTE 8		9.8	1.2	120	1													H24-32	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-3.4	NOTE 8		9.8	1.2	120	1													H24-34	15A/1P	X				30	15	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-4.1	NOTE 8		9.8	1.2	120	1													H2G-20	20A/1P	X				30	20	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-4.2	NOTE 8		16	1.8	120	1													H22-18	20A/1P	X				30	20	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-4.3	NOTE 8		16	1.8	120	1													H22-20	20A/1P	X				30	20	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-4.4	NOTE 8		16	1.8	120	1													H24-38	20A/1P	X				30	20	1	2#10+#10G-3/4"C	NOTE 11,12	
FB-4.5	NOTE 8		16	1.8	120	1													H24-40	20A/1P	X				30	20	1	2#10+#10G-3/4"C	NOTE 11,12	
ERV-1	NOTE 8		24	8.6	208	3													H24-3	45A/3P	X				60	45	3R	3#6+#10G-3/4"C	NOTE 11	
EV-1			1	0.12	208	1													H24-16	15A/2P	X	X						2#12+#12G-3/4"C		
EV-2			1	0.12	208	1															X	X								2#12+#12G-3/4"C
EV-3			1	0.12	208	1													H24-20	15A/2P	X	X						2#12+#12G-3/4"C		
EV-4			1	0.12	208	1															X	X								2#12+#12G-3/4"C
EV-5			1	0.12	208	1													H2G-6	15A/2P	X	X						2#12+#12G-3/4"C		
EV-6			1	0.12	208	1															X	X								2#12+#12G-3/4"C
FCU-1	NOTE 8		1	0.2	208	1													H22-2	15A/2P	X				30	15	1	2#12+#12G-3/4"C		
HP-1	NOTE 8		6.9	1.4	208	1															X					3	15	3R	2#12+#12G-3/4"C	NOTE 14
FCU-2	NOTE 8		1	0.2	208	1													H24-10	15A/2P	X				30	15	1	2#12+#12G-3/4"C		
HP-2	NOTE 8		6.9	1.4	208	1															X					3	15	3R	2#12+#12G-3/4"C	NOTE 14
P-6	AT UNIT	3/8	4.4	0.52	120	1													H24-24	15A/1P	X						MMS	1	2#12+#12G-3/4"C	
P-7	AT UNIT	3/8	4.4	0.52	120	1															X								MMS	1
RTU-5	NOTE 8		142.4	51.3	208	3													H22-3	200A/3P	X				200	200	3R	4#3/0+#6G-2"C	NOTE 11	
RTU-6	NOTE 8		68	24.5	208	3													H22-9	90A/3P	X				100	90	3R	3#2+#8G-1 1/2"C	NOTE 11	
RTU-7	NOTE 8		55	19.8	208	3													H22-15	70A/3P	X				100	70	3R	3#4+#8G-1 1/2"C	NOTE 11	
UH-1	NOTE 8	1/20	1	0.12	120	1													H22-22	20A/1P	X				30	15	1	2#12+#12G-3/4"C	NOTE 11	
UH-2	NOTE 8	1/20	1	0.12	120	1															X					30	15	1	2#12+#12G-3/4"C	NOTE 11
UH-3	NOTE 8	1/20	1	0.12	120	1													H24-16	15A/1P	X				30	15	1	2#12+#12G-3/4"C	NOTE 11	
UH-4	NOTE 8	1/2	2	0.24	120	1															X					30	15	1	2#12+#12G-3/4"C	NOTE 11

NOTES:

- NOTES 2-6 APPLY TO ALL APPLICABLE LOADS.
- PROVIDE THERMAL OVERLOAD UNITS FOR ALL STARTERS SIZED TO MATCH LOAD NAMEPLATE AND NEC REQUIREMENTS.
- BRANCH CIRCUIT WIRING METHODS SHALL BE AS NOTED ON THE DRAWINGS AND/OR SPECIFICATIONS FOR THE APPLICABLE LOCATION. THE FINAL THREE FEET (MAXIMUM) SHALL BE FLEXIBLE METAL OR LIQUIDTIGHT FLEXIBLE METAL CONDUIT.
- COPPER BRANCH CIRCUIT CONDUCTOR SIZING BASED UPON NEC TABLE 310.16. MAKE ADJUSTMENTS TO CONDUCTORS FOR TEMPERATURE OR VOLTAGE DROP THAT EXCEED NEC AND SPECIFICATION CRITERIA.
- RACEWAY SIZES ARE BASED UPON GRSC AND LFMC WITH THWN CONDUCTORS.
- VFD SHALL BE CONTROLLED VIA REMOTE 4-20mA OR 0-5V SIGNAL PROVIDED BY THE HVAC ATC CONTRACTOR.
- REQUIRED DISCONNECT IS PROVIDED INTEGRAL/PREWIRED TO MECHANICAL EQUIPMENT.
- REQUIRED STARTER IS PROVIDED INTEGRAL/PREWIRED TO MECHANICAL EQUIPMENT.
- DISCONNECT FOR 251W AND 252W MOTORS SHALL BE SIX POLE.
- PROVIDE NEUTRAL FROM SOURCE TO STARTER ONLY FOR 120V CONTROL POWER OF 208V 3PH UNITS.
- FUSES FOR DISCONNECT SWITCHES SHALL BE CLASS RK5.
- SCOPE OF WORK SHALL BE CARRIED AS ADD ALTERNATE. REFER TO MECHANICAL DRAWINGS FOR ADDITIONAL INFORMATION.
- UTILIZE EXISTING BREAKER IN MAIN SWITCHBOARD TO POWER NEW EQUIPMENT. SEE ONE-LINE DIAGRAM FOR ADDITIONAL INFORMATION.
- OUTDOOR UNIT POWERS INDOOR UNIT.

KEY

- FVNR FULL VOLTAGE NON-REVERSING
- FVR FULL VOLTAGE REVERSING
- 2S1W TWO SPEED SINGLE WINDING
- 2S2W TWO SPEED TWO WINDING
- RVAT REDUCED VOLTAGE AUTOTRANSFORMER
- RVPW REDUCED VOLTAGE PART WINDING
- RVDOT REDUCED VOLTAGE WYE DELTA OPEN TRANSITION
- RVYDCT REDUCED VOLTAGE WYE DELTA CLOSED TRANSITION
- MMS MANUAL MOTOR STARTER
- CB CIRCUIT BREAKER
- MCP MOTOR CIRCUIT PROTECTOR
- PB START AND STOP PUSH BUTTON
- HOA HAND-OFF-AUTOMATIC SELECTOR SWITCH
- CPT CONTROL POWER TRANSFORMER
- VFD VARIABLE FREQUENCY DRIVE W/O BYPASS
- VFD/B VARIABLE FREQUENCY DRIVE W/ BYPASS
- CNTCR CONTACTOR - NO THERMAL OVERLOAD



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SCALE: NO SCALE

DATE: 2024-01-31

REVISIONS:

2023-10-17: SD PLUS

2023-12-22: DD PLUS

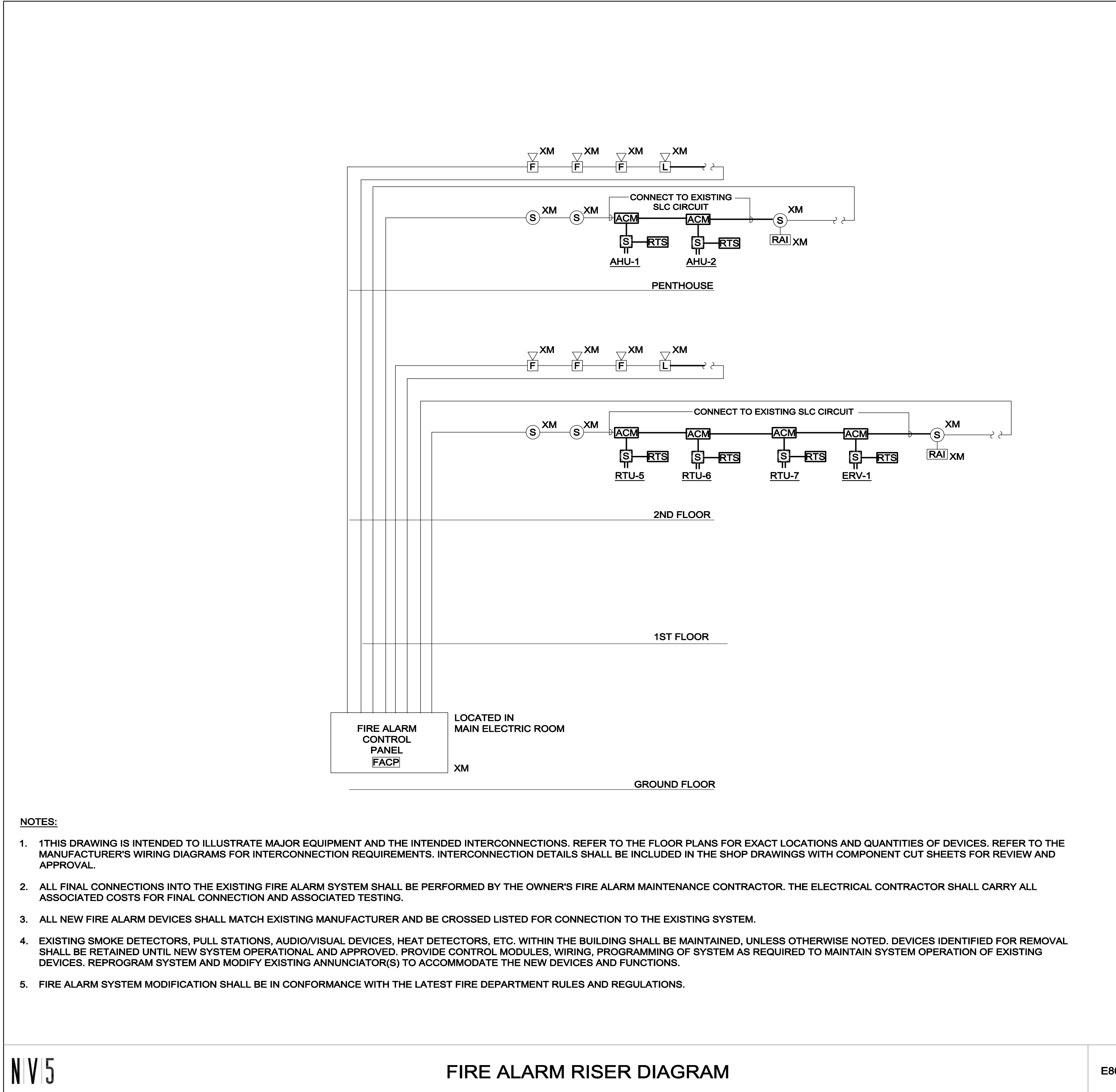
2024-01-31: CD'S

DRAWN BY: MVM

ELECTRICAL SCHEDULES

FIRE ALARM PERMIT SUBMISSION NOTES

- REFERENCE TO NFPA 72 ARE TO THE 2013 EDITION IN ACCORDANCE WITH 780 CMR.
- THIS DRAWING CONSTITUTES THE TIER ONE FLOOR PLAN SUBMISSION IN ACCORDANCE WITH THE MA STATE BUILDING CODE 780CMR 901.2.1.1. THESE REQUIREMENTS INCLUDE, BUT ARE NOT LIMITED TO THE FOLLOWING:
 - FLOOR PLAN ILLUSTRATING ALL ROOM USES.
 - LOCATION OF ALL INITIATING DEVICES. CEILING TYPE AND HEIGHT ARE INCLUDED WHERE DETECTION ILLUSTRATED AND UNUSUAL CONDITIONS APPLY SUCH AS HEIGHT OVER 10 FEET OR WHERE BEAMS AND JOISTS ARE PRESENT.
 - LOCATION OF ALL FIRE ALARM CONTROL PANELS AND ANNUNCIATORS.
- THE INSTALLING CONTRACTOR IS RESPONSIBLE FOR THE DEVELOPMENT AND SUBMISSION OF THE REQUIRED TIER TWO SHOP DRAWINGS IN ACCORDANCE WITH 780CMR 907.1.2. TIER TWO SHOP DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW AND BE OF SUFFICIENT QUALITY TO BE APPROVED PRIOR TO THE CONTRACTORS SUBMISSION TO THE AHJ FOR PERMIT.
- NFPA 72 AND 780CMR 907.1.2 TIER TWO SHOP DRAWING REQUIREMENTS INCLUDE, BUT ARE NOT LIMITED TO THE FOLLOWING:
 - NAME, LICENSE NUMBER AND LICENSE EXPIRATION DATE OF THE INSTALLING CONTRACTOR.
 - RISER DIAGRAM WITH ALL DEVICES, INTERCONNECTING WIRING AND CIRCUITING INTENT.
 - CALCULATIONS FOR BATTERY CAPACITY AND VOLTAGE DROP.
 - MANUFACTURER'S CUT SHEETS FOR ALL DEVICES AND MATERIALS.
 - THE ACTUAL BUILDING FA SEQUENCE OF OPERATIONS OBTAINED FROM THE OWNER'S FA MAINTENANCE CONTRACTOR
 - FLOOR PLANS DERIVED FROM THE TIER ONE SUBMISSION PLANS WITH THE FOLLOWING INFORMATION MODIFIED/ADDED:
 - ACAD PLANS WILL BE MADE AVAILABLE FOR THE CONTRACTORS USE INCLUDING ALL TIER ONE INFORMATION IN ACCORDANCE WITH THE CONTRACTUAL REQUIREMENTS. THE DOCUMENT SHALL CLEARLY INDICATE THE CONTRACTOR'S OWNERSHIP OF ILLUSTRATED INFORMATION.
 - CONDUIT ROUTING AND CONDUCTOR TYPE AND COUNT BETWEEN ALL DEVICES ILLUSTRATING INSTALLATION INTENT. WHERE REQUIRED BY THE RISER AND/OR SPECIFICATIONS, CLEARLY ILLUSTRATE CLASS A SEPARATIONS.
 - INITIATING DEVICE ADDRESSES WHERE MANUFACTURER CAN APPLY THEM PRIOR TO INSTALLATION ON THE SLC.
- NFPA 72 AND 780CMR 907.1.2.1.3 72 TIER THREE RECORD DRAWINGS INCLUDE, BUT ARE NOT LIMITED TO THE FOLLOWING:
 - AS-BUILT PLANS DERIVED FROM THE TIER TWO FLOOR PLANS ILLUSTRATING INSTALLED CONDITIONS, DEVICE ADDRESSES, FINAL TAP SETTINGS AND AUDIBLE AMBIENT AND TEST DB READINGS THROUGHOUT THE SPACE.
 - WRITTEN VERSION OF SEQUENCE OF OPERATION SHALL BE INCLUDED.
 - O&M MANUAL PER NFPA 72 REQUIREMENTS.
 - SYSTEM RECORD OF COMPLETION FORM PER NFPA 72 FIGURES 7.8.2(a) THRU (f) SECTIONS AS APPLICABLE TO THE PROJECT SCOPE.
 - SYSTEM RECORD OF INSPECTION AND TESTING FORM PER NFPA 72 FIGURE 7.8.2(g) THRU (i) SECTIONS AS APPLICABLE TO THE PROJECT SCOPE.
 - CONFIRMATION THAT A RECORD COPY OF THE SITE SPECIFIC SOFTWARE HAS BEEN DELIVERED TO THE OWNER'S REPRESENTATIVE.



- NOTES:**
- THIS DRAWING IS INTENDED TO ILLUSTRATE MAJOR EQUIPMENT AND THE INTENDED INTERCONNECTIONS. REFER TO THE FLOOR PLANS FOR EXACT LOCATIONS AND QUANTITIES OF DEVICES. REFER TO THE MANUFACTURER'S WIRING DIAGRAMS FOR INTERCONNECTION REQUIREMENTS. INTERCONNECTION DETAILS SHALL BE INCLUDED IN THE SHOP DRAWINGS WITH COMPONENT CUT SHEETS FOR REVIEW AND APPROVAL.
 - ALL FINAL CONNECTIONS INTO THE EXISTING FIRE ALARM SYSTEM SHALL BE PERFORMED BY THE OWNER'S FIRE ALARM MAINTENANCE CONTRACTOR. THE ELECTRICAL CONTRACTOR SHALL CARRY ALL ASSOCIATED COSTS FOR FINAL CONNECTION AND ASSOCIATED TESTING.
 - ALL NEW FIRE ALARM DEVICES SHALL MATCH EXISTING MANUFACTURER AND BE CROSSED LISTED FOR CONNECTION TO THE EXISTING SYSTEM.
 - EXISTING SMOKE DETECTORS, PULL STATIONS, AUDIO/VISUAL DEVICES, HEAT DETECTORS, ETC. WITHIN THE BUILDING SHALL BE MAINTAINED, UNLESS OTHERWISE NOTED. DEVICES IDENTIFIED FOR REMOVAL SHALL BE RETAINED UNTIL NEW SYSTEM OPERATIONAL AND APPROVED. PROVIDE CONTROL MODULES, WIRING, PROGRAMMING OF SYSTEM AS REQUIRED TO MAINTAIN SYSTEM OPERATION OF EXISTING DEVICES. REPROGRAM SYSTEM AND MODIFY EXISTING ANNUNCIATOR(S) TO ACCOMMODATE THE NEW DEVICES AND FUNCTIONS.
 - FIRE ALARM SYSTEM MODIFICATION SHALL BE IN CONFORMANCE WITH THE LATEST FIRE DEPARTMENT RULES AND REGULATIONS.

NV5 FIRE ALARM RISER DIAGRAM E801

FIRE ALARM LEGEND

[FACP]	FIRE ALARM CONTROL PANEL
▽ 150cd [L]	FIRE ALARM VISUAL DEVICE
[S]	DUCT MOUNTED SMOKE DETECTOR
[F] SC	FIRE ALARM MANUAL PULL STATION "SC" INDICATES STOPPER COVER
[RAI]	REMOTE ALARM INDICATOR
[RTS]	REMOTE TEST STATION
[ACM]	INDIVIDUAL ADDRESSABLE CONTROL MODULE
▽ 110cd [E] WG	FIRE ALARM AUDIBLE AND VISUAL DEVICE, NUMERAL INDICATES CANDELA VALUE
(S)	FIRE ALARM SMOKE DETECTOR, PHOTO ELECTRIC

EXISTING EQUIPMENT LEGEND

XM	EXISTING EQUIPMENT TO REMAIN
X	EXISTING EQUIPMENT TO BE REMOVED
XR	EXISTING EQUIPMENT TO BE RELOCATED
XN	NEW LOCATION OF EXISTING RELOCATED EQUIPMENT
NR	EXISTING EQUIPMENT TO BE REMOVED AND NEW EQUIPMENT TO BE INSTALLED ON EXISTING BRANCHFEEDER
[]	EXISTING EQUIPMENT FOR INFORMATION ONLY- INDICATED BY SYMBOL WITH LIGHT AND OUT OF FUNCTION LINE TYPE
[- - -]	EXISTING EQUIPMENT TO BE REWORKED- INDICATED BY SYMBOL WITH DASHED AND IN FUNCTION LINE TYPE

ABBREVIATIONS

AM/MP	AMPERE	KWH	KILOWATT HOURS
AC	ALTERNATING CURRENT	LTG	LIGHTING
ADA	AMERICAN WITH DISABILITIES ACT	MCB	MAIN CIRCUIT BREAKER
AF	AMPERE FRAME	MEC	MASSACHUSETTS ELECTRICAL CODE
AFF	ABOVE FINISHED FLOOR	M/G	MOTOR/GENERATOR SET
AFG	ABOVE FINISHED GRADE	MH	MANHOLE
AIC	AMPERE INTERRUPTING CAPACITY	MLO	MAIN LUGS ONLY
AL	ALUMINUM	MTD	MOUNTED
AT	AMPERE TRIP	MTG	MOUNTING
ATS	AUTOMATIC TRANSFER SWITCH	NC	NORMALLY CLOSED CONTACT
AWG	AMERICAN WIRE GAUGE	NEC	NATIONAL ELECTRICAL CODE
B	BURIED	NO	NORMALLY OPEN CONTACT
C	CONDUIT	NTS	NOT TO SCALE
CA	CABLE	#	NUMBER
CATV	CABLE TELEVISION	OPD	OVER CURRENT PROTECTION DEVICE
CCTV	CLOSED CIRCUIT TELEVISION SYSTEM	POS	PROVIDED UNDER OTHER SECTIONS
CB	CIRCUIT BREAKER	PVC	POLYVINYL CHLORIDE
CKT	CIRCUITS	PWR	POWER
CPU	CENTRAL PROCESSING UNIT	RGS	RIGID GALVANIZED STEEL
CL	CENTERLINE	RMS	ROOT MEAN SQUARE VALUE
DB	DECIBEL	RPM	REVOLUTIONS PER MINUTE
DC	DIRECT CURRENT	SPD	SURGE PROTECTIVE DEVICE
DWG	DRAWING	SN	SOLID NEUTRAL
EC	ELECTRICAL CONTRACTOR	SWBD	SWITCHBOARD
EMT	ELECTRIC METALLIC TUBING	TB	TERMINAL BLOCK
FDR	FEEDER	TEL	TELEPHONE
FLMT	FLEXIBLE LIQUID TIGHT METALLIC TUBING	TERMN	TERMINAL
FREQ	FREQUENCY	TSP	TWISTED SHIELDED-PAIR
GEC	GROUNDING ELECTRODE CONDUCTOR	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
GFI	GROUND FAULT INTERRUPTING	TYP	TYPICAL
GND	GROUND	UG	UNDERGROUND
HH	HANDHOLE	UNO	UNLESS NOTED OTHERWISE
HP	HORSEPOWER	UPS	UNINTERRUPTIBLE POWER SUPPLY
HVAC	HEATING, VENTILATING AND AIR CONDITIONING	UTP	UNSHIELDED TWISTED-PAIR
HZ	HERTZ	V	VOLTS
IG	ISOLATED GROUND	VA	VOLT-AMPERE
JB	JUNCTION BOX	VSD	VARIABLE SPEED DRIVE
KVA	KILOVOLT-AMPERE	W	WATTS
KW	KILOWATT	WP	WEATHERPROOF

NV5
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 Cambridge, MA 02139
 Tel. 617-504-8196
 Fax. 617-812-6364
 cgkvarchitects.com

CITY OF WALTHAM
 610 Main Street
 Waltham, MA 02452

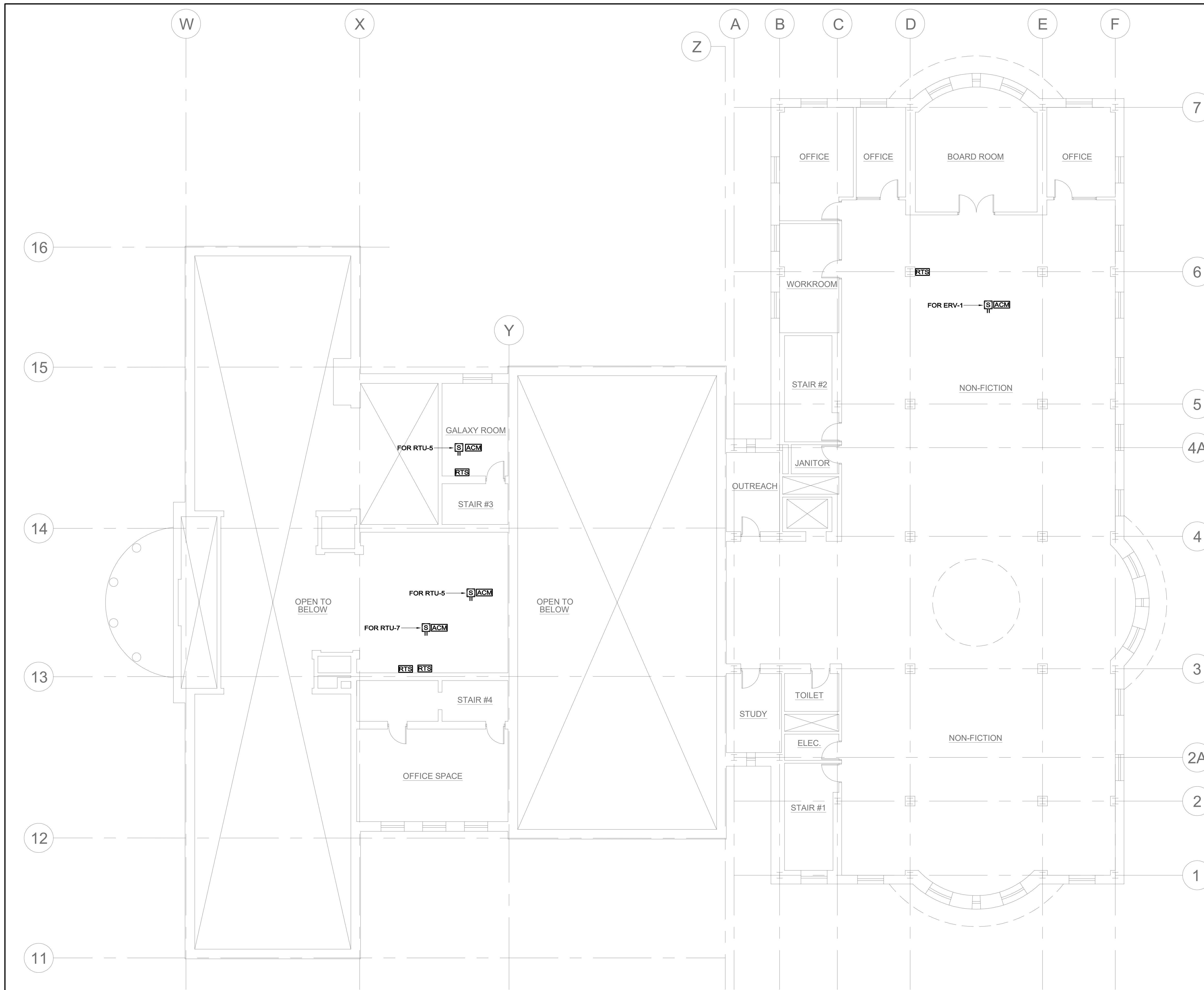
HVAC Replacement at:
WALTHAM PUBLIC LIBRARY
 735 Main Street
 Waltham, MA 02451

SCALE: NO SCALE
 DATE: 2024-01-31
 REVISIONS:
 2023-10-17: SD PLUS
 2023-12-22: DD PLUS
 2024-01-31: CD'S
 DRAWN BY: MVM

FIRE ALARM LEGEND NOTES AND ABBREVIATIONS

W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164 FA-0.0 FIRE_ALARM_LEGEND.dwg [P:\P\] January 31, 2024 - 10:11 pm jstam.ith

W:\BLD\Projects\2023\0220164 - Waltham Public Library HVAC System\300 Drawings\305 Electrical\0220164 PA-2.3 FIRE ALARM SECOND FLOOR NEW WORK PLAN.dwg [PAPER] January 31, 2024 - 10:11pm joshsmith



FIRE ALARM NOTES:

1. REFER TO DRAWING E-0.0 FOR LEGEND, SYMBOLS AND GENERAL NOTES.
2. REFER TO ARCHITECTURAL DRAWINGS FOR ASSOCIATED NOTES, MOUNTING DETAILS, HEIGHT AND EXACT LOCATIONS OF ALL DEVICES.
3. FIRE ALARM BRANCH CIRCUITRY SHALL BE INSTALLED IN CONDUIT FROM THE PANEL TO THE FIRST DEVICE AND/OR WHERE EXPOSED. FIRE ALARM BRANCH CIRCUITRY MAY BE TYPE MC CABLE WHERE CONCEALED ABOVE SUSPENDED CEILINGS AND IN METAL STUD WALLS.
4. MC CABLE FOR FIRE ALARM SERVICE SHALL HAVE A RED IDENTIFIER ALONG ITS ENTIRE LENGTH. JUNCTION BOX COVERS AND CONDUIT COUPLINGS FOR ALL FIRE ALARM WIRING RACEWAYS SHALL BE PAINTED RED PRIOR TO INSTALLATION.
5. MAINTAIN CONTINUITY OF BRANCH CIRCUITRY ASSOCIATED WITH ALL EXISTING FIRE ALARM DEVICES TO REMAIN.

N|V|5
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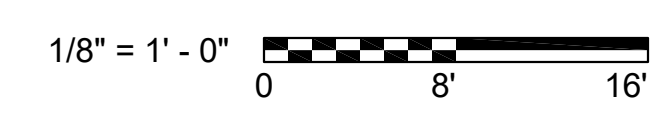
CITY OF WALTHAM
 610 Main Street
 Waltham, MA 02452

HVAC Replacement at:
 WALTHAM PUBLIC LIBRARY
 735 Main Street
 Waltham, MA 02451

SCALE: 1/8" = 1'-0"
 DATE: 2024-01-31
 REVISIONS:
 2023-10-17: SD PLUS
 2023-12-22: DD PLUS
 2024-01-31: CD'S
 DRAWN BY: MVM

**ELECTRICAL
 FIRE ALARM
 SECOND FLOOR
 NEW WORK PLAN**

1 SECOND FLOOR PLAN
 1/8" = 1'-0"



APPENDIX A

Eastern Environmental Inc.

203 Prospect St
Brockton, MA 02301
(617) 623-6678

January 12, 2024

City Of Waltham
610 Main Street
Waltham MA 02452

RE: Asbestos Inspection, 735 Main Street, Waltham, MA

On January 5, 2023, Sasha Lomba, Massachusetts licensed asbestos inspector AI900722, inspected the roof at the above address for the presence of asbestos prior to renovation. There were 2 sections on the roof, one was of the old building and the other was the roof from the newer side of the building. Areas 1-3 are the old side and area 4 is the newer side.

The older side's last layer was cement and the newer side's last layer on the roof was wood.

The following materials were suspected to contain asbestos and sampled:

Material	Location
Rubber roof and mastic (top)	Area 1
Insulation	Area 1
Rubber roof and mastic (top)	Area 2
Insulation	Area 2
Rubber roof and mastic (top)	Area 3
Insulation	Area 3
Roof (sticky bottom layer)	Area 3
Rubber roof and mastic (top)	Area 4
Insulation	Area 4

The samples were delivered to Asbestos Identification Lab for analysis. The samples were analyzed by the EPA endorsed method of Polarized Light Microscopy with Dispersion Staining (PLM/DS) method. The PLM/DS is a qualitative and quantitative form of analysis that yields the type of asbestos in a sample, if any.

The following materials tested positive for the presence of asbestos:

Material	Location	Approx Quantity
-----------------	-----------------	------------------------

None

The asbestos containing material must be removed by a Massachusetts licensed asbestos abatement contractor prior to demolition. If any unknown materials are encountered during demolition, they must be tested by a Massachusetts licensed asbestos inspector. See enclosed results.

If you should require more information on this matter, please do not hesitate to contact me at (617) 623-6678.

Sincerely,



Daniel Gomes Jr
President



Asbestos Identification Laboratory.

165 New Boston St., Ste 227
Woburn, MA 01801
781-932-9600

Web: www.asbestosidentificationlab.com Email:
mikemanning@asbestosidentificationlab.com



Batch: 109888

Project Information

Roof
735 Main St.,
Waltham

Method: BULK PLM ANALYSIS,
EPA/600/R-93/116

Daniel Gomes
Eastern Environmental Inc
203 Prospect St.
Brockton, MA 02301

Dear Daniel Gomes,

Asbestos Identification Laboratory has completed the analysis of the samples from your office for the above referenced project. The Analysis Method is BULK PLM ANALYSIS, EPA/600/R-93/116. The information and analysis contained in this report have been generated using the EPA /600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials. Materials or products that contain more than 1% of any kind or combination of asbestos are considered an asbestos containing building material as determined by the EPA. This Polarized Light Microscope (PLM) technique may be performed either by visual estimation or point counting. Point counting provides a determination of the area percentage of asbestos in a sample. If the asbestos is estimated to be less than 10% by visual estimation of friable material, the determination may be repeated using the point counting technique. The results of the point counting supersede visual PLM results. Results in this report only relate to the items tested. This report may not be used by the customer to claim product endorsement by NVLAP or any other U.S. Government Agency.

Laboratory results represent the analysis of samples as submitted by the customer. Information regarding sample location, description, area, volume, etc., was provided by the customer. Information provided by the customer can affect the validity of results. Asbestos Identification Laboratory is not responsible for sample collection activities or analytical method limitations. Unless notified in writing to return samples, Asbestos Identification Laboratory discards customer samples after 30 days. Samples containing subsamples or layers will be analyzed separately when applicable. Reports are kept at Asbestos Identification Laboratory for three years. All customer information will be maintained in confidentiality. This report shall not be reproduced, except in full, without the written consent of Asbestos Identification Laboratory.

- NVLAP Lab Code: 200919-0
- Massachusetts Certification License: AA000208
- State of Connecticut, Department of Public Health Approved Environmental Laboratory Registration Number: PH-0142
- State of Maine, Department of Environmental Protection Asbestos Analytical Laboratory License Number: LB-0078(Bulk) LA-0087(Air)
- State of Rhode Island and Providence Plantations. Department of Health Certification: AAL-121
- State of Vermont, Department of Health Environmental Health License AL934461

Thank you Daniel Gomes for your business.

Michael Manning
Owner/Director

FieldID LabID	Material	Location	Color	Non-Asbestos %	Asbestos %
A 1204557	Rubber Roof (Top)	Area 1	black	Non-Fibrous 100	None Detected
B 1204558	Mastic for A	Area 1	black	Non-Fibrous 100	None Detected
C 1204559	Insulation	Area 1	multi	Cellulose 60 Non-Fibrous 40	None Detected
D 1204560	Rubber Roof (Top)	Area 1	multi	Non-Fibrous 100	None Detected
E 1204561	Mastic for D	Area 2	black	Non-Fibrous 100	None Detected
F 1204562	Insulation	Area 2	multi	Cellulose 60 Non-Fibrous 40	None Detected
G 1204563	Rubber Roof (Top)	Area 3	multi	Non-Fibrous 100	None Detected
H 1204564	Mastic for G	Area 3	black	Non-Fibrous 100	None Detected
I 1204565	Insulation	Area 3	gray	Cellulose 60 Non-Fibrous 40	None Detected
J 1204566	Roof (Bottom Layer)	Area 3	gray	Cellulose 60 Non-Fibrous 40	None Detected
K 1204567	Roof Rubber (Top)	Area 4	black	Non-Fibrous 100	None Detected
L 1204568	Mastic for K	Area 4	black	Non-Fibrous 100	None Detected
M 1204569	Insulation	Area 4	multi	Cellulose 60 Non-Fibrous 40	None Detected

Sampled: January 05, 2024 Received: January 10, 2024 Analyzed: January 10, 2024

Thursday 11 January 2024

Analyzed by:

David Thomas

Appendix A-4
 Batch: 109888

Eastern Environmental Inc.

203 Prospect St
Brockton, MA 02301
(617) 623-6678

January 18, 2024

City of Waltham
610 Main St
Waltham, MA 02452

RE: Asbestos Inspection, 735 Main Street, Waltham, MA

On January 10, 2024, Richard Alomar, Massachusetts licensed asbestos inspector AI900594, inspected the library at the above address for the presence of asbestos prior to renovation of the maintenance department, lecture hall, technical services, Back lot entry lobby, reference desk area, circulation department head office, galaxy room, penthouse, and the non-fiction area. Mechanical systems will be replaced and some walls and ceilings will be partially demolished in the process.

The following materials were suspected to contain asbestos and sampled:

Material	Location
Wall Sheet Rock	Lecture Hall
Wall Sheet Rock	Non-fiction area
Ceiling Plaster & Skim Coat	Galaxy Room
Ceiling Plaster & Skim Coat	Circulation Department Head Office
Ceiling Plaster & Skim Coat	Technical Services Area
Spray On Fireproofing	Penthouse

The following materials were not suspected to contain asbestos:

Material	Location
Cement floor	Maintenance Department
Cement floor	Circulation Department Head Office
Cement floor	Penthouse
Brick Wall	Maintenance Department

The samples were delivered to Asbestos Identification Lab for analysis. The samples were analyzed by the EPA endorsed method of Polarized Light Microscopy with Dispersion Staining (PLM/DS) method. The PLM/DS is a qualitative and quantitative form of analysis that yields the type of asbestos in a sample, if any.

The following materials tested positive for the presence of asbestos:

Material	Location	Approx Quantity
None		

If any unknown materials are encountered during demolition, they must be tested by a Massachusetts licensed asbestos inspector. All asbestos containing materials must be removed by a licensed Massachusetts abatement contractor prior to demolition. See enclosed results.

If you should require more information on this matter, please do not hesitate to contact me at (617) 623-6678.

Sincerely,
Daniel Gomes Jr.
Daniel Gomes Jr
President



Asbestos Identification Laboratory.

165 New Boston St., Ste 227
Woburn, MA 01801
781-932-9600

Web: www.asbestosidentificationlab.com Email:
mikemanning@asbestosidentificationlab.com



Batch: 109959

Project Information

735 Main St,
Waltham

Method: BULK PLM ANALYSIS,
EPA/600/R-93/116

Daniel Gomes
Eastern Environmental Inc
203 Prospect St.
Brockton, MA 02301

Dear Daniel Gomes,

Asbestos Identification Laboratory has completed the analysis of the samples from your office for the above referenced project. The Analysis Method is BULK PLM ANALYSIS, EPA/600/R-93/116. The information and analysis contained in this report have been generated using the EPA /600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials. Materials or products that contain more than 1% of any kind or combination of asbestos are considered an asbestos containing building material as determined by the EPA. This Polarized Light Microscope (PLM) technique may be performed either by visual estimation or point counting. Point counting provides a determination of the area percentage of asbestos in a sample. If the asbestos is estimated to be less than 10% by visual estimation of friable material, the determination may be repeated using the point counting technique. The results of the point counting supersede visual PLM results. Results in this report only relate to the items tested. This report may not be used by the customer to claim product endorsement by NVLAP or any other U.S. Government Agency.

Laboratory results represent the analysis of samples as submitted by the customer. Information regarding sample location, description, area, volume, etc., was provided by the customer. Information provided by the customer can affect the validity of results. Asbestos Identification Laboratory is not responsible for sample collection activities or analytical method limitations. Unless notified in writing to return samples, Asbestos Identification Laboratory discards customer samples after 30 days. Samples containing subsamples or layers will be analyzed separately when applicable. Reports are kept at Asbestos Identification Laboratory for three years. All customer information will be maintained in confidentiality. This report shall not be reproduced, except in full, without the written consent of Asbestos Identification Laboratory.

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- State of Rhode Island and Providence Plantations. Department of Health Certification: AAL-121
- State of Vermont, Department of Health Environmental Health License AL934461

Thank you Daniel Gomes for your business.

Michael Manning
Owner/Director

FieldID LabID	Material	Location	Color	Non-Asbestos %	Asbestos %
A 1205347	Wall Sheet Rock	Lecture Hall	gray	Cellulose 5 Non-Fibrous 95	None Detected
B 1205348	Wall Sheet Rock	Non Fiction	gray	Cellulose 5 Non-Fibrous 95	None Detected
C 1205349	Ceiling Plaster	Galaxy Room	white	Non-Fibrous 100	None Detected
D 1205350	Skim Coat	Galaxy Room	white	Non-Fibrous 100	None Detected
E 1205351	Ceiling Plaster	Circulation Dept Head Office	gray	Cellulose 5 Non-Fibrous 95	None Detected
F 1205352	Skim Coat	Circulation Dept Head Office	white	Non-Fibrous 100	None Detected
G 1205353	Ceiling Plaster	Tech Services	gray	Cellulose 5 Non-Fibrous 95	None Detected
H 1205354	Skim Coat	Tech Services	white	Non-Fibrous 100	None Detected
I 1205355	Spray on Fireproofing	Penthouse	gray	Fiberglass 35 Mineral Wool 35 Cellulose 10 Non-Fibrous 20	None Detected
J 1205356	Spray on Fireproofing	Penthouse	gray	Fiberglass 35 Mineral Wool 35 Cellulose 10 Non-Fibrous 20	None Detected

Sampled: January 11, 2024 Received: January 11, 2024 Analyzed: January 11, 2024

Friday 12 January 2024

Analyzed by:

Valerie Garnette

Appendix A, 11
 Batch: 109959

