



REQUEST FOR PROPOSALS

Item Description: ARPA RECREATION CENTER HVAC IMPROVEMENTS

Procurement/MinuteTraq #: 47371

Date to be opened: 11/18/2024

Issuing Department: Department of Public Property

QUESTIONS

• Please direct questions relative to the specifications outlined (beginning on page 13) to the issuing department's subject matter expert:

o Name: Ben Lobaugh

- o Title: Senior Capital Improvements Project Manager
- o Email Address: blobaugh@providenceri.gov
- Please direct questions related to the bidding process, how to fill out forms, and how to submit a bid (Pages 1-6) to the Purchasing Department.
 - o Email: <u>purchasing@providenceri.gov</u>
 - Please use the subject line "Solicitation Question"
- Please direct questions relative to the Minority and Women's Business Enterprise Program and the corresponding forms (Pages 14-15) to the MBE/WBE Outreach Director for the City of Providence, Grace Diaz
 - o Email: gdiaz@providenceri.gov
 - Please use subject line "MBE WBE Forms"

Pre-bid Conference

There will be a Mandatory Pre-Bid Conference

Date: Wednesday, October 30, 2024 Time: 9:00am

Location: John Rollins Rec Center, 674 Prairie Ave, Providence, RI 02903

The prebid will start at John Rollins Rec Center and then proceed to the other centers in turn.

Deadline for questions submissions: Friday, November 8, 2024 at 12:00pm



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

INSTRUCTIONS FOR SUBMISSION

Bids may be submitted up to **2:15 P.M.** on the above meeting date at the **Department of the City Clerk. Room 311, City Hall. 25 Dorrance Street, Providence.** At 2:15 P.M. all bids will be publicly opened and read at the Board of Contract Meeting in Conference Room 305, on the 3rd floor of City Hall.

- Bidders must submit 2 copies of their bid in sealed envelopes or packages labeled with the captioned Item Description and the City Department to which the solicitation and bid are related and must include the company name and address on the envelope as well. (On page 1).
- If required by the Department, please keep the original bid bond and check in only one of the envelopes.
- Communications to the Board of Contract and Supply that are not competitive sealed bids (i.e. product information/samples) should have "**NOT A BID**" written on the envelope or wrapper.
- Only use form versions and templates included in this solicitation. If you have an old version of a form do not recycle it for use in this bid.
- The bid envelope and information relative to the bid must be addressed to:

Board of Contract and Supply Department of the City Clerk – City Hall, Room 311 25 Dorrance Street Providence, RI 02903

**<u>PLEASE NOTE</u>: This bid may include details regarding information that you will need to provide (such as proof of licenses) to the issuing department before the formalization of an award.

This information is <u>NOT</u> requested to be provided in your initial bid by design.

All bids submitted to the City Clerk become public record. Failure to follow instructions could result in information considered private being posted to the city's Open Meetings Portal and made available as a public record. The City has made a conscious effort to avoid the posting of sensitive information on the City's Open Meetings Portal, by requesting that such sensitive information be submitted to the issuing department only at their request.



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

BID PACKAGE CHECKLIST

Digital forms are available in the City of Providence Purchasing Department Office or online at http://www.providenceri.gov/purchasing/how-to-submit-a-bid/

The <u>Technical Proposal for Qualification</u> bid package MUST include the following, in this order:

- Bid Form 1: Bidder's Blank as the cover page/ 1st page (see page 6 of this document)
- Bid Form 2: Certification of Bidder as 2nd page (see page 7 of this document)
- Bid Form 3: Certificate Regarding Public Records (see page 8 of this document)
- Bid Form 4: Affidavit of City Vendor (see pages 9 and 10 of this document)
- Forms from the Minority and Women Business Enterprise Program: Based on Bidder Category. See forms and instructions enclosed (pages 11-12) or on:

 https://www.providenceri.gov/purchasing/minority-women-owned-business-mbewbe-procurement-program/

*Please note: MBE/WBE forms must be completed for EVERY bid submitted and must be inclusive of <u>ALL</u> required signatures. Forms without all required signatures will be considered <u>incomplete</u>.

- Bidder's Proposal/Packet: Formal response to the specifications outlined in this RFP, including pricing information and details related to the good(s) or service(s) being provided. Please be mindful of formatting responses as requested to ensure clarity.
- Financial Assurance, <u>if requested</u> (as indicated on page 5 of this document under "Bid Terms")

All of the above listed documents are REQUIRED. (With the exception of financial assurances, which are only required if specified on page 5.)

***Failure to meet specified deadlines, follow specific submission instructions, or enclose all required documents with all applicable signatures will result in disqualification, or in an inability to appropriately evaluate bids.



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

NOTICE TO VENDORS

- 1. The Board of Contract and Supply will make the award to the lowest qualified and responsible bidder.
- 2. In determining the lowest responsible bidder, cash discounts based on preferable payment terms will not be considered.
- 3. Where prices are the same, the Board of Contract and Supply reserves the right to award to one bidder, or to split the award.
- 4. No proposal will be accepted if the bid is made in collusion with any other bidder.
- 5. Bids may be submitted on an "equal in quality" basis. The City reserves the right to decide equality. Bidders must indicate brand or the make being offered and submit detailed specifications if other than brand requested.
- 6. A bidder who is an out-of-state corporation shall qualify or register to transact business in this State, in accordance with the Rhode Island Business Corporation Act, RIGL Sec. 7-1.2-1401, et seq.
- 7. The Board of Contract and Supply reserves the right to reject any and all bids.
- 8. If the City Department that is seeking the within described bids deems that it is in the City's best interest, the City reserves the right to waive any requirement of this RFP.
- 9. Competing bids may be viewed in person at the Department of the City Clerk, City Hall, Providence, immediately upon the conclusion of the formal Board of Contract and Supply meeting during which the bids were unsealed/opened. Bids may also be accessed electronically on the internet via the City's Open Meetings Portal.
- 10. As the City of Providence is exempt from the payment of Federal Excise Taxes and Rhode Island Sales Tax, prices quoted are not to include these taxes.
- 11. In case of error in the extension of prices quoted, the unit price will govern.
- 12. The contractor will **NOT** be permitted to: a) assign or underlet the contract, or b) assign either legally or equitably any monies or any claim thereto without the previous written consent of the City Purchasing Director.
- 13. Delivery dates must be shown in the bid. If no delivery date is specified, it will be assumed that an immediate delivery from stock will be made.
- 14. A certificate of insurance will normally be required of a successful vendor.
- 15. For many contracts involving construction, alteration and/or repair work, State law provisions concerning payment of prevailing wage rates apply (<u>RIGL Sec. 37-13-1 et seq.</u>)
- 16. No goods should be delivered, or work started without a Purchase Order.
- 17. Submit 2 copies of the bid to the City Clerk, unless the specification section of this document indicates otherwise.
- 18. Bidder must certify that it does not unlawfully discriminate on the basis of race, color, national origin, gender, gender identity or expression, sexual orientation and/or religion in its business and hiring practices and that all of its employees are lawfully employed under all applicable federal, state and local laws, rules and regulations. (See Bid Form 2.)



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

BID TERMS

1.	and	nancial assurances may be required in order to be a successful bidder for Commodity or Construction d Service contracts. <u>If either of the first two checkboxes below is checked, the specified assurance</u> ist accompany a bid, or the bid will not be considered by the Board of Contract and Supply. The
	thi	rd checkbox indicates the lowest responsible bidder will be contacted and required to post a bond to awarded the contract.
	a)	A certified check for <u>\$</u> must be deposited with the City Clerk as a guarantee that the Contract will be signed and delivered by the bidder.
	b)	A bid bond in the amount of <u>5</u> per centum (%) of the proposed total price, must be deposited with the City Clerk as a guarantee that the contract will be signed and delivered by the bidder; and the amount of such bid bond shall be retained for the use of the City as liquidated damages in case of default. Any person signing a bid bond as an attorney-in-fact shall include with the bid bond an original, or a photocopy or facsimile of an original, power of attorney.
	c)	\boxtimes A performance and payment bond with a satisfactory surety company will be posted by the bidder in a sum equal to one hundred per centum (100%) of the awarded contract.
	d)	☐ No financial assurance is necessary for this item.
2.		wards will be made within nighty (90) days of bid opening . All bid prices will be considered firm, less qualified otherwise. Requests for price increases will not be honored.
3.		ilure to deliver within the time quoted or failure to meet specifications may result in default in

strikes, lockouts, accidents, and Acts of God. The following entry applies only for COMMODITY BID TERMS:

4. Payment for partial delivery will not be allowed except when provided for in blanket or term contracts. The following entries apply only for CONSTRUCTION AND SERVICE BID TERMS:

5. Only one shipping charge will be applied in the event of partial deliveries for blanket or term contracts.

accordance with the general specifications. It is agreed that deliveries and/or completion are subject to

- 6. Prior to commencing performance under the contract, the successful bidder shall attest to compliance with the provisions of the Rhode Island Worker's Compensation Act, <u>RIGL 28-29-1</u>, et seq. If exempt from compliance, the successful bidder shall submit a sworn Affidavit by a corporate officer to that effect, which shall accompany the signed contract.
- 7. Prior to commencing performance under the contract, the successful bidder shall, submit a certificate of insurance, in a form and in an amount satisfactory to the City.



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

BID FORM 1: Bidders Blank

- 1. Bids must meet the attached specifications. Any exceptions or modifications must be noted and fully explained.
- 2. Bidder's responses must be in ink or typewritten, and all blanks on the bid form should be completed.
- 3. The price or prices proposed should be stated both in WRITING and in FIGURES, and any proposal not so stated may be rejected. Contracts exceeding twelve months must specify annual costs for each year.
- 4. Bids **SHOULD BE TOTALED** so that the final cost is clearly stated (unless submitting a unit price bid), however **each item should be priced individually**. Do not group items. Awards may be made on the basis of *total* bid or by *individual items*.
- 5. All bids MUST BE SIGNED IN INK.

Name of Bidder (Firm or Individual):	
Contact Name:	
Business Address:	
Business Phone #:	
Contact Email Address:	
Agrees to bid on (Write the "Item Description" here):	
If the bidder's company is based in a state other than Rhode	
<u>Island</u> , list name and contact information for a local agent	
for service of process that is located within Rhode Island	
Delivery Date (if applicable):	
Name of Surety Company (if applicable):	
Total Amount in Writing*:	
Total Amount in Figures*:	
If you are submitting a unit price bid, please insert "Unit Price Bid"	
Use additional pages if necessary for additional bidding details.	
	Signature of Representation
	Title



BOARD OF CONTRACT AND SUPPLY CITY OF PROVIDENCE, RHODE ISLAND

BID BREAKDOWN

Base Bid as defined and noted in the Request for Proposal:

A. JOHN ROLLINS, LUMP SUM	\$
B. VINCENT BROWN, LUMP SUM	\$
C. WEST END, LUMP SUM	\$
D. ZUCCOLO, LUMP SUM	\$
E. TOTAL BASE BID	\$

Add Alternate #1: Igliozzi Recreation Center

F. LUMP SUM	\$

Signature of Representation
Title

Printed Name



BOARD OF CONTRACT AND SUPPLY CITY OF PROVIDENCE, RHODE ISLAND

BID FORM 2: Certification of Bidder

(Non-Discrimination/Hiring)

Up	Jpon behalf of	(Firm or Individual Bidding),
Ι,	,(N	ame of Person Making Certification),
bei	peing its	(Title or "Self"), hereby certify that:
1.	. Bidder does not unlawfully discriminate on the basis of race orientation and/or religion in its business and hiring practice	
2.	2. All of Bidder's employees have been hired in compliance w laws, rules and regulations.	ith all applicable federal, state and local
I af	affirm by signing below that I am duly authorized on behalf of	Bidder, on
this	hisday of20	
		Signature of Representation
	_	

Printed Name



BOARD OF CONTRACT AND SUPPLY CITY OF PROVIDENCE, RHODE ISLAND

BID FORM 3: Certificate Regarding Public Records

Upon	behalf of	(Firm or Individual Bidding),
being	its	(Title or "Self"), hereby certify an
	standing that:	
1.	(RFQ's), documents contained with	Requests for Proposals (RFP's) and Requests for Qualification hin, and the details outlined on those documents become public erk's office and opening at the corresponding Board of Contract
2.	effort to request that sensitive/per	e issuing department for this RFP/RFQ have made a conscious onal information be submitted directly to the issuing erification of specific details is critical the evaluation of a
3.	* **	nation may be crucial to evaluating bids. Failure to provide ication, or an inability to appropriately evaluate bids.
4.	If sensitive information that has n defined supplemental information submitted to the City Clerk, the C	t been requested is enclosed or if a bidder opts to enclose the prior to the issuing department's request in the bidding packet ty of Providence has no obligation to redact those details and ne information becoming public record.
5.	The City of Providence observes the bidding packet may not be sul	public and transparent bidding process. Information required in mitted directly to the issuing department at the discretion of the ormation, such as pricing terms, from becoming public. Bidders
I affir	m by signing below that I am duly a	athorized on behalf of Bidder, on
this	day of	
		Signature of Representation
		Signature of Representation



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

BID FORM 4: Affidavit of City Vendor

Per our Code of Ordinances Sec. 21.-28.1 (e), this form applies to a) the business, b) any political action committee whose name includes the name of the business, c) all persons holding ten (10) percent or greater equity interest or five thousand dollars (\$5,000.00) or greater cash value interest in the business at any time during the reporting period, d) all executive officers of the business entity, e) any spouse or dependent child of any individual identified in a) though d) above.

Executive officers who are not residents of the state of Rhode Island are exempted from this requirement.

Per <u>R.I.G.L.</u> § 36-14-2, "Business" means a sole proprietorship, partnership, firm, corporation, holding company, joint stock company, receivership, trust, or any other entity recognized in law through which business for profit or not for profit is conducted.

Nar	ne o	f the person making this affidavit:		
Pos	ition	in the "Business"		
Nar	ne o	f Entity		
Add	dress	::		_
Pho	ne n	umber:		
The	nun	nber of persons or entities in your entity th	hat are required to report under Sec. 2128.1 (e):	·
Rea	d th	ne following paragraph and answer one	of the options:	
are	not i	in writing within the 12 month period prec	this bid submission with the City of Providence, ceding the date of notification that the contract has calendar year to (please list all persons or entities	as reached the \$100,000 threshold,
a.	Me	mbers of the Providence City Council? □] Yes □ No	
	•	If Yes, please complete the following:		
		Recipient(s) of the Contribution: Contribution Date(s):	Contribution Amount(s):	
b.	Car •	ndidates for election or reelection to the Pr If Yes, please complete the following: Recipient(s) of the Contribution:	rovidence City Council? Yes No	
		Contribution Date(s):	Contribution Amount(s):	



BOARD OF CONTRACT AND SUPPLY CITY OF PROVIDENCE, RHODE ISLAND

 The Mayor of Providence? ☐ Yes ☐ No If Yes, please complete the following: Recipient(s) of the Contribution: 		
Contribution Date(s):	Contribution Amount(s):	
Candidates for election or reelection to the office If Yes, please complete the following: Recipient(s) of the Contribution: Contribution Date(s):	of Mayor of Providence? ☐ Yes Contribution Amount(s):	□ No
Signed under the pains and penalties of perju-	ry.	
	If Yes, please complete the following: Recipient(s) of the Contribution: Contribution Date(s): Candidates for election or reelection to the office If Yes, please complete the following: Recipient(s) of the Contribution: Contribution Date(s): Signed under the pains and penalties of perjusted.	 If Yes, please complete the following: Recipient(s) of the Contribution: Contribution Date(s):



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

MBE/WBE Participation Plan

Bidder's Name:

Please complete separate forms for each MBE/WBE subcontractor/supplier to be utilized on the solicitation.

Bidder's Address:						
Point of Contact:						
Telephone:						
Email:						
Procurement #:						
Project Name:						
Which one of the followiness' status in terrowned Business Enter State of Rhode Islands. This form is intended.	or Woman with the ly).	□MBE	□WBE	□Neither MBE nor W		
including a description Please note that all MI time of bid. The MBE instructions and requir Nonprofit or Construction provide upda	n of the work to be pose. BE/WBE subcontract /WBE Directory can rements). rganizations are not a projects unable to ates to the MBE/WI	erformed an tors/supplied be found had t required to identify su	d the percentagers must be certifere. Please visit, to complete the bcontractors p	e of the work as fied by the Offic the <u>City's MBI</u> rest of this for	submitted to the prime contracte of Diversity, Equity and Ope E/WBE page for details of the	actor/vendor. pportunity at the program (e.g.
Name of Subcontracto	or/Supplier:					
Type of RI Certification	on:	□MBE	$\Box W$	BE	□Neither	
Address:						
Point of Contact:						
Telephone:						
Email:						
Detailed Description of Work to Be Performed by Subcontractor or Materials to be Supplied by Supplier Per the Scope of Work provided in the RFP						
Total Contract Value ((\$):		Subcontr Value (\$)		Participation Rate (%):	
Anticipated Date of Po	erformance:					
I certify under penalty of perjury that the forgoing statements are true and correct.						
Prime Contractor/Vendor Signature				Title		Date
Subcontractor/Suppl			Title		Date	

^{*}If you did not meet the 20% MBE/WBE combined participation goal, submit a Waiver Request Form.



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

MBE/WBE Waiver Request Form

or Duly Authorized Representative

Fill out this form only if you did not meet the 20% MBE/WBE participation goal. State-certified MBE or WBE Prime Bidders are NOT REQUIRED to fill out this form.

Submit this form to the City of Providence MBE/WBE Outreach Director, Grace Diaz, at gdiaz@providenceri.gov, for review **prior** to bid submission. This waiver applies only to the current bid which you are submitting to the City of Providence and does not apply to other bids your company may submit in the future. In case a waiver is needed, City Department Directors should not recommend a bidder for an award if this form is not included, absent or is not signed by the city of Providence MBE/WBE director.

Prime Bidder:		Contact Email and Phone	
Company Name, Address:		Trade	
Project /Item Description (as seen	on RFP):		
Γο receive a waiver, you must lis whom you interacted, and the rea	son the MBE/WBE company		
MBE/WBE Company Name	Individual's Name	Company Name	Why did you choose not to work with this company?
vaiver of % MBE/WBE	(20% minus the value of B o	ox F on the Subcontractor Disclo	f the total bid value. I am requesting sure Form). If an opportunity is fort will be made to select MBE/W
Signature of Prime Contractor / or Duly Authorized Representativ	Printed Printed	Name	Date Signed
Signature of City of Providence MBE/WBE Outreach Director /		Name of City of Providence //BE Outreach Director	Date Signed



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

BID PACKAGE SPECIFICATIONS

See Construction Drawings and Specifications package under Attachment A.

PROVISIONS OF THIS PROJECT

- Upon the Issuance of the Award from the Board of Contract the City shall issue a Contract to be executed by the City and the vendor incorporating the bid specifications. All Provisions of the Specifications are binding.
- Any Permits Required by the City of Providence and/or State of Rhode Island Shall be Obtained by the Vendor Permit Fees by the City of Providence Shall be Waived the State ADA Fee Must be Paid
- This project qualifies for prevailing wages per the Davis Bacon Act (HUD). Federal certified payrolls will need to
 be submitted to the owner for all hours worked on site for this project. The Wage Decision for this project shall be as
 recorded on the Bid Date and is available at https://sam.gov/content/wage-determinations. Weekly Certified payrolls
 must be Submitted with Pay Requests Including Monthly Utilization Form
- Prime Contractor must be actively registered with SAM.gov to perform project.
- Prime Contractor must be enrolled in a registered apprenticeship program.
- An Insurance Certificate Shall be Submitted to the City Within 10 Days of Award
- A Copy of the Vendors Contractor's License Must be Submitted within 10 Days of Award
- All On-Site Personnel Shall be Licensed (If Required) and Shall have Proof of All Licenses Required by the State of Rhode Island to Perform the Work Required
- Pay Requests Must be Submitted on Approved AIA Billing Documents (City will Provide if Needed)
- All Subcontractors Shall be Listed on the Bid Form All Insurance & Payroll Requirements Apply
 - General Contractor Shall be the Insurance Certificate Holder and the City Shall be Named as 'Additionally Insured' with Respect to Liability Insurance
- A Submittal Log Must be Submitted within 10 Days of Award

CLOSE OUT DOCUMENTS

- Prior to Final Payment the Vendor Shall Provide the Following:
 - o Copies of Permits Signed off and Approved (If Any)
 - o Operating Manuals and Warranties Shall Be Transferred and/or Delivered
 - o Full and Completed As-Built Drawings Shall be Submitted for Approval
 - Training Shall be Provided to City Personnel (If Required)
 - o Certification by Manufacturers Representative (If Required)

QUALIFICATIONS

Qualifications will be evaluated on the basis of similar project experience for:

- a. Completion of similar projects within the last 5 years.
- b. Size and dollar value of similar completed projects.
- c. Contractor's performance with similar projects. (references will be checked)
- d. Relevant experience of individuals assigned to the project.



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

SUPPLEMENTAL INFORMATION

If the issuing department for this RFP determines that your firm's bid is best suited to accommodate their need, you will be asked to provide proof of the following prior to formalizing an award.

An inability to provide the outlined items at the request of the department may lead to the disqualification of your bid.

This information is <u>NOT</u> requested to be provided in your initial bid that you will submit to the City Clerk's office by the "date to be opened" noted on page 1. This list only serves as a list of items that your firm should be ready to provide on request.

<u>All bids submitted to the City Clerk become public record</u>. Failure to follow instructions could result in information considered private being posted to the city's Open Meetings Portal and made available as a public record.

You must be able to provide:

- Business Tax ID will be requested after an award is approved by the Board of Contract and Supply.
- Proof of Insurance.
- Certificate of Good Standing with the Rhode Island Secretary of State.

The following attachments are included as part of this RFP:

- Attachment A Construction Documents
- Attachment B Apprentice and First Source Requirements



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

CITY OF PROVIDENCE STANDARD TERMS & CONDITIONS

- 1. The terms "you" and "your" contained herein refer to the person or entity that is a party to the agreement with the City of Providence ("the City") and to such person's or entity's employees, officers, and agents.
- 2. The Request For Proposals ("RFP") and these Standard Terms and Conditions together constitute the entire agreement of the parties ("the Agreement") with regard to any and all matters. By your submission of a bid proposal or response to the City's RFP, you accept these Standard Terms & Conditions and agree that they supersede any conflicting provisions provided by bid or in any terms and conditions contained or linked within a bid and/or response. Changes in the terms and conditions of the Agreement, or the scope of work thereunder, may only be made by a writing signed by the parties.
- 3. You are an independent contractor and in no way does this Agreement render you an employee or agent of the City or entitle you to fringe benefits, workers' compensation, pension obligations, retirement or any other employment benefits. The City shall not deduct federal or state income taxes, social security or Medicare withholdings, or any other taxes required to be deducted by an employer, and this is your responsibility to yourself and your employees and agents.
- 4. You shall not assign your rights and obligations under this Agreement without the prior written consent of the City. Any assignment without prior written consent of the City shall be voidable at the election of the City. The City retains the right to refuse any and all assignments in the City's sole and absolute discretion.
- 5. Invoices submitted to the City shall be payable sixty (60) days from the time of receipt by the City. Invoices shall include support documentation necessary to evidence completion of the work being invoiced. The City may request any other reasonable documentation in support of an invoice. The time for payment shall not commence, and invoices shall not be processed for payment, until you provide reasonably sufficient support documentation. In no circumstances shall the City be obligated to pay or shall you be entitled to receive interest on any overdue invoice or payment. In no circumstances shall the City be obligated to pay any costs associated with your collection of an

- outstanding invoice.
- 6. For contracts involving construction, alteration, and/or repair work, the provisions of applicable state labor law concerning payment of prevailing wage rates (R.I. Gen. Laws §§ 37-13-1 et seq., as amended) and the City's First Source Ordinance (Providence Code of Ordinances §§ 21-91 et seq., as amended) apply.
- 7. With regard to any issues, claims, or controversies that may arise under this Agreement, the City shall not be required to submit to dispute resolution or mandatory/binding arbitration. Nothing prevents the parties from mutually agreeing to settle any disputes using mediation or non-binding arbitration.
- 8. To the fullest extent permitted by law, you shall indemnify, defend, and hold harmless the City, its employees, officers, agents, and assigns from and against any and all claims, damages, losses, allegations, demands, actions, causes of action, suits, obligations, fines, penalties, judgments, liabilities, costs and expenses, including but not limited to attorneys' fees, of any nature whatsoever arising out of, in connection with, or resulting from the performance of the work provided in the Agreement.
- 9. You shall maintain throughout the term of this Agreement the insurance coverage that is required by the RFP or, if none is required in the RFP, insurance coverage that is considered in your industry to be commercially reasonable, and you agree to name the City as an additional insured on your general liability policy and on any umbrella policy you carry.
- 10. The City shall not subject itself to any contractual limitations on liability. The City shall have the time permitted within the applicable statute of limitations, and no less, to bring or assert any and all causes of action, suits, claims or demands the City may have arising out of, in connection with, or resulting from the performance of the work provided in the Agreement, and in no event does the City agree to limit your liability to the price of the Agreement or any other monetary limit.
- 11. The City may terminate this Agreement upon five (5) days' written notice to you if you fail to observe any of the terms and conditions of this Agreement, or if the City believes your ability to perform the terms and conditions of this Agreement has been materially impaired in any way, including but in no

Revised: 4/29/2023



BOARD OF CONTRACT AND SUPPLYCITY OF PROVIDENCE, RHODE ISLAND

way limited to loss of insurance coverage, lapsing of a surety bond, if required, declaration of bankruptcy, or appointment of a receiver. In the event of termination by the City, you shall be entitled to just and equitable compensation for any satisfactory work completed and expenses incurred up to the date of termination.

- 12. Written notice hereunder shall be deemed to have been duly served if delivered in person to the individual or member of the firm or entity or to an officer of the entity for whom it was intended, or if delivered at or sent by registered or certified mail to the last business address known by the party providing notice.
- 13. In no event shall the Agreement automatically renew or be extended without a writing signed by the parties.
- 14. You agree that products produced or resulting from the performance of the Agreement are the sole property of the City and may not be used by you without the express written permission of the City.
- 15. For any Agreement involving the sharing or exchange of data involving potentially confidential and/or personal information, you shall comply with any and all state and/or federal laws or regulations applicable to confidential and/or personal information you receive from the City, including but not limited to the Rhode Island Identity Theft Protection Act, R.I. Gen. Laws § 11-49.3-1, during the term of the Agreement. You shall implement and maintain appropriate physical, technical, and administrative security measures for the protection of, and to prevent access to, use, or disclosure of, confidential and/or personal information. In the event of a breach of such information, you shall notify the City of such breach immediately, but in no event later than twenty-four (24) hours after discovery of such breach.
- 16. The Agreement is governed by the laws of the State of Rhode Island. You expressly submit yourself to and agree that any and all actions arising out of, in connection with, or resulting from the performance of the Agreement or relationship between the parties shall occur solely in the venue and jurisdiction of the State of Rhode Island or the federal court located in Rhode Island.
- 17. The failure of the City to require performance of any provision shall not affect the City's right to

- require performance at any time thereafter, nor shall a waiver of any breach or default of this Agreement constitute a waiver of any subsequent breach or default or a waiver of the provision itself.
- 18. If any term or provision of this Agreement, or the application thereof to any person or circumstance shall, in any extent, be invalid or unenforceable, the remainder of this Agreement shall not be affected thereby, and each term and provision shall be valid and enforceable to the fullest extent permitted by law.

CITY OF PROVIDENCE DEPARTMENT OF PUBLIC PROPERTY HVAC AND ELECTRICAL UPGRADES AT

VARIOUS RECREATION CENTERS PROVIDENCE, RI

PROJECT LOCATION MAPS

PROJECT LOCATION **PROVIDENCE** RHODE ISLAND RECREATION CENTER

VARIOUS RECREATION CENTERS

A. VINCENT IGLIOZZI **RECREATION CENTER** WEST END **RECREATION CENTER** JOHN H. ROLLINS

AREA MAP

VINCENT BROWN RECREATION CENTER 438 HOPE ST,

A. VINCENT IGLIOZZI RECREATION CENTER 675 PLAINFIELD ST,

JOHN H. ROLLINS RECREATION CENTER 674 PRAIRE AVE, PROVIDENCE, RI 02905

WEST END RECREATION CENTER 109 BUCKLIN ST,

ZUCCOLO RECREATION CENTER

LOCATION MAP

PROVIDENCE, RI 02909







LOCATION: VARIOUS RECREATION CENTERS

ADDRESS: VARIOUS LOCATIONS, PROVIDENCE, RI

OCCUPANCY CLASSIFICATION: ASSEMBLY GROUP A-3

G-000

SHEET INDEX SHEET NUMBER SHEET TITLE GENERAL COVER SHEET ARCHITECTURAL ARCHITECTURAL PLANS - BROWN ARCHITECTURAL PLANS - IGLIOZZI **ARCHITECTURAL PLANS - ROLLINS** ARCHITECTURAL PLANS - WEST END ARCHITECTURAL PLANS - ZUCCOLO ARCHITECTURAL DETAILS MECHANICAL MECHANICAL COVER SHEET MECHANICAL DEMOLITION PLANS - BROWN MECHANICAL DEMOLITION PLANS - IGLIOZZI MECHANICAL DEMOLITION PLANS - ROLLINS MECHANICAL DEMOLITION PLANS - WEST END MECHANICAL DEMOLITION PLANS - ZUCCOLO MECHANICAL PLANS - BROWN MECHANICAL PLANS - IGLIOZZI MECHANICAL PLANS - ROLLINS MECHANICAL PLANS - WEST END MECHANICAL PLANS - ZUCCOLO MECHANICAL DETAILS & CONTROL DIAGRAMS ELECTRICAL E-000 **ELECTRICAL COVER SHEET** ELECTRICAL DEMOLITION PLANS - BROWN **ELECTRICAL DEMOLITION PLANS - IGLIOZZI** ELECTRICAL DEMOLITION PLANS - ROLLINS ELECTRICAL DEMOLITION PLANS - WEST END ELECTRICAL DEMOLITION PLANS - ZUCCOLO E-101 **ELECTRICAL PLANS - BROWN** This drawing is the property of <u>StudioJAED</u> and is prepared for the exclusive use of its clients at the location indicated. No other use ELECTRICAL PLANS - IGLIOZZI E-103 ELECTRICAL PLANS - ROLLINS ARCHITECT / ENGINEER SEAL ELECTRICAL PLANS - WEST END E-105 ELECTRICAL PLANS - ZUCCOLO E-500 ELECTRICAL DETAILS PLUMBING PLUMBING PLANS REVISIONS CODE INFORMATION 1. APPLICABLE CODES AND STANDARDS 2021 SBC-1 RHODE ISLAND STATE BUILDING CODE (IBC 2018) 2021 SBC-3 RHODE ISLAND STATE PLUMBING CODE (IPC 2018) 2021 SBC-4 RHODE ISLAND STATE MECHANICAL CODE (IMC 2018) **COVER SHEET** 2021 SBC-5 RHODE ISLAND STATE ELECTRICAL CODE (NEC 2020) 2021 SBC-8 RHODE ISLAND STATE ENERGY CONSERVATION CODE (IECC 2018) NFPA 101, LIFE SAFETY CODE, 2018 CONSTRUCTION NFPA 72 NATIONAL FIRE ALARM AND SIGNALING CODE, 2019 NFPA 13 STANDARD FOR THE INSTALLATION OF SPRINKLER SYSTEMS, 2016 DOCUMENTS ICC ANSI A117.1, 2017 OCTOBER 15, 2024 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN (ADAAG) 2. PROJECT DATA OWNER: DEPARTMENT OF PUBLIC PROPERTY

PROVIDENCE, RI 02906

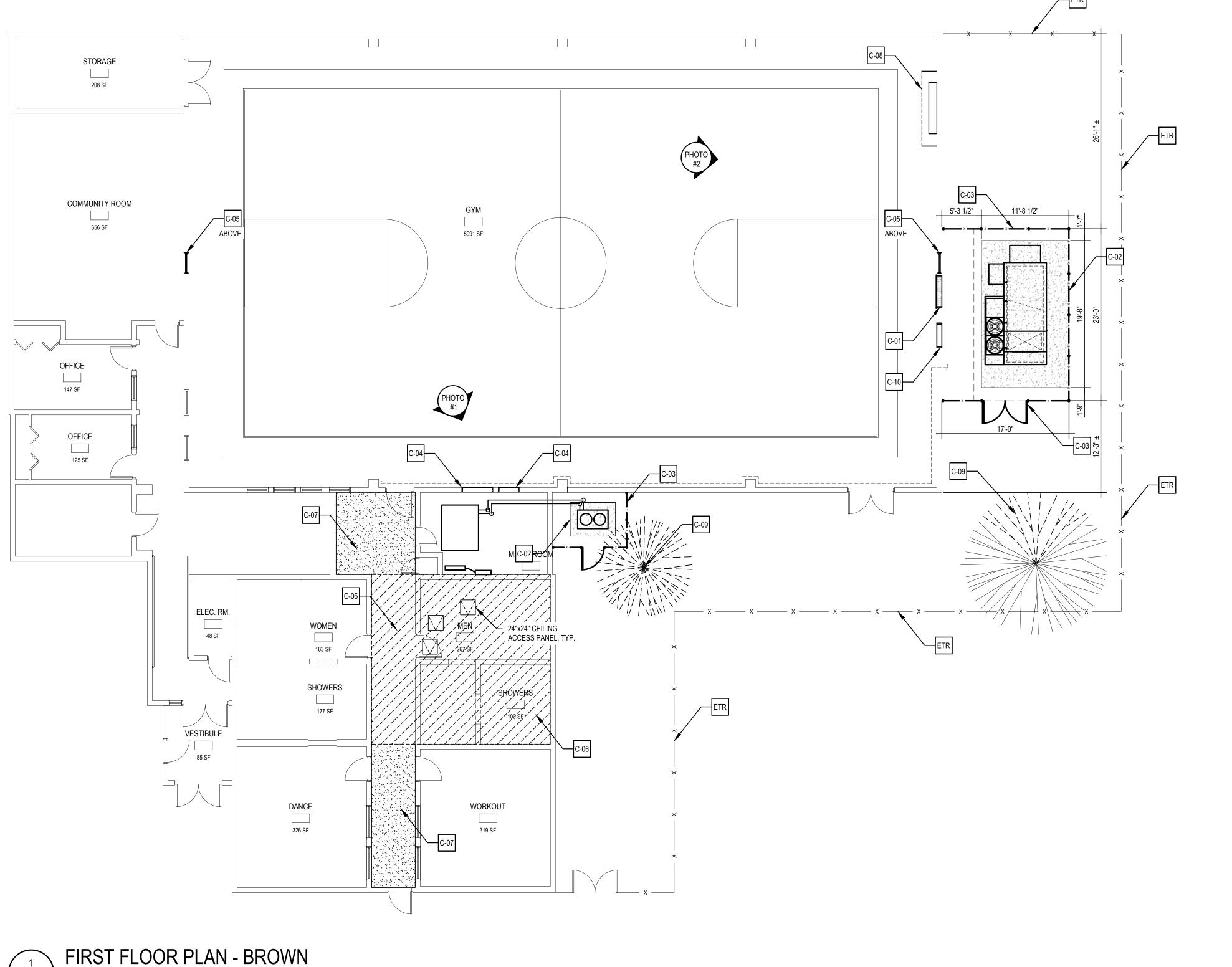
PROVIDENCE, RI 02909

PROVIDENCE, RI 02907

18 GESLER ST,

SITE MAP

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A-101 SCALE: 1/8" = 1'-0"

GENERAL NOTES

- ALL AREAS AND PARTITIONS NOT DASHED OR NOTED TO BE REMOVED SHALL REMAIN INTACT. PATCH AND REPAIR EXISTING ADJACENT PARTITIONS AND FINISHES AS REQUIRED AFTER DEMOLITION TO MATCH EXISTING OR IN ACCORDANCE W/ PROPOSED
- PROVIDE INTERIOR AND EXTERIOR SHORING, BRACING, OR OTHER SUPPORT TO PREVENT MOVEMENT, SETTLEMENT, OR
- COLLAPSE OF ELEMENTS TO BE DEMOLISHED AND ADJACENT EXISTING ELEMENTS TO REMAIN. SELECTIVE DEMOLITION WORK INCLUDES REMOVAL OF NON-STRUCTURAL ITEMS INDICATED. REFER TO MECH, PLBG, ELEC,
- LOCATE AND IDENTIFY EXISTING UTILITIES, INCLUDING SANITARY SEWER SYSTEM, AND ASCERTAIN THEIR CONDITION TO ENSURE ADEQUATE PERFORMANCE OF ALL UTILITIES IN NEW CONSTRUCTION. PROTECT UTILITY LINES AND HARDWARE DURING DEMOLITION AND CONSTRUCTION PHASES.
- THE CONTRACTOR SHALL SAFELY SECURE ANY AND ALL PIPING, WIRING, CABLES, OR DEVICES THAT ARE NOT SCHEDULED FOR
- DEMOLITION THAT WERE SECURED BY ITEMS THAT HAVE BEEN OR ARE SCHEDULED FOR DEMOLITION. 6. UPON COMPLETION OF THE DEMOLITION WORK, ALL AREAS SHALL BE LEFT BROOM CLEAN TO THE SATISFACTION OF THE OWNER.

DEMOLITION DWGS FOR ADDITIONAL SCOPE. THIS DRAWING DOES NOT SHOW ELEC, WATER, HVAC, AND MOST OTHER SERVICES

- CONTRACTOR SHALL PROMPTLY PATCH AND REPAIR DAMAGE CAUSED TO ADJACENT CONSTRUCTION BY DEMOLITION WORK. RESTORE EXPOSED FINISHES IN A MANNER THAT ELIMINATES EVIDENCE OF PATCHING AND REFINISHING.
- 8. IF HAZARDOUS MATERIALS ARE ENCOUNTERED DURING DEMOLITION OPERATIONS, NOTIFY OWNER IMMEDIATELY COMPLY WITH APPLICABLE REGULATIONS, LAWS, AND ORDINANCES CONCERNING REMOVAL, HANDLING, AND PROTECTION AGAINST EXPOSURE OR ENVIRONMENTAL POLLUTION. BURNING OF REMOVED MATERIALS IS NOT PERMITTED ON THE PROJECT SITE.
- 9. COORDINATE ALL DEMOLITION WORK ON THE EXISTING BUILDING WITH THE OWNER BEFORE PROCEEDING.
- 10. COORDINATE ROOF BREECHING INFILL LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 12 & 13/A-501 FOR MORE
- 11. COORDINATE NEW ROOF OPENING LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 10 & 11/A-501 FOR MORE

12. PROVIDE ABUSE RESISTANT GYP. BD. UNLESS NOTED OTHERWISE.

(KEY NOTES MAY **KEY NOTES** VARY BY SHEET)

- DEMOLISH AND DISPOSE OF EXISTING MASONRY EXTERIOR WALL AS INDICATED, INCLUDING BUT NOT LIMITED TO, ALL CMU $^{\prime\prime}$ blocks, Bricks, Masonry Ties, and Fasteners. Coordinate exact opening size & location with Mechanical Drawings $rlief{T}$ PROVIDE TEMPORARY SHORING PRIOR TO NEW LINTEL INSTALLATION. FURNISH AND INSTALL NEW LINTEL AT NEW EXTERIOR WALL DUCT PENETRATION. MINIMUM 8" BEARING AT EACH END. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS AND ARCHITECT IN FIELD. SEE EXTERIOR WALL DUCT PENETRATION DETAIL 1/A-501 FOR MORE INFORMATION.
- REMOVE EXISTING VEGETATION, RAISED PLANTING BEDS, AND EARTH TO -2'-0" BELOW GRADE AS REQUIRED TO FACILITATE NEW TURN-DOWN SLAB. FURNISH AND INSTALL NEW TURNED-DOWN SLAB ON GRADE, BELOW NEW UNIT. SEE TURNED-DOWN SLAB DETAIL 2/A-501. TURNED-DOWN SLAB TO EXTEND PAST AIR HANDLING UNIT FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 3'-0". TURNED-DOWN SLAB TO EXTEND PAST **HEAT PUMP UNIT** FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 1'-0".
- $\,\,\,$ REMOVE EXISTING VEGETATION, RAISED PLANTING BEDS, AND EARTH AS REQUIRED TO FACILITATE NEW FENCE WITH ASSOCIATED $^{\text{C-U}3}$ FOOTINGS. FURNISH AND INSTALL NEW 6'-0" TALL CHAINLINK FENCE WITH GATE, PRIVACY SLATS, AND ASSOCIATED CONCRETE FOOTINGS. NEW 3'-0" GATES TO BE CENTERED ON NEW TURN-DOWN SLAB, SEE PLAN FOR QUANTITY. POSTS TO BE PLACED NO MORE THAN 5'-0" O.C. SEE TYPICAL CHAINLINK FENCE DETAILS 4 & 5/A-501 FOR MORE INFORMATION.
- AT LOCATION OF DEMOLISHED DUCT PENETRATION, INFILL MASONRY OPENING WITH NEW PAINTED TYPE "X" GYP. BD. OVER 3 5/8" C-04 CFMF STUDS @ 16" O.C. COLOR TO MATCH ADJACENT SURFACE. SEE WALL INFILL DETAIL 6/A-501 FOR MORE INFORMATION.
- AT LOCATION OF DEMOLISHED EXHAUST FAN, FURNISH AND INSTALL NEW STOREFRONT SYSTEM WITH INSULATED PANEL TO INFIL EXISTING MASONRY OPENING - VERIFY SIZE OF M.O. IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION.
- CLIENTS AT THE LOCATION INDICATED. NO OTHER 🗍 DEMOLISH EXISTING GYP. BD. CEILING, INCLUDING BUT NOT LIMITED TO, EXISTING FRAMING, FASTENERS, AND ACCESS PANELS AS USE IS AUTHORIZED OR INTENDED. REQUIRED TO FACILITATE MECHANICAL SCOPE. HATCHED AREA INDICATES EXTENT OF DEMOLITION. COORDINATE WITH MECHANICAL DRAWINGS. REMOVE AND STORE / SUSPEND EXISTING LIGHTS, AND FIRE DETECTION DEVICES FOR REINSTALLATION. FURNISH AND INSTALL NEW PAINTED GYP. BD. CEILING, INCLUDING NEW CHICAGO GRID AND NEW ACCESS PANELS. REINSTALL EXISTING ELECTRICAL AND FIRE DETECTION DEVICES, AND LIGHTING. COORDINATE LOCATION OF NEW ACCESS PANELS IN FIELD SEE MECHANICAL AND ELECTRICAL PLANS FOR ADDITIONAL INFORMATION. MOISTURE RESISTANT GYP. BD IS TO BE INSTALLED IN RESTROOMS AND SHOWERS.
- $\mid \mid_{ extsf{C-07}} \mid$ PATCH AND PAINT ADJACENT CEILING TO NEAREST WALL BREAK AND BLEND TO EXISTING COLOR/SHADE.
- REMOVE EXISTING SCOREBOARD AND ASSOCIATED BRACKETS AND NETTING. COORDINATE NEW HEIGHT/LOCATION IN THE FIELD ³⁻⁰⁸ WITH OWNER. PROVIDE NEW, SHORTER NET IF EXISTING HANGS BELOW 10'-0" A.F.F.
- C-09 TRIM/REMOVE EXISTING TREE/VEGETATION AS REQUIRED TO FACILITATE INSTALLATION OF NEW HVAC UNIT.
- DEMOLISH AND DISPOSE OF EXISTING EXTERIOR STOREFRONT GLAZING, EXISTING FRAME TO REMAIN. INFILL EXISTING FRAME WITH NEW INSULATED PANEL - VERIFY SIZE OF OPENING IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION.
 PROVIDE FLASHING AND SEALANT AT MECHANICAL OPENING. SEE MECHANICAL DRAWINGS FOR MORE INFORMATION.

SYMBOL LEGEND

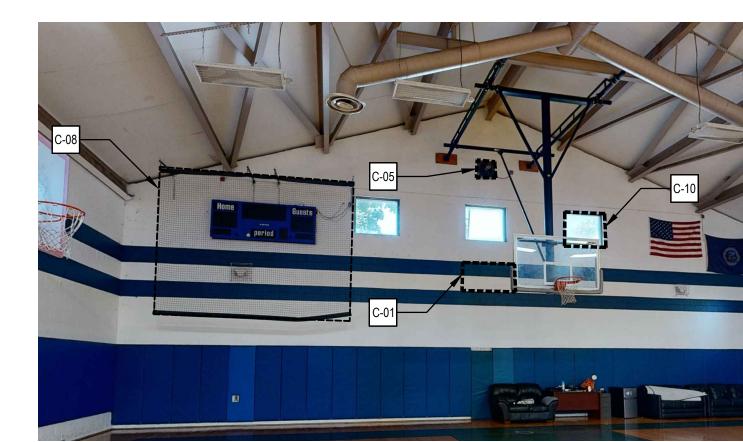
KEY NOTE TAG. SEE KEY NOTE INSTRUCTIONS / NARRATIVE FOR MORE INFORMATION HATCH INDICATES EXTENT OF

GYP. BD CEILING REPLACEMENT

HATCH INDICATES EXTENT OF EXISTING CEILING TO BE PAINTED

EXISTING TREE TO BE TRIMMED OR REMOVED TO FACILITATE CONSTRUCTION

REFERENCE PHOTO #1



REFERENCE PHOTO #2

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ARCHITECT / ENGINEER SEAL

REVISIONS

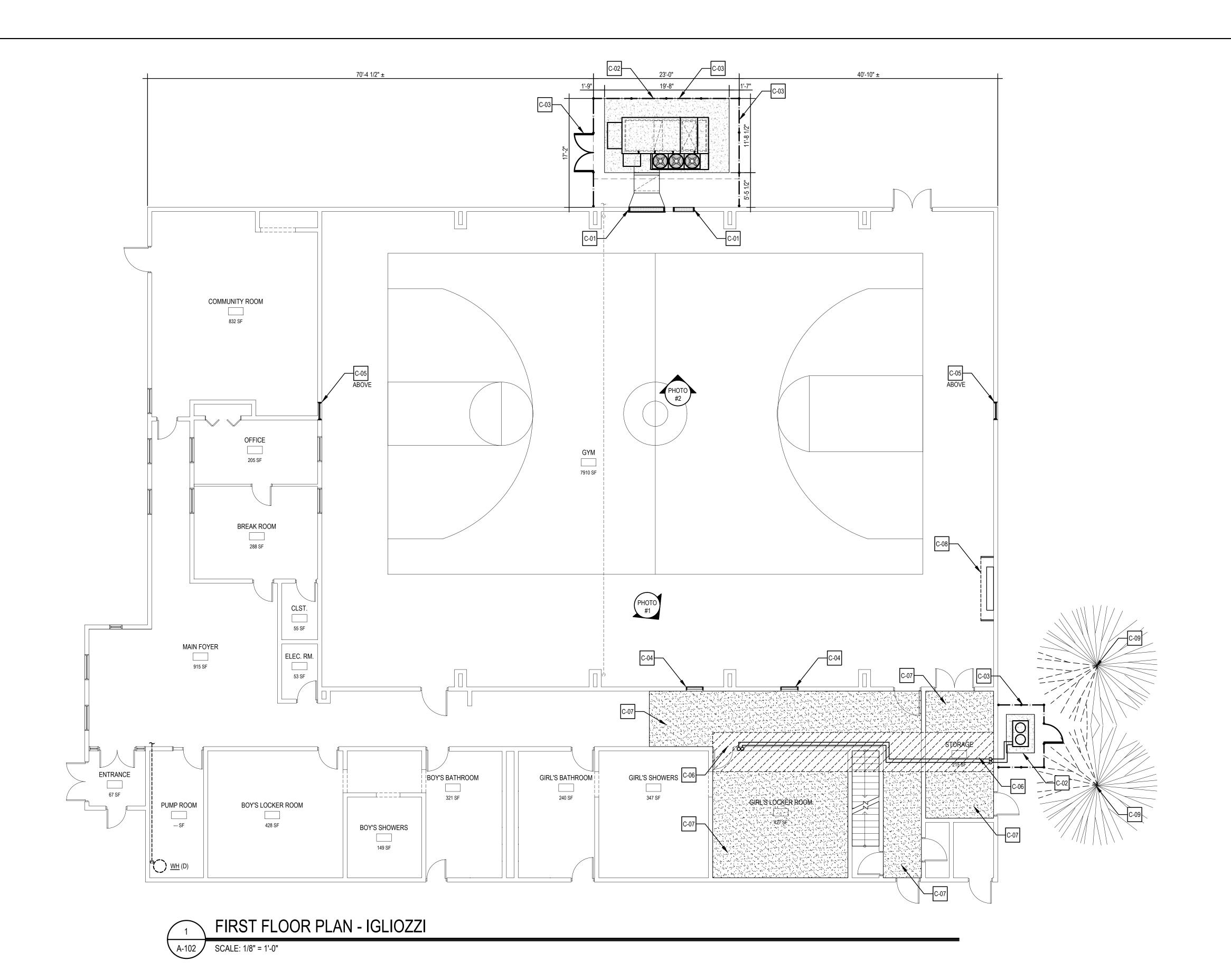
DESCRIPTION

ARCHITECTURAL PLANS - BROWN

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GENERAL NOTES ALL AREAS AND PARTITIONS NOT DASHED OR NOTED TO BE REMOVED SHALL REMAIN INTACT. PATCH AND REPAIR EXISTING ADJACENT PARTITIONS AND FINISHES AS REQUIRED AFTER DEMOLITION TO MATCH EXISTING OR IN ACCORDANCE W/ PROPOSED PROVIDE INTERIOR AND EXTERIOR SHORING, BRACING, OR OTHER SUPPORT TO PREVENT MOVEMENT, SETTLEMENT, OR COLLAPSE OF ELEMENTS TO BE DEMOLISHED AND ADJACENT EXISTING ELEMENTS TO REMAIN. SELECTIVE DEMOLITION WORK INCLUDES REMOVAL OF NON-STRUCTURAL ITEMS INDICATED. REFER TO MECH, PLBG, ELEC,

DEMOLITION DWGS FOR ADDITIONAL SCOPE. THIS DRAWING DOES NOT SHOW ELEC, WATER, HVAC, AND MOST OTHER SERVICES

4. LOCATE AND IDENTIFY EXISTING UTILITIES, INCLUDING SANITARY SEWER SYSTEM, AND ASCERTAIN THEIR CONDITION TO ENSURE ADEQUATE PERFORMANCE OF ALL UTILITIES IN NEW CONSTRUCTION. PROTECT UTILITY LINES AND HARDWARE DURING DEMOLITION AND CONSTRUCTION PHASES.

THE CONTRACTOR SHALL SAFELY SECURE ANY AND ALL PIPING, WIRING, CABLES, OR DEVICES THAT ARE NOT SCHEDULED FOR DEMOLITION THAT WERE SECURED BY ITEMS THAT HAVE BEEN OR ARE SCHEDULED FOR DEMOLITION.

6. UPON COMPLETION OF THE DEMOLITION WORK, ALL AREAS SHALL BE LEFT BROOM CLEAN TO THE SATISFACTION OF THE OWNER. CONTRACTOR SHALL PROMPTLY PATCH AND REPAIR DAMAGE CAUSED TO ADJACENT CONSTRUCTION BY DEMOLITION WORK.

RESTORE EXPOSED FINISHES IN A MANNER THAT ELIMINATES EVIDENCE OF PATCHING AND REFINISHING. 8. IF HAZARDOUS MATERIALS ARE ENCOUNTERED DURING DEMOLITION OPERATIONS, NOTIFY OWNER IMMEDIATELY COMPLY WITH APPLICABLE REGULATIONS, LAWS, AND ORDINANCES CONCERNING REMOVAL, HANDLING, AND PROTECTION AGAINST EXPOSURE

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9. COORDINATE ALL DEMOLITION WORK ON THE EXISTING BUILDING WITH THE OWNER BEFORE PROCEEDING.

10. COORDINATE ROOF BREECHING INFILL LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 12 & 13/A-501 FOR MORE

11. COORDINATE NEW ROOF OPENING LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 10 & 11/A-501 FOR MORE

12. PROVIDE ABUSE RESISTANT GYP. BD. UNLESS NOTED OTHERWISE.

(KEY NOTES MAY **KEY NOTES** VARY BY SHEET)

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REMOVE EXISTING VEGETATION AND EARTH TO -2'-0" BELOW GRADE AS REQUIRED TO FACILITATE NEW TURN-DOWN SLAB. FURNISH AND INSTALL NEW TURNED-DOWN SLAB ON GRADE, BELOW NEW UNIT. SEE TURNED-DOWN SLAB DETAIL 2/A-501. TURNED-DOWN SLAB TO EXTEND PAST AIR HANDLING UNIT FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 3'-0". TURNED-DOWN SLAB TO EXTEND PAST **HEAT PUMP UNIT** FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 1'-0".

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REMOVE AND STORE / SUSPEND EXISTING LIGHTS, AND FIRE DETECTION DEVICES FOR REINSTALLATION. FURNISH AND INSTALL NEW PAINTED GYP. BD. CEILING, INCLUDING NEW CHICAGO GRID. REINSTALL EXISTING ELECTRICAL AND FIRE DETECTION DEVICES,

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AND LIGHTING. SEE MECHANICAL AND ELECTRICAL PLANS FOR ADDITIONAL INFORMATION. C-07 PATCH AND PAINT ADJACENT CEILING TO NEAREST WALL BREAK AND BLEND TO EXISTING COLOR/SHADE.

C-08 REMOVE EXISTING SCOREBOARD AND ASSOCIATED BRACKETS AND NETTING. COORDINATE NEW HEIGHT/LOCATION IN THE FIELD WITH OWNER. PROVIDE NEW, SHORTER NET IF EXISTING HANGS BELOW 10'-0" A.F.F.

C-09 TRIM/REMOVE EXISTING TREE/VEGETATION AS REQUIRED TO FACILITATE INSTALLATION OF NEW HVAC UNIT.

SYMBOL LEGEND

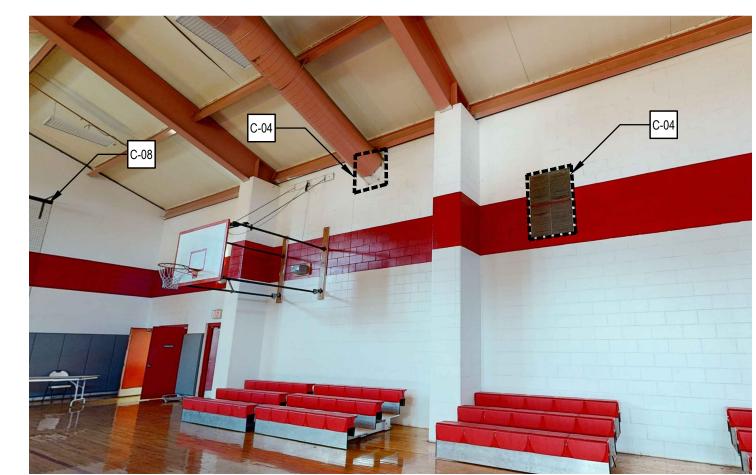
KEY NOTE TAG. SEE KEY NOTE INSTRUCTIONS / NARRATIVE FOR MORE INFORMATION

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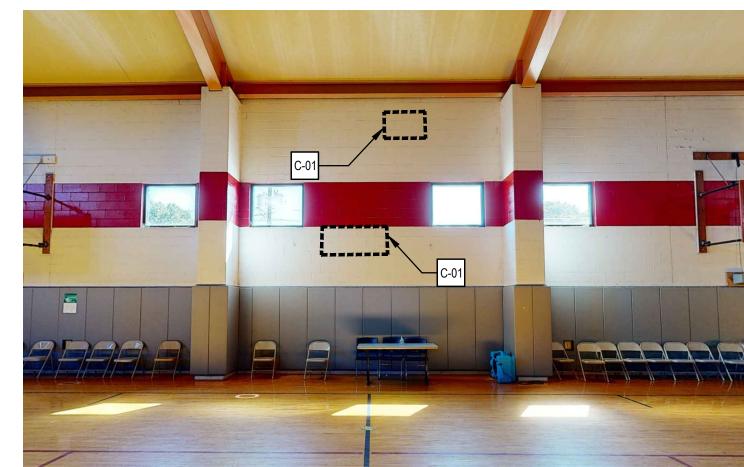
HATCH INDICATES EXTENT OF GYP. BD CEILING REPLACEMENT

EXISTING TREE TO BE TRIMMED OR REMOVED TO FACILITATE CONSTRUCTION

HATCH INDICATES EXTENT OF EXISTING CEILING TO BE PAINTED



REFERENCE PHOTO #1



REFERENCE PHOTO #2

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ARCHITECT / ENGINEER SEAL

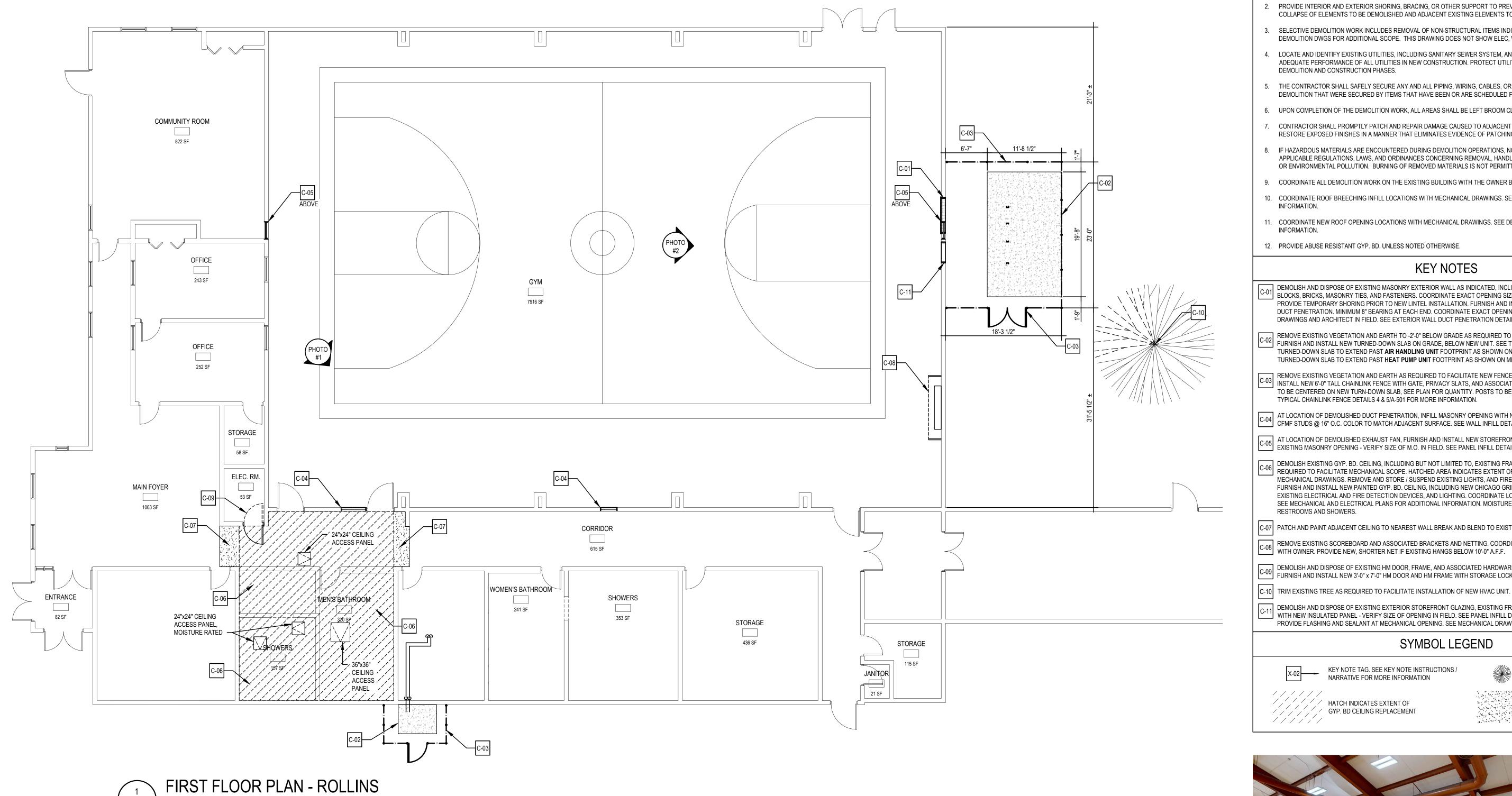
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CONSTRUCTION DOCUMENTS OCTOBER 15, 2024

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GENERAL NOTES

- ALL AREAS AND PARTITIONS NOT DASHED OR NOTED TO BE REMOVED SHALL REMAIN INTACT. PATCH AND REPAIR EXISTING ADJACENT PARTITIONS AND FINISHES AS REQUIRED AFTER DEMOLITION TO MATCH EXISTING OR IN ACCORDANCE W/ PROPOSED
- PROVIDE INTERIOR AND EXTERIOR SHORING, BRACING, OR OTHER SUPPORT TO PREVENT MOVEMENT, SETTLEMENT, OR COLLAPSE OF ELEMENTS TO BE DEMOLISHED AND ADJACENT EXISTING ELEMENTS TO REMAIN.
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12. PROVIDE ABUSE RESISTANT GYP. BD. UNLESS NOTED OTHERWISE.

DEMOLITION AND CONSTRUCTION PHASES.

(KEY NOTES MAY **KEY NOTES** VARY BY SHEET)

DEMOLISH AND DISPOSE OF EXISTING MASONRY EXTERIOR WALL AS INDICATED, INCLUDING BUT NOT LIMITED TO, ALL CMU BLOCKS, BRICKS, MASONRY TIES, AND FASTENERS. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS PROVIDE TEMPORARY SHORING PRIOR TO NEW LINTEL INSTALLATION. FURNISH AND INSTALL NEW LINTEL AT NEW EXTERIOR WALL DUCT PENETRATION. MINIMUM 8" BEARING AT EACH END. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS AND ARCHITECT IN FIELD. SEE EXTERIOR WALL DUCT PENETRATION DETAIL 1/A-501 FOR MORE INFORMATION.

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REMOVE EXISTING VEGETATION AND EARTH AS REQUIRED TO FACILITATE NEW FENCE WITH ASSOCIATED FOOTINGS. FURNISH AND INSTALL NEW 6'-0" TALL CHAINLINK FENCE WITH GATE, PRIVACY SLATS, AND ASSOCIATED CONCRETE FOOTINGS. NEW 3'-0" GATES TO BE CENTERED ON NEW TURN-DOWN SLAB, SEE PLAN FOR QUANTITY. POSTS TO BE PLACED NO MORE THAN 5'-0" O.C. SEE TYPICAL CHAINLINK FENCE DETAILS 4 & 5/A-501 FOR MORE INFORMATION.

AT LOCATION OF DEMOLISHED DUCT PENETRATION, INFILL MASONRY OPENING WITH NEW PAINTED TYPE "X" GYP. BD. OVER 3 5/8" C-04] CFMF STUDS @ 16" O.C. COLOR TO MATCH ADJACENT SURFACE. SEE WALL INFILL DETAIL 6/A-501 FOR MORE INFORMATION.

C-05 AT LOCATION OF DEMOLISHED EXHAUST FAN, FURNISH AND INSTALL NEW STOREFRONT SYSTEM WITH INSULATED PANEL TO INFILL EXISTING MASONRY OPENING - VERIFY SIZE OF M.O. IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION.

🗍 DEMOLISH EXISTING GYP. BD. CEILING, INCLUDING BUT NOT LIMITED TO, EXISTING FRAMING, FASTENERS, AND ACCESS PANELS AS ^{--UO} REQUIRED TO FACILITATE MECHANICAL SCOPE. HATCHED AREA INDICATES EXTENT OF DEMOLITION. COORDINATE WITH MECHANICAL DRAWINGS. REMOVE AND STORE / SUSPEND EXISTING LIGHTS, AND FIRE DETECTION DEVICES FOR REINSTALLATION. FURNISH AND INSTALL NEW PAINTED GYP. BD. CEILING, INCLUDING NEW CHICAGO GRID AND NEW ACCESS PANELS. REINSTALL EXISTING ELECTRICAL AND FIRE DETECTION DEVICES, AND LIGHTING. COORDINATE LOCATION OF NEW ACCESS PANELS IN FIELD SEE MECHANICAL AND ELECTRICAL PLANS FOR ADDITIONAL INFORMATION. MOISTURE RESISTANT GYP. BD IS TO BE INSTALLED IN RESTROOMS AND SHOWERS.

C-07 PATCH AND PAINT ADJACENT CEILING TO NEAREST WALL BREAK AND BLEND TO EXISTING COLOR/SHADE.

REMOVE EXISTING SCOREBOARD AND ASSOCIATED BRACKETS AND NETTING. COORDINATE NEW HEIGHT/LOCATION IN THE FIELD with owner. Provide New, Shorter Net if Existing Hangs Below 10'-0" A.F.F.

DEMOLISH AND DISPOSE OF EXISTING HM DOOR, FRAME, AND ASSOCIATED HARDWARE. TEMPORARILY SHORE AS REQUIRED. FURNISH AND INSTALL NEW 3'-0" x 7'-0" HM DOOR AND HM FRAME WITH STORAGE LOCKSET IN EXISTING 3'-4" x 7'-4" M.O.

DEMOLISH AND DISPOSE OF EXISTING EXTERIOR STOREFRONT GLAZING, EXISTING FRAME TO REMAIN. INFILL EXISTING FRAME WITH NEW INSULATED PANEL - VERIFY SIZE OF OPENING IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION. PROVIDE FLASHING AND SEALANT AT MECHANICAL OPENING. SEE MECHANICAL DRAWINGS FOR MORE INFORMATION.

SYMBOL LEGEND

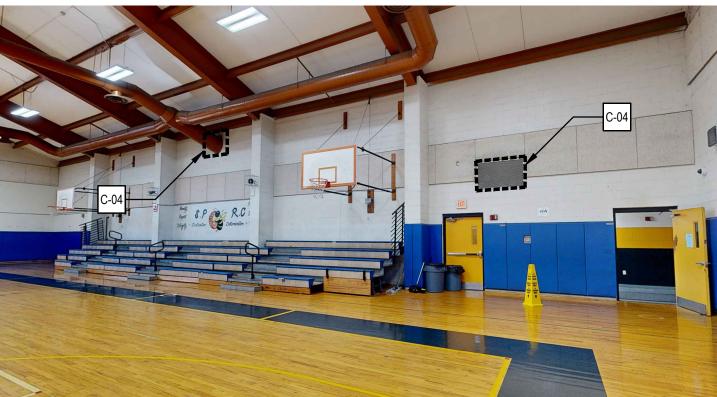
KEY NOTE TAG. SEE KEY NOTE INSTRUCTIONS / NARRATIVE FOR MORE INFORMATION

HATCH INDICATES EXTENT OF GYP. BD CEILING REPLACEMENT

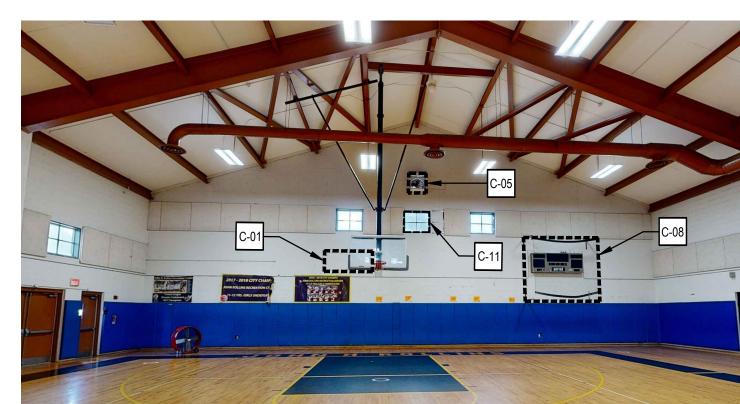
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EXISTING TREE TO BE TRIMMED OR REMOVED TO FACILITATE CONSTRUCTION

HATCH INDICATES EXTENT OF EXISTING CEILING TO BE PAINTED



REFERENCE PHOTO #1



REFERENCE PHOTO #2

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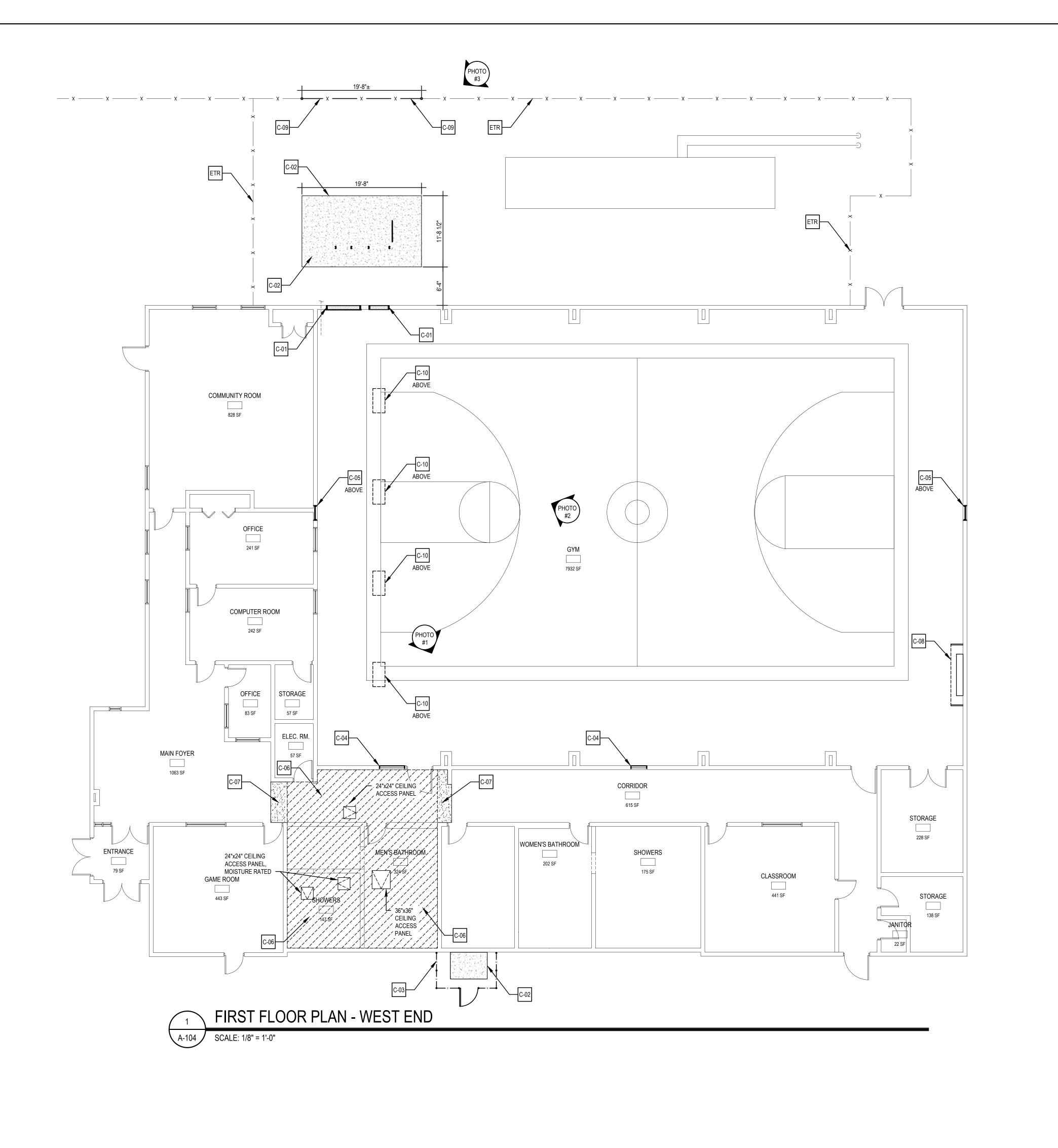
ARCHITECT / ENGINEER SEAL

REVISIONS DESCRIPTION

ARCHITECTURAL PLANS - ROLLINS

CONSTRUCTION DOCUMENTS OCTOBER 15, 2024

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GENERAL NOTES

ALL AREAS AND PARTITIONS NOT DASHED OR NOTED TO BE REMOVED SHALL REMAIN INTACT. PATCH AND REPAIR EXISTING ADJACENT PARTITIONS AND FINISHES AS REQUIRED AFTER DEMOLITION TO MATCH EXISTING OR IN ACCORDANCE W/ PROPOSED

PROVIDE INTERIOR AND EXTERIOR SHORING, BRACING, OR OTHER SUPPORT TO PREVENT MOVEMENT, SETTLEMENT, OR COLLAPSE OF ELEMENTS TO BE DEMOLISHED AND ADJACENT EXISTING ELEMENTS TO REMAIN.

SELECTIVE DEMOLITION WORK INCLUDES REMOVAL OF NON-STRUCTURAL ITEMS INDICATED. REFER TO MECH, PLBG, ELEC,

LOCATE AND IDENTIFY EXISTING UTILITIES, INCLUDING SANITARY SEWER SYSTEM, AND ASCERTAIN THEIR CONDITION TO ENSURE ADEQUATE PERFORMANCE OF ALL UTILITIES IN NEW CONSTRUCTION. PROTECT UTILITY LINES AND HARDWARE DURING DEMOLITION AND CONSTRUCTION PHASES.

THE CONTRACTOR SHALL SAFELY SECURE ANY AND ALL PIPING, WIRING, CABLES, OR DEVICES THAT ARE NOT SCHEDULED FOR DEMOLITION THAT WERE SECURED BY ITEMS THAT HAVE BEEN OR ARE SCHEDULED FOR DEMOLITION.

DEMOLITION DWGS FOR ADDITIONAL SCOPE. THIS DRAWING DOES NOT SHOW ELEC, WATER, HVAC, AND MOST OTHER SERVICES

6. UPON COMPLETION OF THE DEMOLITION WORK, ALL AREAS SHALL BE LEFT BROOM CLEAN TO THE SATISFACTION OF THE OWNER.

CONTRACTOR SHALL PROMPTLY PATCH AND REPAIR DAMAGE CAUSED TO ADJACENT CONSTRUCTION BY DEMOLITION WORK. RESTORE EXPOSED FINISHES IN A MANNER THAT ELIMINATES EVIDENCE OF PATCHING AND REFINISHING.

8. IF HAZARDOUS MATERIALS ARE ENCOUNTERED DURING DEMOLITION OPERATIONS, NOTIFY OWNER IMMEDIATELY COMPLY WITH APPLICABLE REGULATIONS, LAWS, AND ORDINANCES CONCERNING REMOVAL, HANDLING, AND PROTECTION AGAINST EXPOSURE OR ENVIRONMENTAL POLLUTION. BURNING OF REMOVED MATERIALS IS NOT PERMITTED ON THE PROJECT SITE.

9. COORDINATE ALL DEMOLITION WORK ON THE EXISTING BUILDING WITH THE OWNER BEFORE PROCEEDING.

10. COORDINATE ROOF BREECHING INFILL LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 12 & 13/A-501 FOR MORE 11. COORDINATE NEW ROOF OPENING LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 10 & 11/A-501 FOR MORE

12. PROVIDE ABUSE RESISTANT GYP. BD. UNLESS NOTED OTHERWISE.

(KEY NOTES MAY **KEY NOTES** VARY BY SHEET)

DEMOLISH AND DISPOSE OF EXISTING MASONRY EXTERIOR WALL AS INDICATED, INCLUDING BUT NOT LIMITED TO, ALL CMU BLOCKS, BRICKS, MASONRY TIES, AND FASTENERS. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS PROVIDE TEMPORARY SHORING PRIOR TO NEW LINTEL INSTALLATION. FURNISH AND INSTALL NEW LINTEL AT NEW EXTERIOR WALL DUCT PENETRATION. MINIMUM 8" BEARING AT EACH END. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS AND ARCHITECT IN FIELD. SEE EXTERIOR WALL DUCT PENETRATION DETAIL 1/A-501 FOR MORE INFORMATION.

🗍 REMOVE EXISTING VEGETATION AND EARTH TO -2'-0" BELOW GRADE AS REQUIRED TO FACILITATE NEW TURN-DOWN SLAB. FURNISH AND INSTALL NEW TURNED-DOWN SLAB ON GRADE, BELOW NEW UNIT. SEE TURNED-DOWN SLAB DETAIL 2/A-501. TURNED-DOWN SLAB TO EXTEND PAST **AIR HANDLING UNIT** FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 3'-0". TURNED-DOWN SLAB TO EXTEND PAST **HEAT PUMP UNIT** FOOTPRINT AS SHOWN ON MECHANICAL PLANS, MIN. 1'-0".

REMOVE EXISTING VEGETATION AND EARTH AS REQUIRED TO FACILITATE NEW FENCE WITH ASSOCIATED FOOTINGS. FURNISH AND INSTALL NEW 6'-0" TALL CHAINLINK FENCE WITH GATE, PRIVACY SLATS, AND ASSOCIATED CONCRETE FOOTINGS. NEW 3'-0" GATES TO BE CENTERED ON NEW TURN-DOWN SLAB, SEE PLAN FOR QUANTITY. POSTS TO BE PLACED NO MORE THAN 5'-0" O.C. SEE TYPICAL CHAINLINK FENCE DETAILS 4 & 5/A-501 FOR MORE INFORMATION.

AT LOCATION OF DEMOLISHED DUCT PENETRATION, INFILL MASONRY OPENING WITH NEW PAINTED TYPE "X" GYP. BD. OVER 3 5/8" C-04 CFMF STUDS @ 16" O.C. COLOR TO MATCH ADJACENT SURFACE. SEE WALL INFILL DETAIL 6/A-501 FOR MORE INFORMATION.

C-05 AT LOCATION OF DEMOLISHED EXHAUST FAN, FURNISH AND INSTALL NEW STOREFRONT SYSTEM WITH INSULATED PANEL TO INFILL EXISTING MASONRY OPENING - VERIFY SIZE OF M.O. IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION. CLIENTS AT THE LOCATION INDICATED. NO OTHER 🗖 DEMOLISH EXISTING GYP. BD. CEILING, INCLUDING BUT NOT LIMITED TO, EXISTING FRAMING, FASTENERS, AND ACCESS PANELS AS

REQUIRED TO FACILITATE MECHANICAL SCOPE. HATCHED AREA INDICATES EXTENT OF DEMOLITION. COORDINATE WITH MECHANICAL DRAWINGS. REMOVE AND STORE / SUSPEND EXISTING LIGHTS, AND FIRE DETECTION DEVICES FOR REINSTALLATION. FURNISH AND INSTALL NEW PAINTED GYP. BD. CEILING, INCLUDING NEW CHICAGO GRID AND NEW ACCESS PANELS. REINSTALL EXISTING ELECTRICAL AND FIRE DETECTION DEVICES, AND LIGHTING. COORDINATE LOCATION OF NEW ACCESS PANELS IN FIELD. SEE MECHANICAL AND ELECTRICAL PLANS FOR ADDITIONAL INFORMATION. MOISTURE RESISTANT GYP. BD IS TO BE INSTALLED IN RESTROOMS AND SHOWERS.

C-07 PATCH AND PAINT ADJACENT CEILING TO NEAREST WALL BREAK AND BLEND TO EXISTING COLOR/SHADE.

C-08 REMOVE EXISTING SCOREBOARD AND ASSOCIATED BRACKETS AND NETTING. COORDINATE NEW HEIGHT/LOCATION IN THE FIELD WITH OWNER. PROVIDE NEW, SHORTER NET IF EXISTING HANGS BELOW 10'-0" A.F.F.

REMOVE EXISTING FENCE AS REQUIRED TO FACILITATE INSTALLATION OF NEW AIR HANDLING UNIT. REINSTALL OR PROVIDE NEW

REMOVE EXISTING LIGHT FOR RELOCATION, QUANTITY (4). DEMOLISH EXISTING UNISTRUT. COORDINATE NEW LIGHT LOCATION IN THE FIELD AFTER NEW DUCTWORK INSTALLATION. PROVIDE NEW UNISTRUT AND EXTEND EXISTING WIRING TO FACILITATE RELOCATION. HEIGHT TO MATCH EXISTING.

SYMBOL LEGEND

KEY NOTE TAG. SEE KEY NOTE INSTRUCTIONS / NARRATIVE FOR MORE INFORMATION

HATCH INDICATES EXTENT OF GYP. BD CEILING REPLACEMENT 1//////

REFERENCE PHOTO #3

FENCING TO MATCH EXISTING/ADJACENT.

HATCH INDICATES EXTENT OF EXISTING CEILING TO BE PAINTED

NOTE: OWNER TO REMOVE ALL BANNERS THAT MAY INTERFERE WITH CONSTRUCTION PRIOR TO PROJECT START.

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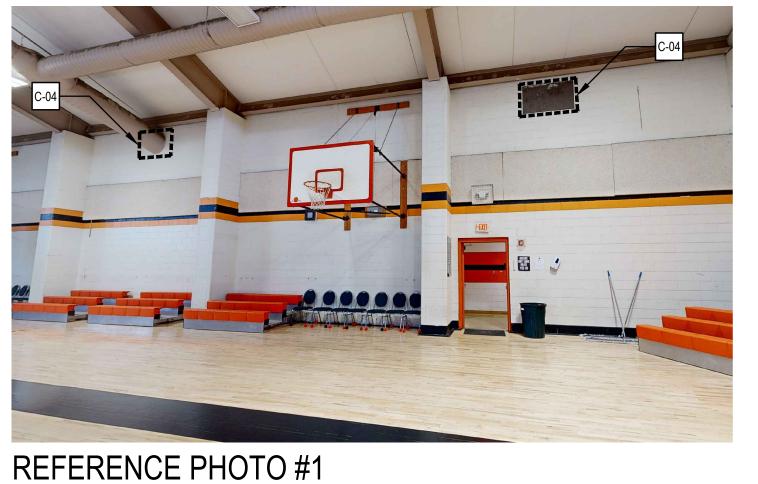
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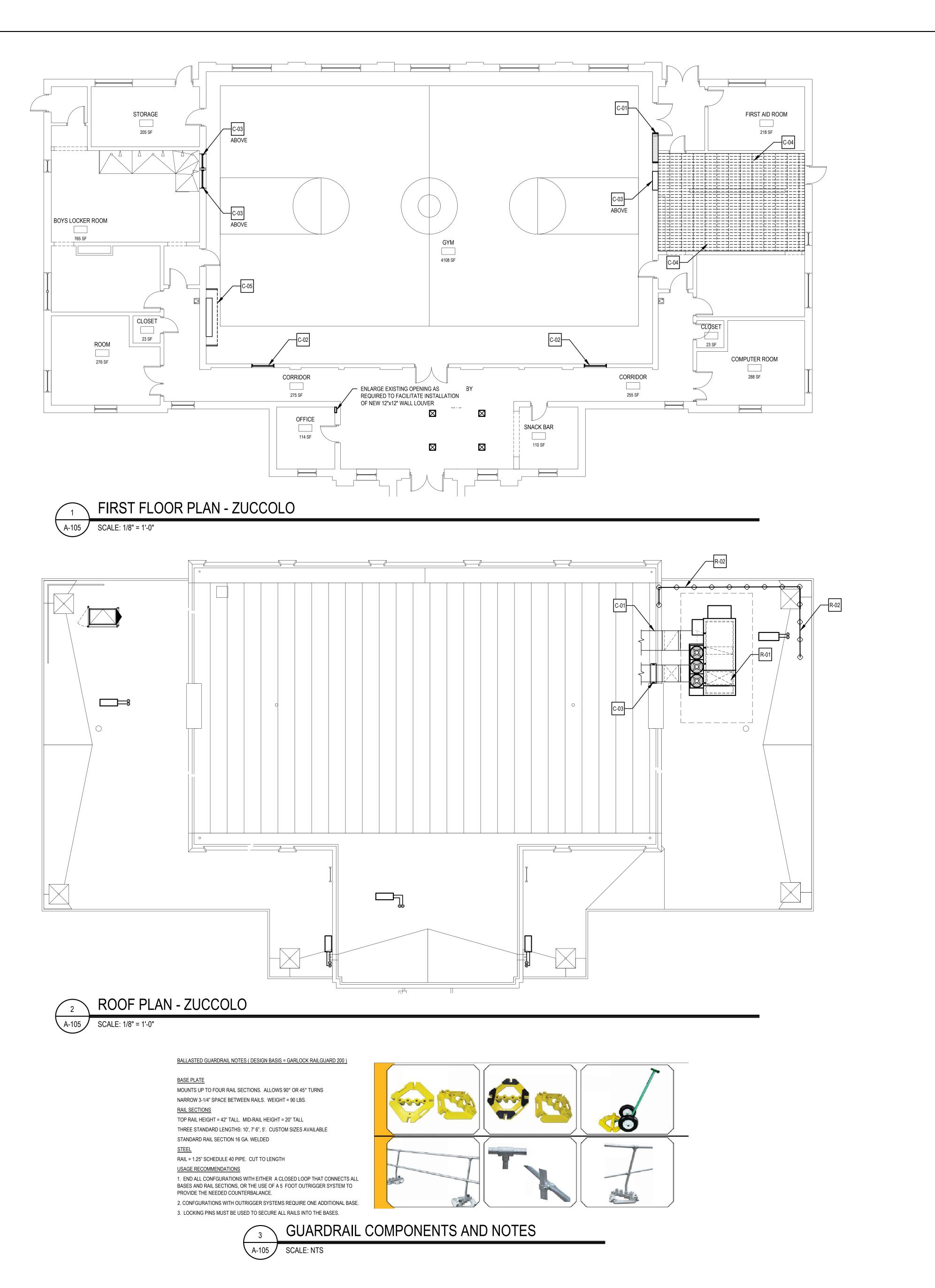
ARCHITECTURAL PLANS - WEST END

CONSTRUCTION DOCUMENTS OCTOBER 15, 2024

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REFERENCE PHOTO #2



GENERAL NOTES

- ALL AREAS AND PARTITIONS NOT DASHED OR NOTED TO BE REMOVED SHALL REMAIN INTACT. PATCH AND REPAIR EXISTING ADJACENT PARTITIONS AND FINISHES AS REQUIRED AFTER DEMOLITION TO MATCH EXISTING OR IN ACCORDANCE W/ PROPOSED
- PROVIDE INTERIOR AND EXTERIOR SHORING, BRACING, OR OTHER SUPPORT TO PREVENT MOVEMENT, SETTLEMENT, OR COLLAPSE OF ELEMENTS TO BE DEMOLISHED AND ADJACENT EXISTING ELEMENTS TO REMAIN.
- SELECTIVE DEMOLITION WORK INCLUDES REMOVAL OF NON-STRUCTURAL ITEMS INDICATED. REFER TO MECH, PLBG, ELEC,
- LOCATE AND IDENTIFY EXISTING UTILITIES, INCLUDING SANITARY SEWER SYSTEM, AND ASCERTAIN THEIR CONDITION TO ENSURE ADEQUATE PERFORMANCE OF ALL UTILITIES IN NEW CONSTRUCTION. PROTECT UTILITY LINES AND HARDWARE DURING DEMOLITION AND CONSTRUCTION PHASES.
- THE CONTRACTOR SHALL SAFELY SECURE ANY AND ALL PIPING, WIRING, CABLES, OR DEVICES THAT ARE NOT SCHEDULED FOR DEMOLITION THAT WERE SECURED BY ITEMS THAT HAVE BEEN OR ARE SCHEDULED FOR DEMOLITION.

DEMOLITION DWGS FOR ADDITIONAL SCOPE. THIS DRAWING DOES NOT SHOW ELEC, WATER, HVAC, AND MOST OTHER SERVICES

- 6. UPON COMPLETION OF THE DEMOLITION WORK, ALL AREAS SHALL BE LEFT BROOM CLEAN TO THE SATISFACTION OF THE OWNER.
- CONTRACTOR SHALL PROMPTLY PATCH AND REPAIR DAMAGE CAUSED TO ADJACENT CONSTRUCTION BY DEMOLITION WORK. RESTORE EXPOSED FINISHES IN A MANNER THAT ELIMINATES EVIDENCE OF PATCHING AND REFINISHING.
- 8. IF HAZARDOUS MATERIALS ARE ENCOUNTERED DURING DEMOLITION OPERATIONS, NOTIFY OWNER IMMEDIATELY COMPLY WITH APPLICABLE REGULATIONS, LAWS, AND ORDINANCES CONCERNING REMOVAL, HANDLING, AND PROTECTION AGAINST EXPOSURE OR ENVIRONMENTAL POLLUTION. BURNING OF REMOVED MATERIALS IS NOT PERMITTED ON THE PROJECT SITE.
- 9. COORDINATE ALL DEMOLITION WORK ON THE EXISTING BUILDING WITH THE OWNER BEFORE PROCEEDING.
- 10. COORDINATE ROOF BREECHING INFILL LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 12 & 13/A-501 FOR MORE
- 11. COORDINATE NEW ROOF OPENING LOCATIONS WITH MECHANICAL DRAWINGS. SEE DETAILS 10 & 11/A-501 FOR MORE

12. PROVIDE ABUSE RESISTANT GYP. BD. UNLESS NOTED OTHERWISE.

KEY NOTES (KEY NOTES MAY VARY BY SHEET)

DEMOLISH AND DISPOSE OF EXISTING MASONRY EXTERIOR WALL AS INDICATED, INCLUDING BUT NOT LIMITED TO, ALL CMU BLOCKS, BRICKS, MASONRY TIES, AND FASTENERS. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS. PROVIDE TEMPORARY SHORING PRIOR TO NEW LINTEL INSTALLATION. FURNISH AND INSTALL NEW LINTEL AT NEW EXTERIOR WALL DUCT PENETRATION. MINIMUM 8" BEARING AT EACH END. COORDINATE EXACT OPENING SIZE & LOCATION WITH MECHANICAL DRAWINGS AND ARCHITECT IN FIELD. SEE EXTERIOR WALL DUCT PENETRATION DETAIL 1/A-501 FOR MORE INFORMATION.

- C-02 AT LOCATION OF DEMOLISHED DUCT PENETRATION, INFILL MASONRY OPENING WITH NEW PAINTED TYPE "X" GYP. BD. OVER 3 5/8" CFMF STUDS @ 16" O.C. COLOR TO MATCH ADJACENT SURFACE. SEE WALL INFILL DETAIL 6/A-501 FOR MORE INFORMATION.
- AT LOCATION OF DEMOLISHED EXHAUST FAN, FURNISH AND INSTALL NEW STOREFRONT SYSTEM WITH INSULATED PANEL TO INFILL C-U3 EXISTING MASONRY OPENING - VERIFY SIZE OF M.O. IN FIELD. SEE PANEL INFILL DETAIL 7/A-501 FOR MORE INFORMATION.
- 「REMOVE AND STORE ALL LIGHTING FIXTURES FOR REINSTALLATION. STRIP EXISTING PAINT FROM THE CONCRETE PLANK C^{-04} Deck/Ceiling above and patch as required. Provide New Paint for existing concrete plank deck, New and existing DUCTWORK, PIPING, HANGERS, AND STRUCTURAL STEEL TO MATCH EXISTING/ADJACENT. REINSTALL EXISTING LIGHTING FIXTURES
- REMOVE EXISTING SCOREBOARD AND ASSOCIATED BRACKETS AND NETTING. COORDINATE NEW HEIGHT/LOCATION IN THE FIELD WITH OWNER. PROVIDE NEW, SHORTER NET IF EXISTING HANGS BELOW 10'-0" A.F.F.
- DEMOLISH AND DISPOSE OF THE EXISTING ROOF ASSEMBLY DOWN TO STRUCTURE FOR INSTALLATION OF NEW DUNNAGE, TYPICAL
- PROVIDE NEW SAFETY GUARDRAIL SYSTEM GARLOCK SAFETY SYSTEMS, RAIL GUARD 200 OR APPROVED EQUAL. PROVIDE OSHA COMPLIANT BALLASTED SYSTEM INCLUDING ALL REQUIRED COMPONENTS AND ACCESSORIES. SYSTEM SHALL BE ENGINEERED BY

 $^{R-01}$ all New Steel Locations. Coordinate with Structural Drawings. Flash and Seal Roof at Location of New Steel

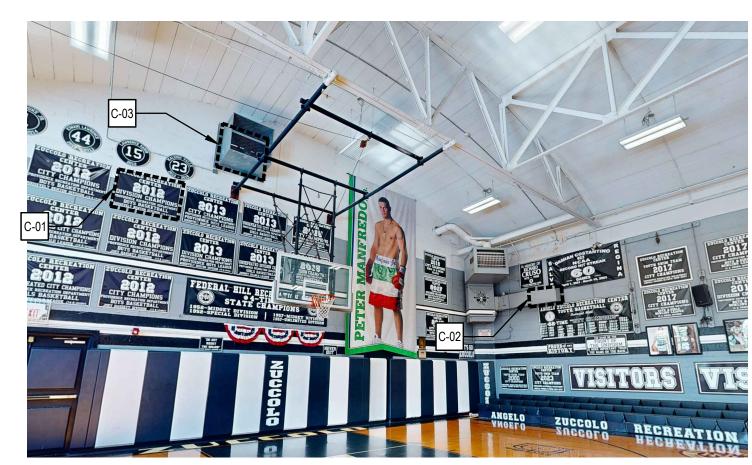
MANUFACTURER. SEE GUARDRAIL COMPONENTS AND NOTES 3/A-105 FOR MORE INFORMATION. SYMBOL LEGEND

KEY NOTE TAG. SEE KEY NOTE INSTRUCTIONS / NARRATIVE FOR MORE INFORMATION HATCH INDICATES EXTENT OF CONCRETE

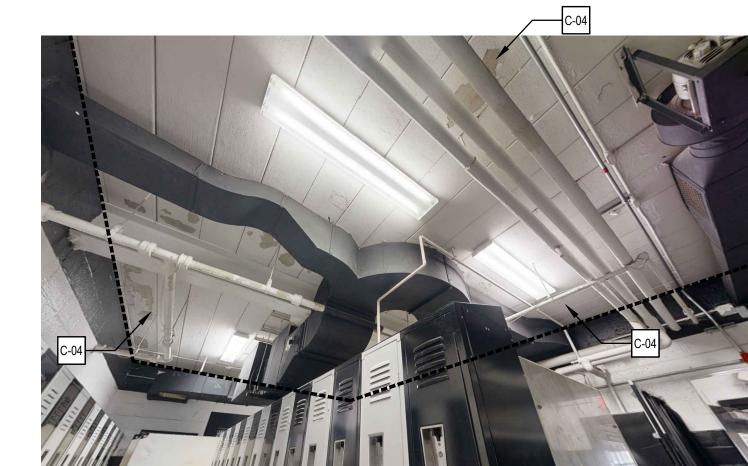
DECK PAINT STRIPPING, PATCHING, AND NEW PAINT TO MATCH EXISTING

NOTE: OWNER TO REMOVE ALL BANNERS THAT MAY INTERFERE WITH CONSTRUCTION PRIOR TO PROJECT START.

NOTE: THE EXISTING ROOF IS UNDER WARRANTY. CONTRACTOR TO COORDINATE DEMOLITION AND NEW WORK WITH ROOFING CONTRACTOR TO MAINTAIN ROOF WARRANTY.



REFERENCE PHOTO #1



REFERENCE PHOTO #2

THIS DRAWING IS THE PROPERTY OF <u>STUDIOJAED</u> DUNNAGE, TYPICAL. COORDINATE WITH STRUCTURAL DRAWINGS. SEE DUNNAGE SEALING DETAIL 5/A-501 FOR MORE INFORMATION. AND IS PREPARED FOR THE EXCLUSIVE USE OF IT CLIENTS AT THE LOCATION INDICATED. NO OTHER USE IS AUTHORIZED OR INTENDED.

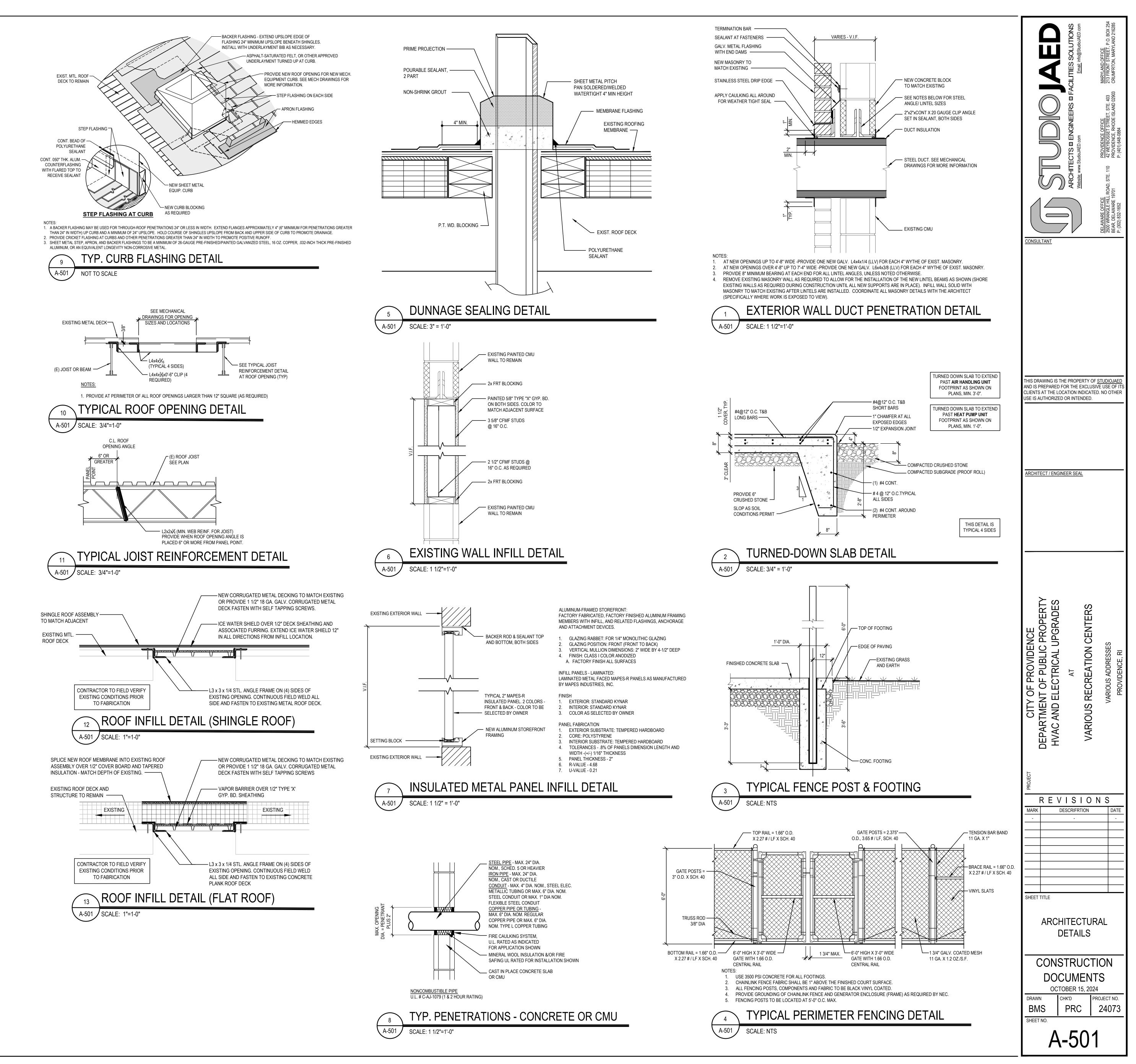
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REVISIONS

ARCHITECTURAL PLANS - ZUCCOLO

CONSTRUCTION **DOCUMENTS** OCTOBER 15, 2024 DRAWN

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GENERAL HVAC NOTES

1. ALL NEW SUPPLY AIR DIFFUSERS AND RETURN AIR REGISTERS SHALL BE EQUIPPED W/ MFGR. SUPPLIED VOLUME DAMPERS.

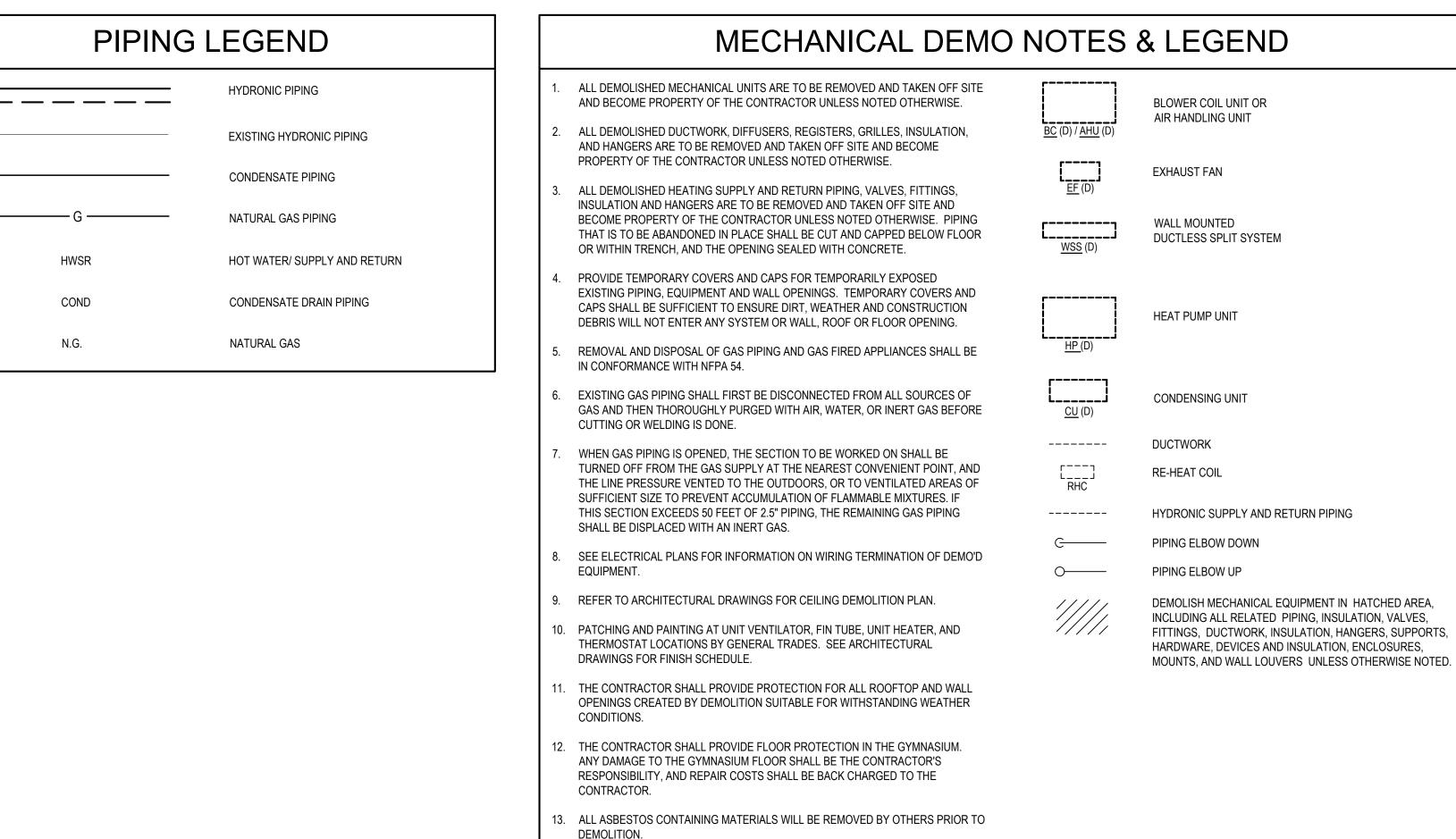
- 2. DUCT SMOKE DETECTORS ARE TO BE SUPPLIED AND INSTALLED WHERE SHOWN IN ACCORDANCE WITH NFPA 72. ACCESS SHALL BE PROVIDED TO SMOKE DETECTORS FOR INSPECTION AND MAINTENANCE. ELECTRICAL CONTRACTOR SHALL MAKE APPROPRIATE AND REQUIRED ELECTRICAL CONNECTIONS TO THE DUCT SMOKE DETECTORS AS SPECIFIED AND REQUIRED FOR PROPER OPERATION. DUCT SMOKE DETECTORS SHALL DE-ENERGIZE THE AIR HANDLING UNIT, OR EXHAUST FAN, THAT THEY ARE ASSOCIATED WITH AND ACTIVATE A VISIBLE AND AUDIBLE SUPERVISORY SIGNAL IN THE BUILDING'S FIRE PROTECTIVE SIGNALING SYSTEM AT A CONSTANTLY ATTENDED LOCATION. ANY SYSTEM THAT IS DE-ENERGIZED BY THE ALARM SHALL NOT RESTART EXCEPT BY MANUAL RESET ON THE UNIT THROUGH THE BAC SYSTEM. SMOKE DETECTORS SHALL COMPLY WITH THE 2018 INTERNATIONAL MECHANICAL CODE IN
- INSULATE ALL NEW DUCTWORK AND EQUIPMENT, AS SPECIFIED UNLESS OTHERWISE NOTED. ALL NON-FLEXIBLE DUCTWORK SHALL BE METAL. DUCTBOARD IS PROHIBITED.
- 4. PROVIDE AND INSTALL ALL GAUGES AND METERS AS SHOWN AND SPECIFIED.
- 5. HVAC EQUIPMENT SHALL BE FURNISHED WITH A MOTOR STARTER SUITABLE FOR THE OFF-ON CONTROL OF THE MOTOR BY A REMOTE THERMOSTAT OR BAS CONTACT. THESE STARTERS SHALL COMPLY WITH NATIONAL ELECTRIC CODE.
- 6. ALL AIR HANDLING UNITS ARE TO BE INSTALLED TO PROVIDE ADEQUATE, UNOBSTRUCTED, ACCESS AND CLEARANCE FOR AIR FILTER REPLACEMENT.
- ALL MOTORS FURNISHED AND INSTALLED BY THE MECHANICAL CONTRACTOR (OR A MECHANICAL SUBCONTRACTOR) SHALL BE PROTECTED AGAINST OVERLOAD IN ACCORDANCE WITH N.E.C.
- 8. VENTS AND PLUMBING VENTS SHALL BE LOCATED A MINIMUM OF 10' FROM ANY INTAKE AIR OPENING.
- 9. MECHANICAL EQUIPMENT AND DEVICES SHALL OPERATE WITHOUT OBJECTIONABLE NOISE AND VIBRATION BEING TRANSMITTED TO OCCUPIED PORTIONS OF THE BUILDING OR ANY PART OF THE BUILDING STRUCTURE BY APPARATUS, PIPING, DUCTWORK, CONDUITS, OR OTHER PARTS OF THE MECHANICAL SYSTEM. SECURE AND BRACE ALL PIPING AND DUCTWORK, PROVIDE FLEXIBLE CONNECTION, VIBRATION ISOLATORS, OR OTHER DEVICES WHERE INDICATED OR REQUIRED TO PREVENT THE TRANSMISSION OF NOISE AND VIBRATION TO THE BUILDING. NC LEVEL IS 35.
- 10. THE CONTRACTOR SHALL PROVIDE ALL WALL AND ROOF PENETRATIONS REQUIRED FOR DUCT ROUTING. THE CONTRACTOR SHALL PATCH AND PAINT ALL PENETRATIONS LEFT BY DEMOLITION WORK AND BY CLEARANCE OPENINGS THAT REMAIN AFTER NEW DUCT INSTALLATIONS.

NOTIFY THE OWNER IN THE EVENT ANY EXISTING HAZARDOUS MATERIALS, SUCH AS ASBESTOS, PCB'S, LEAD, ETC., ARE ENCOUNTERED ON THE PROJECT. THE OWNER WILL ARRANGE WITH A QUALIFIED SPECIALIST FOR THE IDENTIFICATION, TESTING, REMOVAL, HANDLING AND PROTECTION AGAINST EXPOSURE OR ENVIRONMENTAL POLLUTION, TO COMPLY WITH APPLICABLE REGULATIONS, LAWS AND ORDINANCES.

- 12. VARIABLE FREQUENCY DRIVES (VFD) SHALL BE CONSIDERED SYNONYMOUS WITH ADJUSTABLE FREQUENCY DRIVES (AFD).
- 13. THE CONTRACTOR SHALL PROVIDE RADIUSED ELBOWS OR SQUARE THROAT ELBOWS WITH VANES FOR ALL DUCTWORK CHANGES IN DIRECTION, PER SMACNA HVAC DUCT CONSTRUCTION STANDARDS METAL AND FLEXIBLE. SQUARE THROAT ELBOWS WITHOUT VANES AND MITERED ELBOWS ARE NOT PERMITTED.
- 14. ALL QUANTITIES TO BE VERIFIED BY CONTRACTOR.
- 15. PRIOR TO SUBMITTING BID, THE CONTRACTOR SHALL VISIT THE SITE AND BE THOROUGHLY FAMILIAR WITH THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION. CONTRACTOR SHALL INCLUDE IN THEIR BID ALL MATERIALS, LABOR AND ALL INCIDENTALS FOR A COMPLETE INSTALLATION WHETHER SPECIFICALLY INDICATED OR NOT. ALL ERRORS, DISCREPANCIES AND MISSED ITEMS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER DURING THE BIDDING PROCESS BY THE CONTRACTOR. THESE ITEMS SHALL BE INCLUDED IN THE BID PRICE. NO EXTRA COST WILL BE ALLOWED FOR ANY DISCREPANCY WHICH COULD HAVE BEEN NOTICED AT THE SITE BY THE CONTRACTOR.
- 16. INSTALL ALL EQUIPMENT AND MATERIALS PER MANUFACTURER'S WRITTEN INSTRUCTION.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ADDITIONAL COSTS INCURRED AS A RESULT OF SUBSTITUTIONS OR DEVIATIONS FROM THE BASIS OF DESIGN SHOWN ON THESE DRAWINGS.
- 18. CONTRACTOR IS RESPONSIBLE FOR PROVIDING TRANSITIONS AND FLEXIBLE CONNECTIONS BETWEEN ALL UNITS AND SUPPLY, RETURN, OR OUTSIDE AIR DUCTS.
- 19. FOR SYSTEMS UTILIZING A BLOWER COIL PAIRED WITH A VRF HEAT PUMP PROVIDE THE APPROPRIATE AHU COMMUNICATION KIT AND THE APPROPRIATE EEV KIT(S) TO PPAIR THE BLOWER COIL WITH THE HEAT PUMP PER THE MANUFACTURER'S REQUIREMENTS AND INSTRUCTIONS FOR A COMPLETE AND FUNCTIONING SPLIT SYSTEM.

HVAC LEGEND EXISTING DUCTWORK OR EQUIPMENT ROUND RETURN OR EXHAUST AIR DOWN ROUND SUPPLY AIR DOWN ROUND RETURN OR EXHAUST AIR UP ROUND SUPPLY AIR UP RECTANGULAR RETURN OR EXHAUST AIR RECTANGULAR SUPPLY AIR DOWN RECTANGULAR RETURN OR EXHAUST AIR UP RECTANGULAR SUPPLY AIR UP NEW FLEX DUCTWORK FABRIC DUCT CEILING MOUNTED SUPPLY AIR DIFFUSER SIDE-WALL MOUNTED SUPPLY AIR DIFFUSER CEILING MOUNTED RETURN AIR REGISTER SIDE-WALL MOUNTED RETURN AIR REGISTER \equiv VOLUME DAMPER MOTOR OPERATED DAMPER TEMPERATURE SENSOR CARBON DIOXIDE SENSOR **HUMIDITY SENSOR** DUCT SMOKE DETECTOR - FURNISHED AND WIRED BY ELECTRICAL / FIRE ALARM CONTRACTOR, INSTALLED BY MECHANICAL CONTRACTOR EXTENT OF WORK PACKAGED ROOFTOP OR GROUND MOUNTED AIR HANDLING UNIT **BLOWER COIL UNIT** HEAT PUMP UNIT GRAVITY VENTILATOR

PIPING LEGEND ______ EXISTING HYDRONIC PIPING CONDENSATE PIPING NATURAL GAS PIPING HOT WATER/ SUPPLY AND RETURN CONDENSATE DRAIN PIPING



4. THE INFORMATION SHOWN ON THESE DRAWINGS WAS COMPILED FROM EXISTING

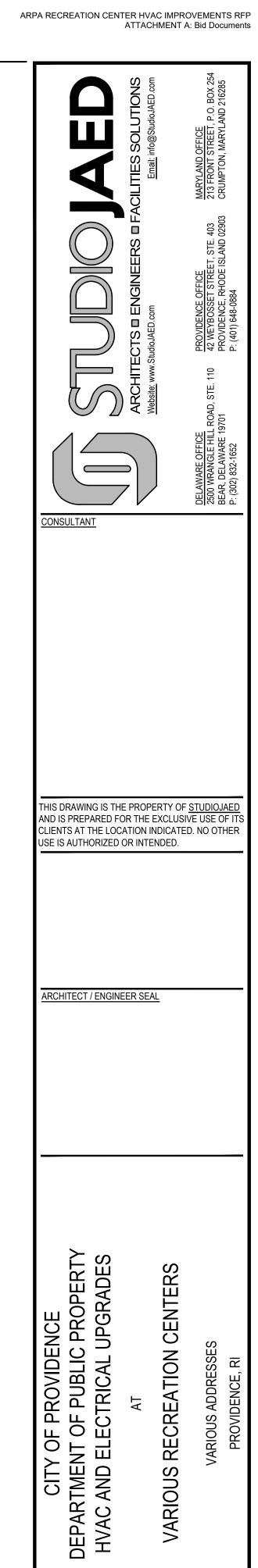
DRAWINGS AND SITE VISITS. HOWEVER, THE INFORMATION MAY STILL VARY

5. CONTRACTOR TO FIELD LOCATE AND DEMOLISH ALL THERMOSTAT SERVING HVAC UNITS TO BE DEMOLISHED. PROVIDE STAINLESS STEEL BLANK PLATE TO

VERIFICATION FOR DEMOLITION WORK.

COVER DEMOLISHED THERMOSTAT JUNCTION BOX

FROM THE ACTUAL INSTALLATION. CONTRACTOR IS RESPONSIBLE FOR FIELD



SHEET TITLE

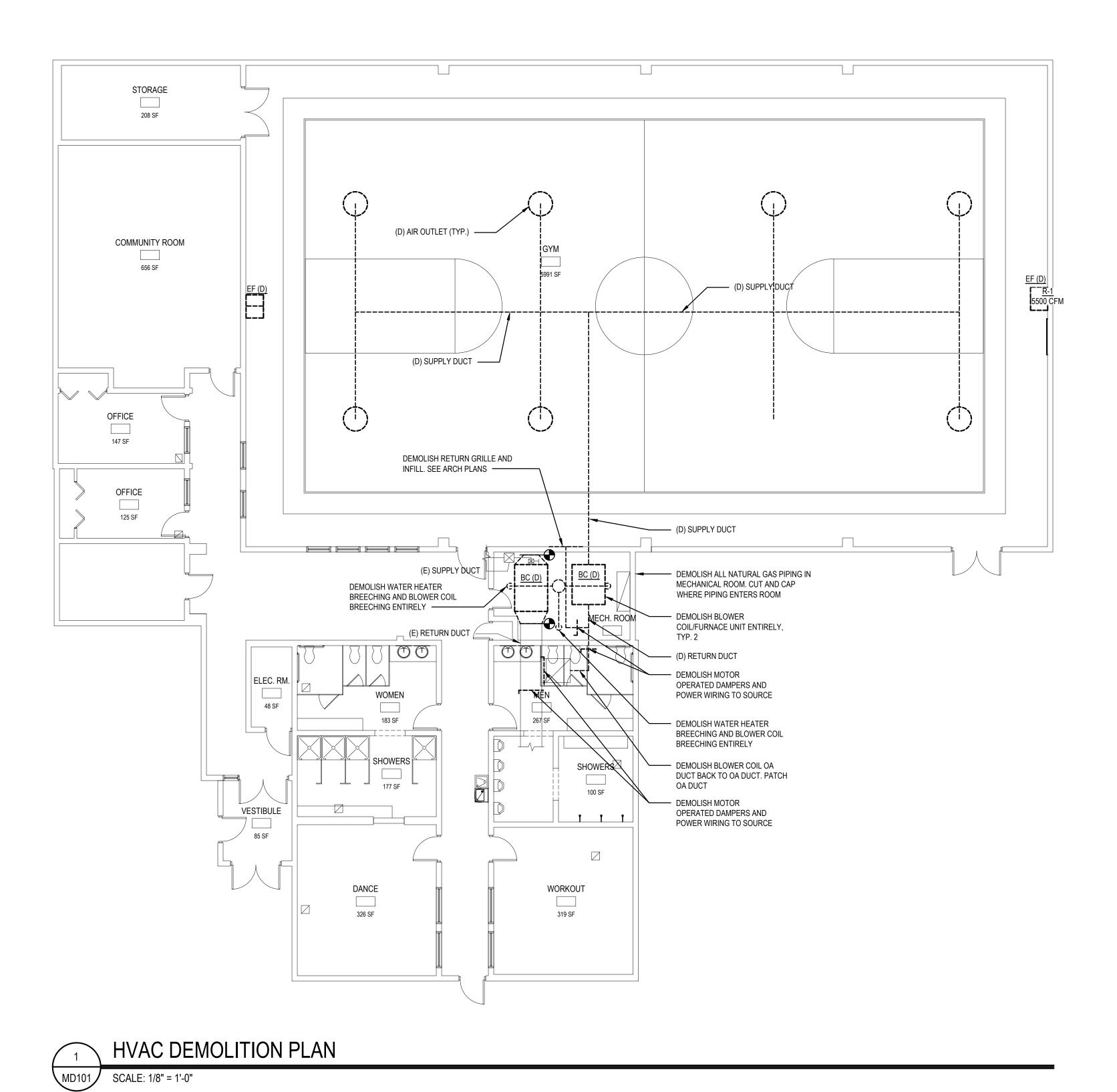
MECHANICAL COVER

SHEET

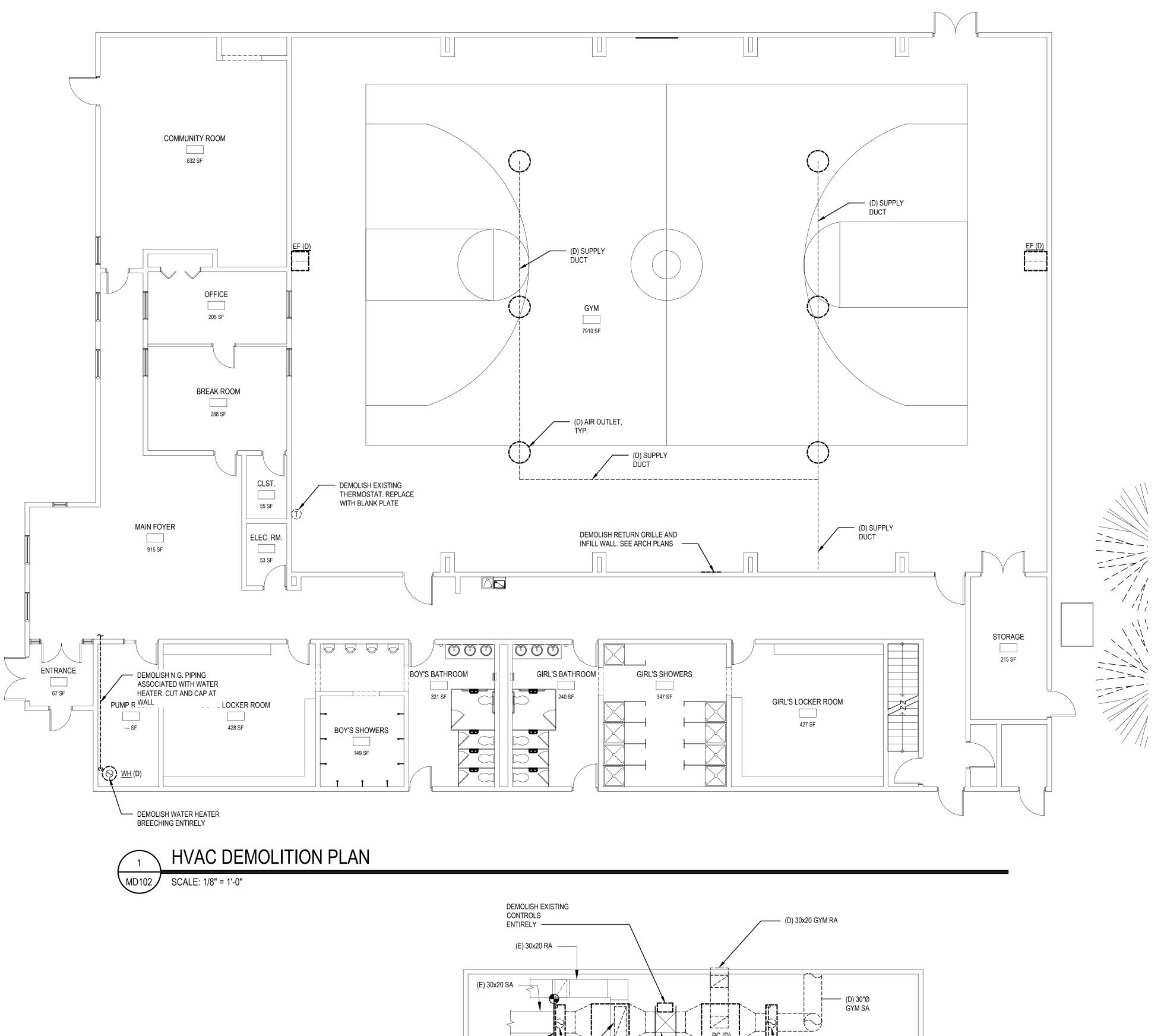
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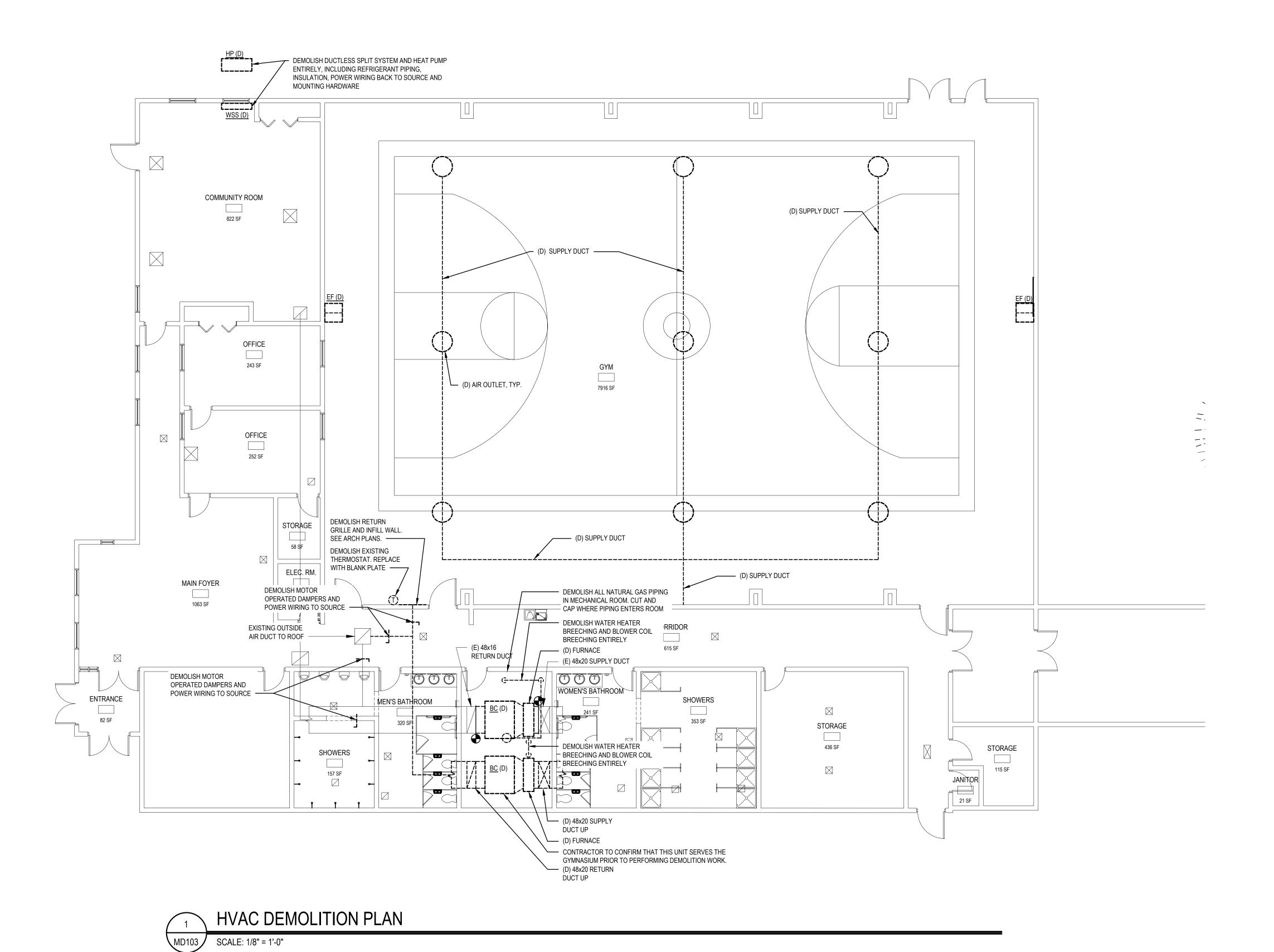


DEMOLISH DUCT FURNACE BREECHING ENTIRELY (E) 35x35 UP TO ROOF DEMOLISH DUCT FURNACE
BREECHING ENTIRELY DEMOLISH N.G. PIPING.
 CUT AND CAP AT WALL DEMOLISH N.G. PIPING.
CUT AND CAP AT WALL

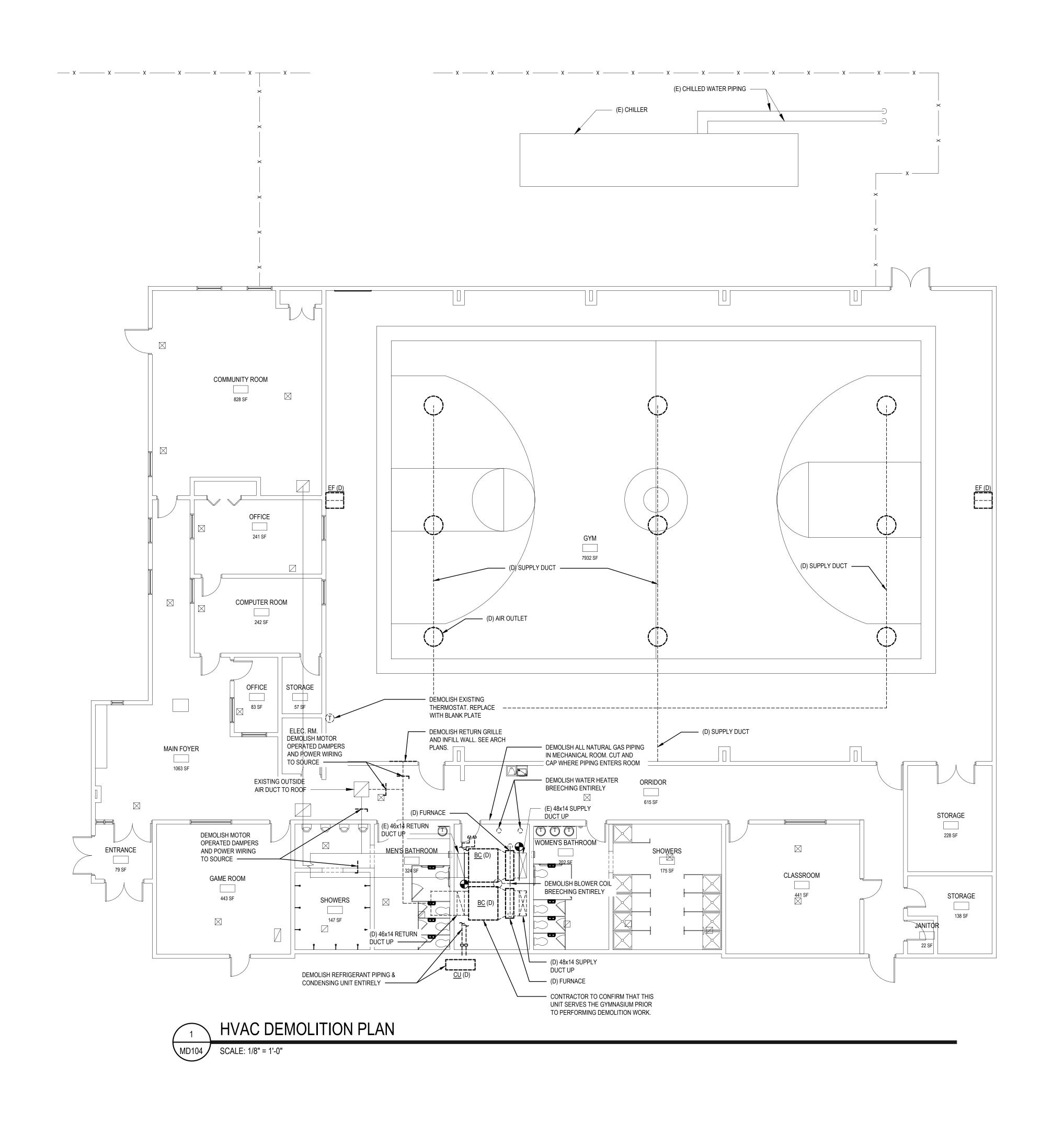
2 HVAC DEMOLITION ATTIC PLAN MD102 SCALE: 1/8" = 1'-0"

ARPA RECREATION CENTER HVAC IMPROVEMENTS RFP ATTACHMENT A: Bid Documents THIS DRAWING IS THE PROPERTY OF <u>STUDIOJAED</u> AND IS PREPARED FOR THE EXCLUSIVE USE OF ITS CLIENTS AT THE LOCATION INDICATED. NO OTHER USE IS AUTHORIZED OR INTENDED. ARCHITECT / ENGINEER SEAL REVISIONS DESCRIPTION SHEET TITLE MECHANICAL **DEMOLITION PLANS -**IGLIOZZI CONSTRUCTION DOCUMENTS
OCTOBER 15, 2024
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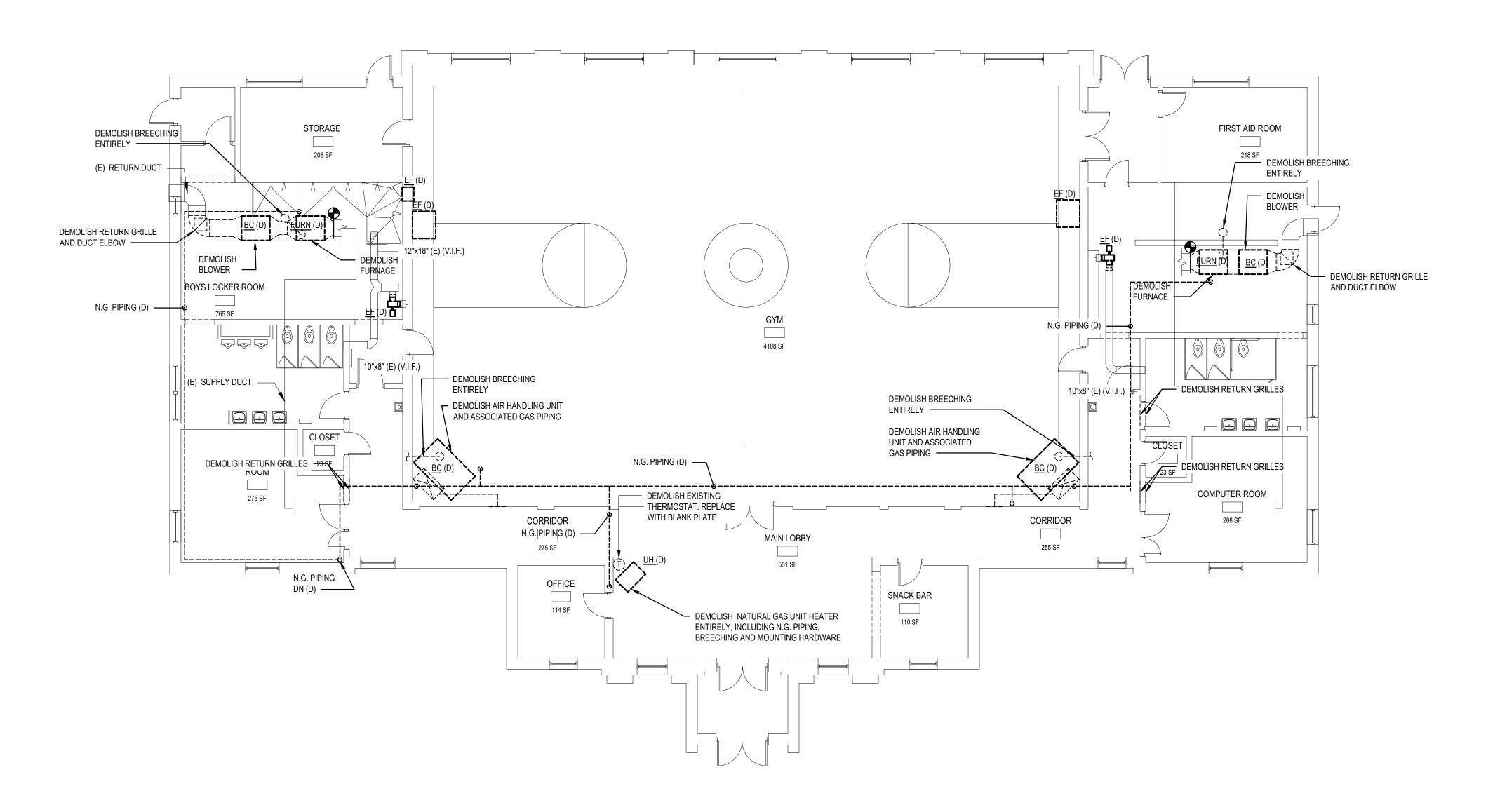
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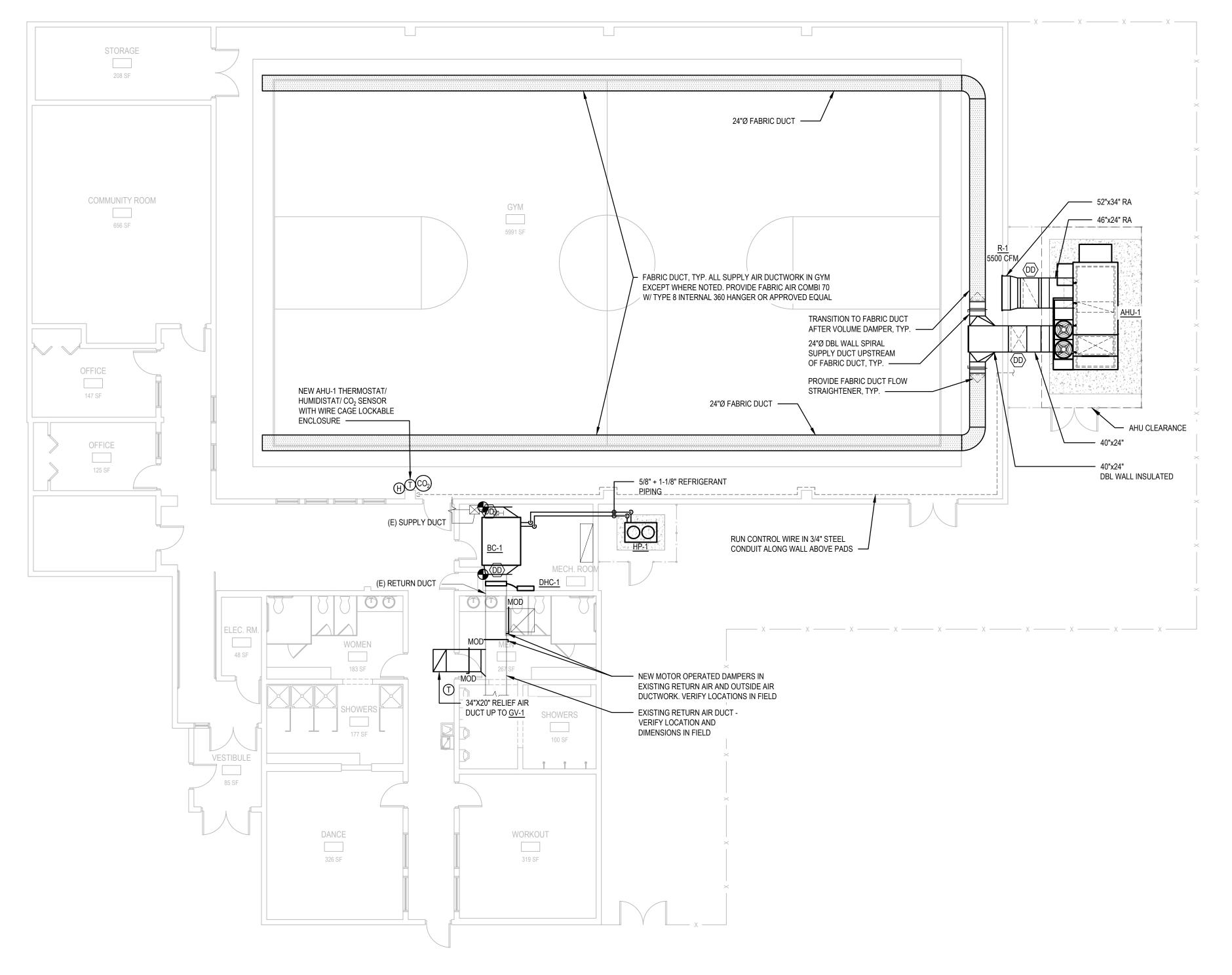


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HVAC DEMOLITION PLAN

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MECHANICAL NEW WORK NOTES

- 1. SEE ARCHITECTURAL PLANS FOR PENETRATION DETAILS, ETC.
- DUCT SMOKE DETECTORS ARE FURNISHED AND WIRED BY ELECTRICAL/FIRE ALARM CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR
- 3. COORDINATE DUCT ELEVATION IN FIELD WITH EXISTING STRUCTURE
- 4. ALL SUPPLY DUCTWORK INSIDE THE BUILDING UPSTREAM OF FABRIC DUCT SHALL BE DOUBLE-WALL INSULATED
- 5. ALL RETURN DUCTWORK SHALL BE LINED WITH 1" JM LINACOUSTIC RC OR APPROVED EQUAL

APPROVED EQUAL). PROVIDE OUTSIDE AIR AND EXHAUST AIR WEATHER HOODS.



<u>R - #</u>		RETURN	GRILLE SO	CHEDULE	
UNIT NUMBER	SIZE (FACE / NECK)	DESCRIPTION	MANUFACTURER	MODEL NUMBER	REMARKS
<u>R-1</u>	52"X34" / 52"X34"	ALUMINUM HEAVY DUTY RETURN GRILLE	KRUEGER	S5480	PROVIDE WITH CUSTOM WIRE GUARD FOR PROTECTION FROM ABUSE
NOTE: PROVIDE EQ	UIPMENT BY KRUEGER O	R APPROVED EQUAL. FINISH SHALL BE FACTORY OFF-WHITE FINIS	SH. CONTRACTOR IS RESI	PONSIBLE TO SELECT APP	PROPRIATE MOUNT DEPENDING ON CEILING TYPE.

<u>AHU - #</u>		P	ACK	AGE	D HE	EAT P	UMP A	AIR HANI	DLING	UNI ⁻	T SC	HEDU	LE (D)	X CO	OLIN	G, DX	HEA	TING	, ELE	CTRI	IC SU	PPLEME	ENTAI	_ HEA	ATING	S, ENERGY RE	COVERY)
	AIRFLOW	OUTSIDE	SUPPLY	EXH	Е	RV - COOLING	MODE		DX	COIL - COOLI	ING MODE			ERV	' - HEATING M	ODE	DX CC	IL - HEATING	MODE		ELECTRIC	HEAT					
UNIT NUMBER	(CFM)	AIR (CFM)	(in w.g.)	EXT. SP. (in w.g.)	CFM	EDB/EWB (°F)	LDB/LWB (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	CFM	EDB (°F)	LDB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	EAT (°F)	LAT (°F)	CAPACITY (KW)	ELEC	FLA	MOCP	VALENT MODEL #	REMARKS
AHU-1	5500	2400	1.0	0.5	2400	86.5/71.6	78.6/65.7	76.6	63.9	52.3	52.3	141.0	184.3	2400	10.8	51.4	63.0	81.4	107.2	81.4	100.2	32.8	208/60/3	105.9	175.0	VXE-112-36D-15A-1-G2	SET $\mathrm{CO_2}$ OCCUPIED MINIMUM FOR 5% OA DURING UNIT STARTUP

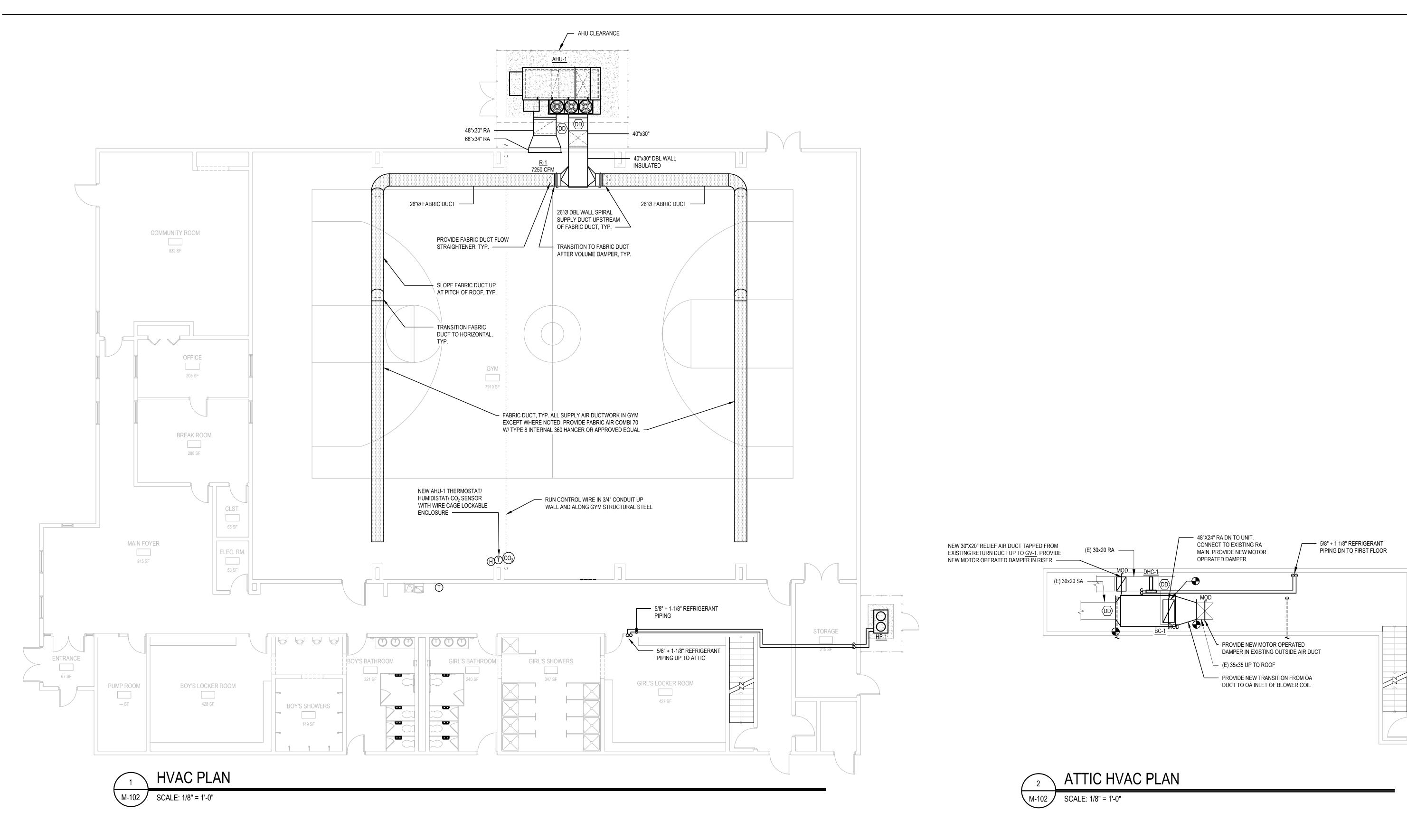
<u>BC - #</u>						S	PLIT	SYS1	EM E	BLOWE	ER CO	OIL S	CHEC	ULE	(DX C	COOLI	NG, D	X HEATING	3)	
		AIRFLOW	OUTSIDE	SUPPLY			DX COIL - CO	OOLING MODE				DX COIL - HE	ATING MODE							
UNIT NUMBER	PAIRED WITH	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	AMBIENT DB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	ELEC	FLA	MOCP	MANUFACTURER	MODEL#	REMARKS
BC-1	HP-1	3750	1000	1.0	78.0	65.1	52.0	51.5	107.2	149.6	10.6	54.2	95.0	167	208/3/60	9.0	20.0	VTS	AVS040-R-FCV	
NOTES: PROVID KIT, DROPLET E															ND FACTORY	INSTALLED VFD,	, RUBBER-IN-S	HEAR FAN ISOLATOR MOUN	TS, CUSTOM DUAL TEMPERATURE DX	COIL TO OPERATE WITH VRF CONDENSING UNIT AND EEV

<u>HP - #</u>				HEAT PU	MP S	CHEC	DULE	1		
UNIT NUMBER	COOLING CAPACITY (MBH)	HEATING CAPACITY (MBH)	DESIGN COOLING OUTDOOR DB/WB (°F)	DESIGN HEATING OUTDOOR DB (°F)	ELEC	MCA	MOCP	MFGR	MODEL	REMARKS
HP-1	168	189	86.5/71.6	10.8	208/3/60	53.6	70	LG	ARUM168BTE5	
NOTE: PROVIDE UN MANUFACTURER'S	NITS AS SCHEDULED TWINNING KITS FOF	OR APPROVED EQU R INSTALLATION AND	JAL. MOUNT UNIT ON MIF D SINGLE-POINT ELECTR	RO HD EQUIPMENT SUF ICAL CONNECTIONS. AI	PORT. PROVID LL UNITS SHALI	E WALL PEN BE PROVID	ETRATIONS ED WITH SP	FOR REFRIGERA RING VIBRATION	NT PIPING AND ELECTRICA I ISOLATORS, MINIMUM 1" E	L AL CONDUITS. PROVIDE DEFLECTION. PROVIDE WITH VER COIL/HEAT PUMP SYSTEM

<u>GV - #</u> G	RAVI	TY VENT	SCHE	DULE
UNIT NUMBER	THROAT SIZE	MANUFACTURER	MODEL#	REMARKS
<u>GV-1</u>	20"X36"	GREENHECK	FGR	
				RAVITY VENTS SHALL BE MOTOR OPERATED DAMPERS.

<u>DHC - #</u>				EL	ECTRI	C DUC	T HEATE	R SCHEDULI	E
MARK	AIRFLOW (CFM)	HEATING E.D.B./L.D.B (°F)	CAPACITY (KW)	DUCT DIMENSIONS	AIRFLOW ORIENTATION	ELECTRICAL	MANUFACTURER	MODEL	REMARKS
DHC-1	3750	55/70	18	36"X24"	HORIZ	208/3/60	WARREN	СВК	VERIFY RETURN DUCT DIMENSIONS IN FIELD. PROVIDE REMOTE MOUNT CONTROL PAN
								DUCT TEMPERATURE SENSORS, METO DISCONNECT PER NEC	MAGNETIC CONTACTORS, 24V CONTROL TRANSFORMERS, AIRFLOW SWITCH FOR POSITIV

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<u>R - #</u>		RETURN	GRILLE SO	CHEDULE	
UNIT NUMBER	SIZE (FACE / NECK)	DESCRIPTION	MANUFACTURER	MODEL NUMBER	REMARKS
<u>R-1</u>	68"X34" / 68"X34"	ALUMINUM HEAVY DUTY RETURN GRILLE	KRUEGER	S5480	PROVIDE WITH CUSTOM WIRE GUARD FOR PROTECTION FROM ABUSE

<u>AHU - #</u>		PA	4CK	AGE	D HE	EAT P	UMP A	IR HANI	OLING	S UNI	Γ SCI	HEDU	LE (D)	(CO	OLING	G, DX	HEA	TING	, ELE	CTRI	C SU	PPLEMI	ENTAI	L HE	ATING	S, ENERGY REC	COVERY)
	AIDELOW	OUTCIDE	SUPPLY	EXH	Е	RV - COOLING	MODE		DX	COIL - COOLI	NG MODE			ERV	- HEATING MO	ODE	DX C	OIL - HEATING	MODE		ELECTRIC	HEAT					
UNIT NUMBER	AIRFLOW (CFM)	OUTSIDE AIR (CFM)	EXT. SP. (in w.g.)	EXT. SP. (in w.g.)	CFM	EDB/EWB (°F)	LDB/LWB (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	CFM	EDB (°F)	LDB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	EAT (°F)	LAT (°F)	CAPACITY (KW)	ELEC	FLA	MOCP	VALENT MODEL #	REMARKS
AHU-1	7250	4600	1.0	0.5	4600	86.5/71.6	78.6/66.0	77.3	64.7	52.6	52.6	188.4	254.6	4600	10.8	51.2	58.8	77.8	145.8	77.8	99.2	49.2	208/60/3	257.0	350.0	VXE-212-52B-20A-1-G2	SET CO_2 OCCUPIED MINIMUM FOR 5% OA DURING UNIT STARTUP
														,										,			EAMS, ENTHALPY ECONOMIZER, CO2 DEMAND CONTROL SURATION SHOWN ON DRAWINGS (CAMBRIDGEPORT OR

APPROVED EQL	UAL). PROVIDE OL	JTSIDE AIR AN	ID EXHAUST AI	R WEATHE	R HOODS.			, 												,
BC - #						S	PLIT	SYS1	EM E	3LOWI	ER C	OIL S	CHE	DULE	(DX	COOLIN	VG, D	X HEATING	3)	
		AIRFLOW	OUTSIDE	SUPPLY			DX COIL - CO	OLING MODE				DX COIL - HE	ATING MODE							
UNIT NUMBER	PAIRED WITH	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	AMBIENT DB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	ELEC	FLA	MOCP	MANUFACTURER	MODEL#	REMARKS
BC-1	HP-1	5000	1050	0.5	77.3	64.5	52.0	51.3	145.9	201.5	10.6	58.5	95.0	13.7	208/3/60	17.4	30.0	VTS	AVS055-R-FCV	

NOTES: PROVIDE EQUIPMENT AS SCHEDULED OR APPROVED EQUAL. PROVIDE WITH DOUBLE WALL CONSTRUCTION, 2" CLOSED CELL INSULATION, DIRECT DRIVE PLENUM FAN WITH ALUMINUM IMPELLER AND FACTORY INSTALLED VFD, RUBBER-IN-SHEAR FAN ISOLATOR MOUNTS, CUSTOM DUAL TEMPERATURE DX COIL TO OPERATE WITH VRF CONDENSING UNIT AND EEV

<u>HP - #</u>				HEAT PU	MP SO	CHEC	DULE			
UNIT NUMBER	COOLING CAPACITY (MBH)	HEATING CAPACITY (MBH)	DESIGN COOLING OUTDOOR DB/WB (°F)	DESIGN HEATING OUTDOOR DB (°F)	ELEC	MCA	MOCP	MFGR	MODEL	REMARKS
HP-1	216	243	86.5/71.6	10.8	208/3/60	60.3	80	LG	ARUM216BTE5	
MANUFACTURER'S	TWINNING KITS FOR	R INSTALLATION AN	D SINGLE-POINT ELECTR	ICAL CONNECTIONS. AI	LL UNITS SHALL	BE PROVID	ED WITH SPI	RING VIBRATION	·	AL CONDUITS. PROVIDE EFLECTION. PROVIDE WITH /ER COIL/HEAT PUMP SYSTEM

<u>GV - #</u> G	RAVI1	TY VENT	SCHEE	DULE
UNIT NUMBER	THROAT SIZE	MANUFACTURER	MODEL#	REMARKS
<u>GV-1</u>	24"X36"	GREENHECK	FGR	
				RAVITY VENTS SHALL BE MOTOR OPERATED DAMPERS.

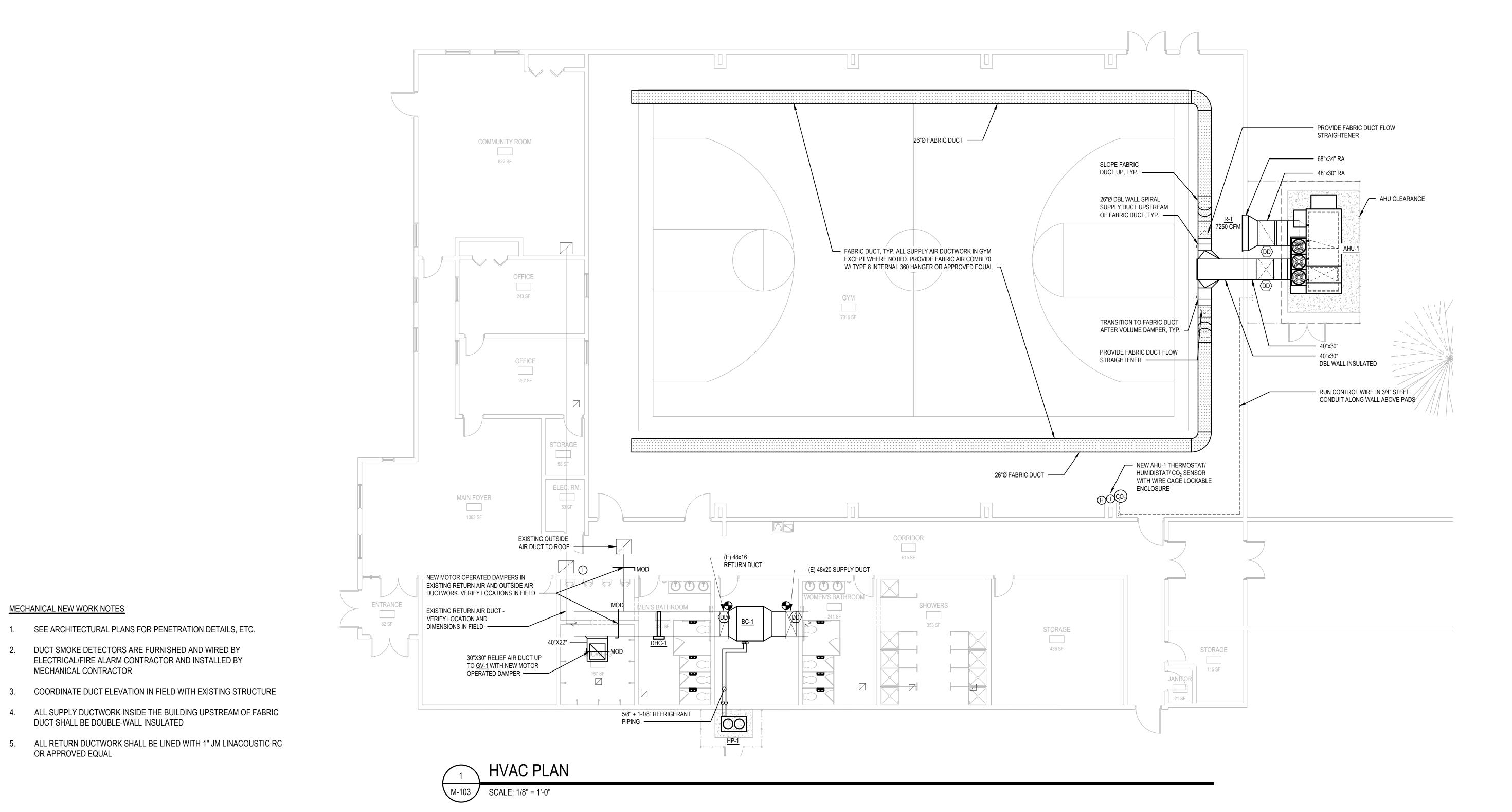
MECHANICAL NEW WORK NOTES

- 1. SEE ARCHITECTURAL PLANS FOR PENETRATION DETAILS, ETC.
- DUCT SMOKE DETECTORS ARE FURNISHED AND WIRED BY ELECTRICAL/FIRE ALARM CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR
- 3. COORDINATE DUCT ELEVATION IN FIELD WITH EXISTING STRUCTURE
- 4. ALL SUPPLY DUCTWORK INSIDE THE BUILDING UPSTREAM OF FABRIC DUCT SHALL BE DOUBLE-WALL INSULATED
- ALL RETURN DUCTWORK SHALL BE LINED WITH 1" JM LINACOUSTIC RC OR APPROVED EQUAL

<u>DHC - #</u>			EL	ECTRIC	C DUC	Γ HEA	TER SCH	EDULE	
MARK	AIRFLOW (CFM)	HEATING E.D.B./L.D.B (°F)	CAPACITY (KW)	DUCT DIMENSIONS	AIRFLOW ORIENTATION	ELECTRICAL	MANUFACTURER	MODEL	REMARKS
DHC-1	5000	60/70	17.5	30"X20"	HORIZ	208/3/60	WARREN	CBK	VERIFY RETURN DUCT DIMENSIONS IN FIELD
					•		•	DUCT TEMPERATURE SENSORS, M FOR TO MAINTAIN 36" CLEARANCE	AGNETIC CONTACTORS, 24V CONTROL TRANSFORMERS, TO DISCONNECT PER NEC

ATTACHMENT A: Bid Documents THIS DRAWING IS THE PROPERTY OF <u>STUDIOJAED</u> AND IS PREPARED FOR THE EXCLUSIVE USE OF ITS CLIENTS AT THE LOCATION INDICATED. NO OTHER USE IS AUTHORIZED OR INTENDED. ARCHITECT / ENGINEER SEAL REVISIONS DESCRIPTION SHEET TITLE MECHANICAL PLANS -IGLIOZZI CONSTRUCTION DOCUMENTS OCTOBER 15, 2024

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<u>R - #</u>		RETURN (GRILLE SO	CHEDULE	
UNIT NUMBER	SIZE (FACE / NECK)	DESCRIPTION	MANUFACTURER	MODEL NUMBER	REMARKS
<u>R-1</u>	68"X34" / 68"X34"	ALUMINUM HEAVY DUTY RETURN GRILLE	KRUEGER	S5480	PROVIDE WITH CUSTOM WIRE GUARD FOR PROTECTION FROM ABUSE
NOTE: PROVIDE EQ	UIPMENT BY KRUEGER OI	R APPROVED EQUAL. FINISH SHALL BE FACTORY OFF-WHITE FINIS	H. CONTRACTOR IS RESP	ONSIBLE TO SELECT APP	ROPRIATE MOUNT DEPENDING ON CEILING TYPE.

<u>AHU - #</u>							· · · · · ·			<u> </u>			(_/		<u> </u>	<u> </u>			, ———	<u> </u>				/		G, ENERGY REC	3
	AIRFLOW	OLITCIDE	SUPPLY	EXH	Е	RV - COOLING N	MODE		DX	COIL - COOL	NG MODE			ERV	HEATING M	ODE	DX CC	OIL - HEATING	MODE		ELECTRIC	HEAT					
UNIT NUMBER	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EXT. SP. (in w.g.)	CFM	EDB/EWB (°F)	LDB/LWB (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	CFM	EDB (°F)	LDB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	EAT (°F)	LAT (°F)	CAPACITY (KW)	ELEC	FLA	MOCP	VALENT MODEL #	REMARKS
AHU-1	7250	4600	1.0	0.5	4600	86.5/71.6	78.6/66.0	77.3	64.7	52.6	52.6	188.4	254.6	4600	10.8	51.2	58.8	77.8	145.8	77.8	99.6	50.0	460/60/3	119.8	125.0	VXE-212-52B-20A-1-G2	SET CO ₂ OCCUPIED MINIMUM FOR 5% OA DURING UNIT STARTUP

BC - #						S	PLIT	SYS1	ГЕМ Е	BLOWE	ER C	OIL S	CHEC	DULE	(DX (COOLIN	VG, D	X HEATING	G)	
		AIRFLOW	OUTSIDE	SUPPLY		_	DX COIL - CO	OLING MODE				DX COIL - HE	ATING MODE							
UNIT NUMBER	PAIRED WITH	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	AMBIENT DB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	ELEC	FLA	MOCP	MANUFACTURER	MODEL #	REMARKS
BC-1	HP-1	5000	900	0.5	76.9	64.2	52.0	51.3	150.4	205.0	10.6	60.4	95.0	208.0	460/3/60	6.7	15	VTS	AVS055-R-FCV	
NOTES: PROVID	E EQUIPMENT AS	S SCHEDULED	OR APPROVE	D EQUAL. P	ROVIDE WITH I	DOUBLE WALL	L CONSTRUCT	ΓΙΟΝ, 2" CLOS	SED CELL INSI	ULATION, DIREC	CT DRIVE PLE	NUM FAN WIT	H ALUMINUM	/ IMPELLER A	ND FACTORY	INSTALLED VFD,	RUBBER-IN-S	HEAR FAN ISOLATOR MOU	ITS, CUSTOM DUAL TEMPERATURE DX	COIL TO OPERATE WITH VRF CONDENSING UNIT AND EEV

	<u>DHC - #</u>			EL	ECTRIC	C DUC	Γ HEA [®]	TER SCH	EDULE	
	MARK	AIRFLOW (CFM)	HEATING E.D.B./L.D.B (°F)	CAPACITY (KW)	DUCT DIMENSIONS	AIRFLOW ORIENTATION	ELECTRICAL	MANUFACTURER	MODEL	REMARKS
┪	DHC-1	5000	60/70	16	48"X16"	HORIZ	460/3/60	WARREN	СВК	VERIFY RETURN DUCT DIMENSIONS IN FIELD
	•					•		•	UCT TEMPERATURE SENSORS, M OR TO MAINTAIN 36" CLEARANCE	AGNETIC CONTACTORS, 24V CONTROL TRANSFORMERS, TO DISCONNECT PER NEC

COOLI									
UNIT NUMBER CAPACITY		DESIGN COOLING OUTDOOR DB/WB (°F)	DESIGN HEATING OUTDOOR DB (°F)	ELEC	MCA	MOCP	MFGR	MODEL	REMARKS
HP-1 216	5 243	86.5/71.6	10.8	460/3/60	38.3	50	LG	ARUM216DTE5	

KIT, DROPLET ELIMINATORS ON COIL, STAINLESS STEEL TRIPLE SLOPED DRAIN PANS, AND FILTER SECTION WITH MERV-11 FILTERS AND MAGNAHELIC FILTER DIFFERENTIAL PRESSURE GAUGE

<u>GV - #</u> G	RAVI	TY VENT	SCHE	DULE							
UNIT NUMBER	THROAT SIZE	MANUFACTURER	MODEL#	REMARKS							
<u>GV-1</u>											
				RAVITY VENTS SHALL BE MOTOR OPERATED DAMPERS.							

MECHANICAL NEW WORK NOTES

MECHANICAL CONTRACTOR

OR APPROVED EQUAL

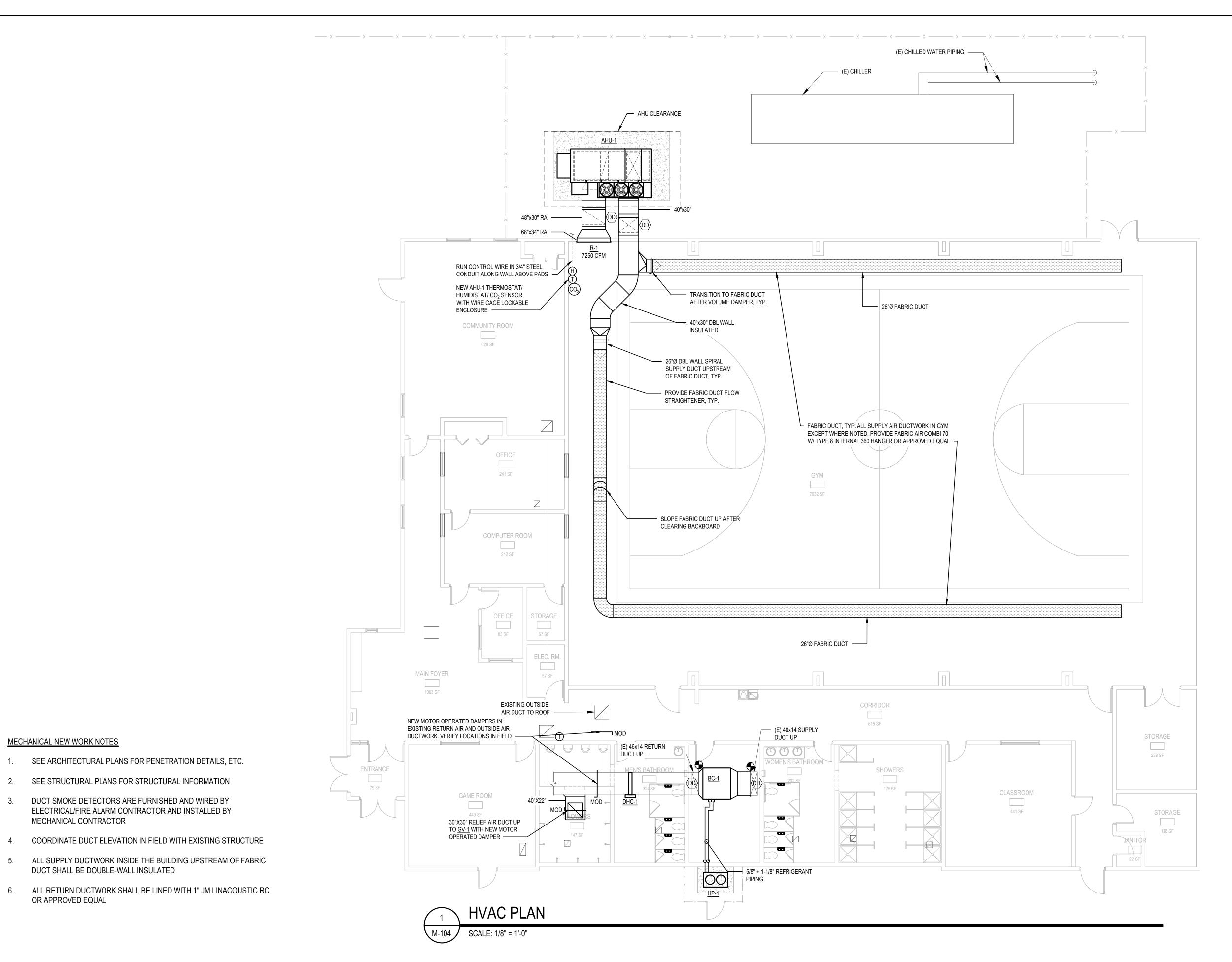
1. SEE ARCHITECTURAL PLANS FOR PENETRATION DETAILS, ETC.

ELECTRICAL/FIRE ALARM CONTRACTOR AND INSTALLED BY

COORDINATE DUCT ELEVATION IN FIELD WITH EXISTING STRUCTURE

2. DUCT SMOKE DETECTORS ARE FURNISHED AND WIRED BY

DUCT SHALL BE DOUBLE-WALL INSULATED



<u>R - #</u>		RETURN	GRILLE SO	CHEDULE	
UNIT NUMBER	SIZE (FACE / NECK)	DESCRIPTION	MANUFACTURER	MODEL NUMBER	REMARKS
<u>R-1</u>	68"X34" / 68"X34"	ALUMINUM HEAVY DUTY RETURN GRILLE	KRUEGER	S5480	PROVIDE WITH CUSTOM WIRE GUARD FOR PROTECTION FROM ABUSE
NOTE: PROVIDE EC	QUIPMENT BY KRUEGER O	R APPROVED EQUAL. FINISH SHALL BE FACTORY OFF-WHITE FINIS	SH. CONTRACTOR IS RESP	PONSIBLE TO SELECT APP	PROPRIATE MOUNT DEPENDING ON CEILING TYPE.

MECHANICAL NEW WORK NOTES

MECHANICAL CONTRACTOR

OR APPROVED EQUAL

DUCT SHALL BE DOUBLE-WALL INSULATED

APPROVED EQUAL). PROVIDE OUTSIDE AIR AND EXHAUST AIR WEATHER HOODS.

1. SEE ARCHITECTURAL PLANS FOR PENETRATION DETAILS, ETC.

. SEE STRUCTURAL PLANS FOR STRUCTURAL INFORMATION

DUCT SMOKE DETECTORS ARE FURNISHED AND WIRED BY ELECTRICAL/FIRE ALARM CONTRACTOR AND INSTALLED BY

4. COORDINATE DUCT ELEVATION IN FIELD WITH EXISTING STRUCTURE

<u>AHU - #</u>		P	ACK	AGE	D H	EAT P	UMP A	AIR HAND	DLING	UNI	T SCI	HEDU	LE (D)	(CO	OLING	G, DX	HEA	TING	, ELE	CTRI	C SU	PPLEME	ENTAL	_ HEA	ATING	G, ENERGY REC	COVERY)
	AIRFLOW	OUTCIDE	SUPPLY	EXH	Е	RV - COOLING	MODE		DX	COIL - COOL	ING MODE			ERV	- HEATING M	ODE	DX C	OIL - HEATING	MODE		ELECTRIC	HEAT					
UNIT NUMBER	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EXT. SP. (in w.g.)	CFM	EDB/EWB (°F)	LDB/LWB (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	CFM	EDB (°F)	LDB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	EAT (°F)	LAT (°F)	CAPACITY (KW)	ELEC	FLA	MOCP	VALENT MODEL #	REMARKS
AHU-1	7250	4600	1.0	0.5	4600	86.5/71.6	78.3/65.8	76.9	64.3	52.3	52.3	188.4	253.2	4600	10.8	52.8	61.1	80.1	146.2	80.1	101.6	49.2	208/60/3	257.0	350.0	VXE-212-52B-20A-1-G2	SET $\mathrm{CO_2}$ OCCUPIED MINIMUM FOR 5% OA DURING UNIT STARTUP
														,			,							,			EAMS, ENTHALPY ECONOMIZER, CO2 DEMAND CONTROL SURATION SHOWN ON DRAWINGS (CAMBRIDGEPORT OR

<u>BC - #</u>						S	SPLIT	SYS	TEM E	BLOWE	ER CO	OIL S	CHE	DULE	(DX (COOLIN	VG, D	X HEATING	3)	
		AIRFLOW	OUTSIDE	SUPPLY			DX COIL - CC	OLING MODE				DX COIL - HE	ATING MODE							
UNIT NUMBER	PAIRED WITH	(CFM)	AIR (CFM)	EXT. SP. (in w.g.)	EDB (°F) EWB (°F) LDB (°F) LWB (°F) SEN		SENS MBH	TOTAL MBH	AMBIENT DB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	ELEC	FLA	MOCP	MANUFACTURER	MODEL#	REMARKS		
BC-1	HP-1	5000	900	0.5	76.9	64.2	52.0	51.3	150.4	205.0	10.6	60.4	95.0	208.0	208/3/60	13.9	30.0	VTS	AVS055-R-FCV	
	DE EQUIPMENT AS ELIMINATORS ON							,		,					ND FACTORY	INSTALLED VFD,	RUBBER-IN-S	HEAR FAN ISOLATOR MOUN	ITS, CUSTOM DUAL TEMPERATURE DX	COIL TO OPERATE WITH VRF CONDENSING UNIT AND EEV

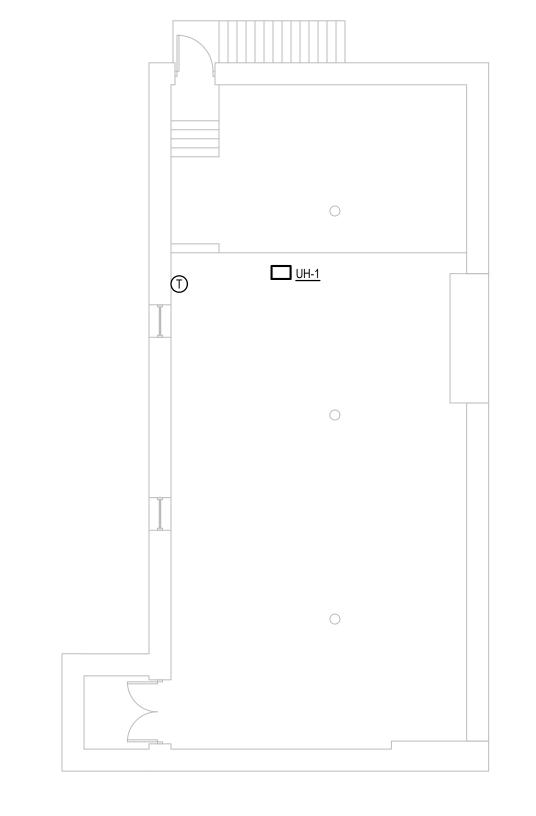
<u>HP - #</u>				HEAT PU	MP SO	CHE	DULE				<u>GV - #</u>	GRAVI	TY VENT	SCHE	DULE
UNIT NUMBER	COOLING CAPACITY (MBH)	HEATING CAPACITY (MBH)	DESIGN COOLING OUTDOOR DB/WB (°F)	DESIGN HEATING OUTDOOR DB (°F)	ELEC	MCA	МОСР	MFGR	MODEL	REMARKS	UNIT NUMBER	THROAT SIZE	MANUFACTURER	MODEL#	REMARKS
HP-1	216	243	86.5/71.6	10.8	208/3/60	60.3	80	LG	ARUM216BTE5		<u>GV-1</u>	30"X30"	GREENHECK	FGR	
MANUFACTURER'S	TWINNING KITS FOR	R INSTALLATION AN	D SINGLE-POINT ELECTR	RICAL CONNECTIONS. AI	L UNITS SHALL	BE PROVID	ED WITH SP	RING VIBRATION		AL CONDUITS. PROVIDE DEFLECTION. PROVIDE WITH VER COIL/HEAT PUMP SYSTEM					RAVITY VENTS SHALL BE MOTOR OPERATED DAMPERS.

<u>DHC - #</u>			EL	ECTRIC	C DUC	T HEA	TER SCH	IEDULE	
MARK	AIRFLOW (CFM)	HEATING E.D.B./L.D.B (°F)	CAPACITY (KW)	DUCT DIMENSIONS	AIRFLOW ORIENTATION	ELECTRICAL	MANUFACTURER	MODEL	REMARKS
DHC-1	5000	60/70	16	46"X14"	HORIZ	208/3/60	WARREN	CBK	VERIFY RETURN DUCT DIMENSIONS IN FIELD
					•			DUCT TEMPERATURE SENSORS, M FOR TO MAINTAIN 36" CLEARANCE	AGNETIC CONTACTORS, 24V CONTROL TRANSFORMERS, TO DISCONNECT PER NEC

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MECHANICAL NEW WORK NOTES

- 1. SEE ARCHITECTURAL PLANS FOR PENETRATION DETAILS, ETC.
- 2. SEE STRUCTURAL PLANS FOR STRUCTURAL INFORMATION
- 3. DUCT SMOKE DETECTORS ARE FURNISHED AND WIRED BY ELECTRICAL/FIRE ALARM CONTRACTOR AND INSTALLED BY MECHANICAL CONTRACTOR
- 4. COORDINATE DUCT ELEVATION IN FIELD WITH EXISTING STRUCTURE
- 5. ALL SUPPLY DUCTWORK INSIDE THE BUILDING UPSTREAM OF FABRIC DUCT SHALL BE DOUBLE-WALL INSULATED
- 6. ALL RETURN DUCTWORK SHALL BE LINED WITH 1" JM LINACOUSTIC RC OR APPROVED EQUAL





<u>L - #</u>		LO	JVER S	CHEDULE	
UNIT NUMBER	CFM	SIZE (WxH)	MIN. FREE AREA (SQ. FT.)	GREENHECK MODEL#	REMARKS
L-1	70	12"X12"	0.25	EHH-401	
NOTES: PROVIDE			PPROVED EQUAL. F	PROVIDE WITH FACTORY HIGH PERF	ORMANCE FLUOROPOLYMER

TO MAINTAIN 36" CLEARANCE TO DISCONNECT PER NEC

MOUNTING KIT.

<u>DHC - #</u>	ELECTRIC DUCT HEATER SCHEDULE													
MARK	AIRFLOW (CFM)	HEATING E.D.B./L.D.B (°F)	CAPACITY (KW)	DUCT DIMENSIONS	AIRFLOW ELECTRICAL		MANUFACTURER	MODEL	REMARKS					
DHC-1	1500	59/71	5.5	24"X12"	HORIZ	208/3/60	WARREN	СВК						
DHC-2	1500	59/71	5.5	24"X12"	HORIZ	208/3/60	WARREN	СВК						
DHC-5	1300	11/74	2.0	6"X6"	HORIZ	208/3/60	WARREN	СВК						
					•		•	DUCT TEMPERATURE SENSORS, M NTROL WITH 0-10VDC INPUT SIGN,						

<u>UH - #</u>	UH-# UNIT HEATER SCHEDULE										
UNIT NUMBER	CFM	INPUT (KW)	ELEC	MFG MODEL#	REMARKS						
UH-1	650	7.5	208/3/60	QMARK MUH-102	PROVIDE WITH LINE VOLTAGE THERMOSTAT						
UH-2	100	4.0	208/1/60	QMARK CWH3408F	PROVIDE WITH SURFACE MOUNT KIT						
NOTES: PROVIDE EQUIPMEN	IT AS SCHEDULED OR AP	PROVED EQUAL. PR	OVIDE WITH FIELD-S	UPPLIED RELAY FOR CO	NNECTION TO BAS						

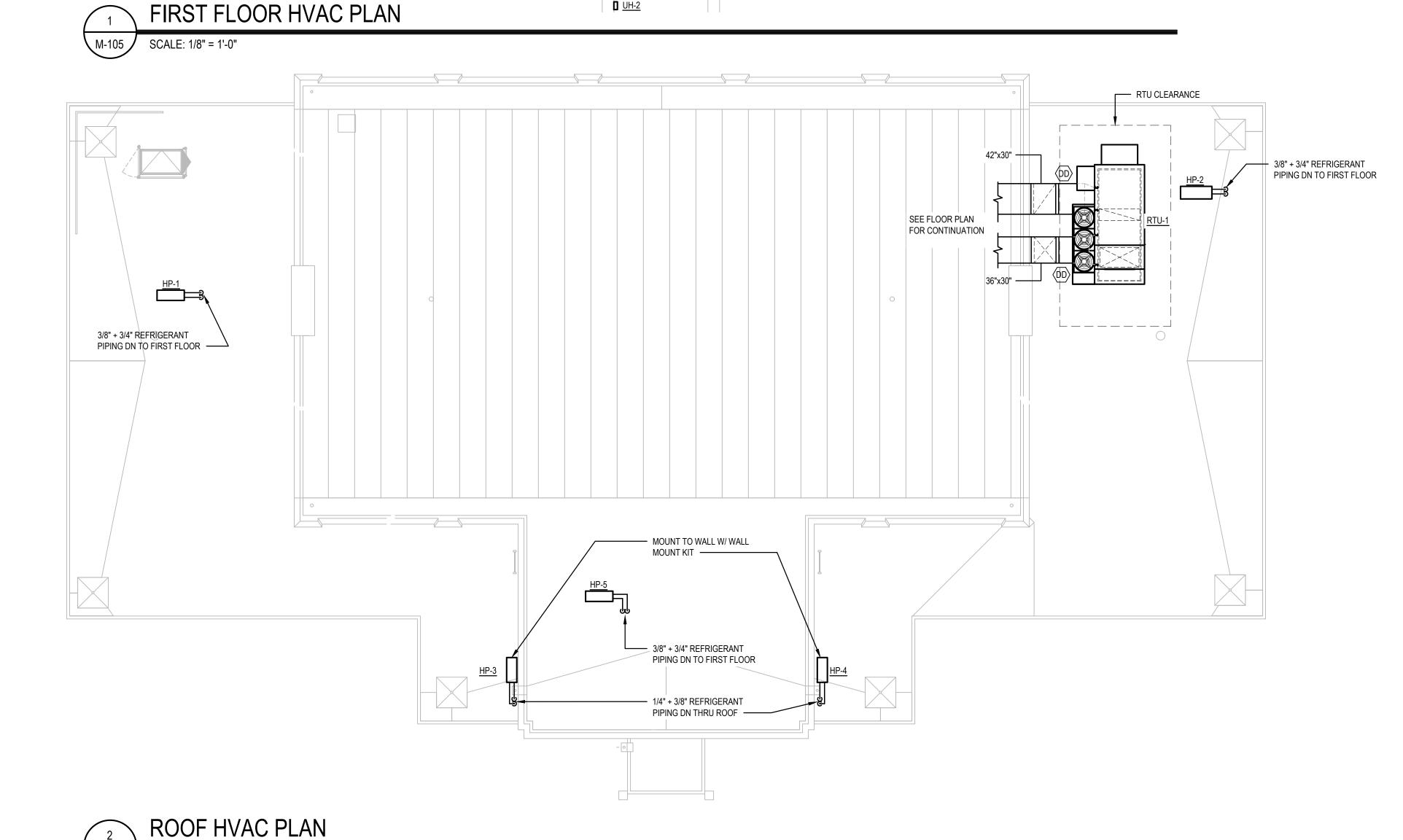
<u>RCP - #</u>	RADIAN	T CEILIN	NG PAN	EL SCHEDI	JLE
UNIT NUMBER	WATTS	DIMENSIONS (FT)	ELEC	QMARK MODEL#	REMARKS
RCP-1	375	2X2	208/1/60	CP378F	
RCP-2	375	2X2	208/1/60	CP378F	
					CTION TO BAS. PROVIDE WITH INECT SWITCH AND SURFACE

<u>EF - #</u>	! -		EXH	HAUS	T FAN	SCH	IEDL	JLE		
UNIT NUMBER	LOCATION	TYPE	CFM	ESP	DRIVE	ELEC	POWER	MOUNT	MANUFACTURER	MODEL#
EF-1	BOY'S LOCKER	CENTRIFUGAL INLINE	400	0.25"	DIRECT EC	115/1/60	1/10 HP	SUSPENDED	GREENHECK	SQ-90-VG
EF-2	GIRLS LOCKER	CENTRIFUGAL INLINE	300	300 0.25" DIRECT EC 115/1/60 1/10 HP SUSPENDED G		GREENHECK	SQ-90-VG			
NOTES: PROVID	E EXHAUST FA	ANS AS SCHEDULED OR API	PROVED EQUA	L. PROVIDE V	WITH RUBBER-IN	N-SHEAR ISO	LATORS, AI	ND FAN MOUNTED	EC MOTOR CONTROL.	

UNIT NUMBER									OUTDOOR UNIT			INDOOR UNIT								
(INDOOR/OUTDOOR)	COOLING CAP (BTU/H)	HEATING CAP (BTU/H)	E.E.R.	ELEC	MCA	MOCP	MANUFACTURER	MODEL NO.	DESIGN OUTDOOR COOLING DB/WB (°F)	DESIGN OUTDOOR HEATING DB (°F)	MODEL#	AIRFLOW (CFM)	OUTSIDE AIR (CFM)	EXT. S.P. (IN-W.G.)	REMARKS					
FC-1/HP-1	48,000	54,000	12.2	208/1/60	24	40	LG	ARUM048GSS5	86.5/71.6	10.8	ARNU483M3A4	1500	300	0.5	"MAX HEAT" OUTDOOR UNIT					
FC-2/HP-2	48,000	54,000	12.2	208/1/60	24	40	LG	ARUM048GSS5	86.5/71.6	10.8	ARNU483M3A4	1500	300	0.5	"MAX HEAT" OUTDOOR UNIT					
FC-3/HP-3	12,000	13,600	12.5	208/1/60	10	15	LG	LSU120HSV5	86.5/71.6	10.8	LSN120HSV5	350	-	-						
FC-4/HP-4	12,000	13,600	12.5	208/1/60	10	15	LG	LSU120HSV5	86.5/71.6	10.8	LSN120HSV5	350	-	-						
FC-5/HP-5	36,000	42,000	13.5	208/1/60	24	40	LG	ARUM036GSS5	86.5/71.6	10.8	ARNU363M3A4	1300	100	0.25	"MAX HEAT" OUTDOOR UNIT					

PACKAGED HEAT PUMP AIR HANDLING UNIT SCHEDULE (DX COOLING, DX HEATING, ELECTRIC SUPPLEMENTAL HEATING, ENERGY RECOVERY)													COVERY)														
	UNIT NUMBER AIRFLOW (CFM)	AIDELOW	OUTSIDE		1	ERV - COOLING	MODE	DX COIL - COOLING MODE			ERV - HEATING MODE		DX CC	DX COIL - HEATING MODE			ELECTRIC HEAT										
			AIR (CFM)		SP. g.) CFM	EDB/EWB (°F)	LDB/LWB (°F)	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	SENS MBH	TOTAL MBH	CFM	EDB (°F)	LDB (°F)	EDB (°F)	LDB (°F)	TOTAL MBH	EAT (°F)	LAT (°F)	CAPACITY (KW)	ELEC FLA	FLA	MOCP	VALENT MODEL #	REMARKS
:04 PM	RTU-1	6500	3200	1.0 0.9	3200	86.5/71.6	77.8/65.3	76.4	63.9	53.5	53.5	156.8	195.6	3200	10.8	55.7	64.0	80.5	114.2	80.5	100.5	41.0	208/60/3	207.3	250.0	VXE-212-52B-17.5A-1-G2	SET $\mathrm{CO_2}$ OCCUPIED MINIMUM FOR 5% OA DURING UNIT STARTUP
5/2024 6	NOTES: PROVIDE EQUIPMENT AS SCHEDULED OR APPROVED EQUAL. PROVIDE WITH R-410A COPPER TUBE ALUMINUM FIN DX COILS WITH MODULATING COMPRESSORS AND MODULATING SCR CONTROL, FACTORY-INSTALLED VFD ON SUPPLY & EXHAUST AIR STREAMS, ENTHALPY ECONOMIZER, CO2 DEMAND CONTROL VENTILATION, MODULATING OA & RA DAMPERS W/ 0-10VDC ACTUATORS, ZONE TEMPERATURE & HUMIDITY SENSOR, AND 2" MERV-8 FILTERS ON ALL AIRSTREAMS. PROVIDE ALL UNITS WITH 120V CONVENIENCE OUTLET & TRANSFORMER POWERED DIRECTLY BY UNIT. PROVIDE CUSTOM 54" TALL VIBRATION ISOLATION (SPRINGS W/ 2" DEFLECTION MIN) SIDE-DISCHARGE PLENUM CURB IN CONFIGURATION SHOWN ON DRAWINGS (CAMBRIDGEPORT OR APPROVED EQUAL). DUCT OPENINGS SHALL BE MIN. 12"+/- CLEAR FROM BOTTOM OF CURB TO ALLOW FOR ROOF INSULATION. PROVIDE OUTSIDE AIR AND EXHAUST AIR WEATHER HOODS.																										

NOTE: PAINT ALL NEW DUCTWORK TO MATCH EXISTING NOTE: PAINT ALL NEW 42"x30" RA 26"Ø FABRIC DUCT -DUCTWORK TO MATCH EXISTING REFRIGERANT PIPING ------ 36"x36" DBL WALL (E) RETURN DUCT INSULATED THRU 3/8" + 3/4" REFRIGERANT EXISTING EF OPENING 26"Ø DBL WALL SPIRAL SUPPLY DUCT UPSTREAM SEE ROOF PLAN OF FABRIC DUCT ----FOR CONTINUATION 3/8" + 3/4" REFRIGERANT MOD PIPING UP TO ROOF FABRIC DUCT, TYP. ALL SUPPLY AIR DUCTWORK IN GYM EXCEPT WHERE NOTED. PROVIDE FABRIC AIR COMBI 70 W/ TYPE 8 INTERNAL 360 HANGER OR APPROVED EQUAL. RUN THROUGH JOISTS, CL @ APPROX. 12'-0 FROM WALL. TRANSITION TO FABRIC COORDINATE WITH ARCHITECT DUCT AFTER VOLUME REFRIGERANT DAMPER, TYP. ——— — PIPING UP TO ROOF -S NEW VOLUME DAMPER FABRIC DUCT FLOW IN EXISTING EXHAUST STRAIGHTENER, TYP. ———— NEW VOLUME DAMPER IN 1250 CFM _ DUCT, TYP. 2 —— EXISTING EXHAUST DUCT. BALANCE TO 150 CFM RUN CONTROL WIRE IN 3/4" STEEL 26"Ø FABRIC DUCT — CONDUIT ALONG WALL ABOVE PADS — - PROVIDE 2'-8" X 1'-4" FIRE (E) SUPPLY DUCT -DAMPER AND SLEEVE IN WALL BETWEEN NEW RETURN GRILLES NEW AHU-1 THERMOSTAT/ PROVIDE 2'-8" X 1'-6" FIRE HUMIDISTAT/ CO₂ SENSOR DAMPER AND SLEEVE IN WALL WITH WIRE CAGE LOCKABLE BETWEEN NEW RETURN GRILLES — ✓ PROVIDE 2'-8" X 1'-6" FIRE ENCLOSURE -__ DAMPER AND SLEEVE IN WALL ROOM BETWEEN NEW RETURN GRILLES COORDINATE DIFFUSER ENLARGE EXISTING BREECHING 3/8" + 3/4" REFRIGERANT LOCATION WITH EXISTING OPENING FOR INSTALLATION OF PIPING UP TO ROOF ——— FC-1 THERMOSTAT -B\ LIGHTS, TYP. NEW LOUVER ---— FC-2 THERMOSTAT COORDINATE LOCATION IN FIELD. PROVIDE COORDINATE LOCATION IN FIELD. PROVIDE ADDITIONAL WOOD BLOCKING TO EXTEND ADDITIONAL WOOD BLOCKING TO EXTEND SURFACE MOUNTING KIT TO CLEAR OBSTACLES — SURFACE MOUNTING KIT TO CLEAR OBSTACLES $\frac{D-1}{325}$ 16"X12" -11/4" + 3/8" REFRIGERANT PIPING UP TO ROOF ----- 1/4" + 3/8" REFRIGERANT PIPING UP TO ROOF UH-2



D - #

DIFFUSER SCHEDULE

UNIT NUMBER SIZE (FACE / NECK) DESCRIPTION MANUFACTURER MODEL NUMBER REMARKS

D-1 12"X12" / 12"X12" ALUMINUM DOUBLE DEFLECTION SUPPLY DIFFUSER KRUEGER 5880 PROVIDE FACE OPERABLE DAMPER

NOTE: PROVIDE EQUIPMENT BY KRUEGER OR APPROVED EQUAL. FINISH SHALL BE FACTORY OFF-WHITE FINISH. CONTRACTOR IS RESPONSIBLE TO SELECT APPROPRIATE MOUNT DEPENDING ON CEILING TYPE.

<u>R - #</u>		RETURN GRILLE	SCHEDUL	.E		
UNIT NUMBER	SIZE (FACE / NECK)	DESCRIPTION	MANUFACTURER	MODEL NUMBER	REMARKS	
<u>R-1</u>	64"X32" / 64"X32"	ALUMINUM HEAVY DUTY RETURN GRILLE	KRUEGER	S5480	PROVIDE WITH CUSTOM WIRE GUARD FOR PROTECTION FROM ABUSE	
<u>R-2</u>	32"X18" / 32"X18"	ALUMINUM RETURN GRILLE	KRUEGER	S580		
<u>R-3</u>	32"X16" / 32"X16"	ALUMINUM RETURN GRILLE	KRUEGER	S580		
NOTE: PROVIDE EQ TYPE.	UIPMENT BY KRUEGER O	R APPROVED EQUAL. FINISH SHALL BE FACTORY OFF-WHITE FINIS	SH. CONTRACTOR IS RESI	PONSIBLE TO SELECT AP	PROPRIATE MOUNT DEPENDING ON CEILING	

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ARCHITECT / ENGINEER SEAL

CITY OF PROVIDENCE
PARTMENT OF PUBLIC PROPERTY
AC AND ELECTRICAL UPGRADES

AT
ARIOUS RECREATION CENTERS

PROJECT

MARK DESCRIPTION
- -

REVISIONS

SHEET TITLE

MECHANICAL PLANS ZUCCOLO

CONSTRUCTION

DOCUMENTS

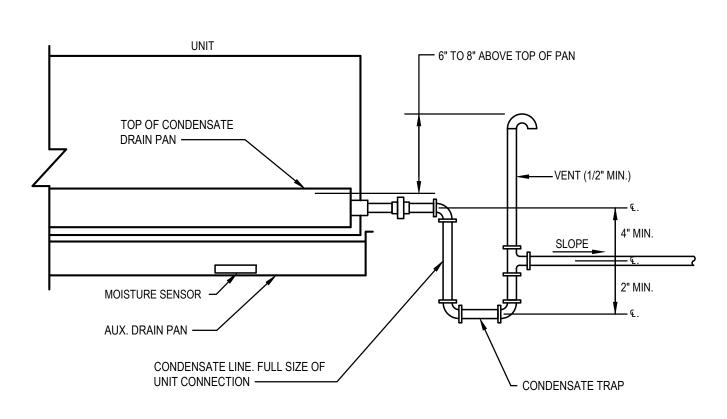
OCTOBER 15, 2024

DRAWN CHK'D PROJECT NO

MA TC 2407

M-105

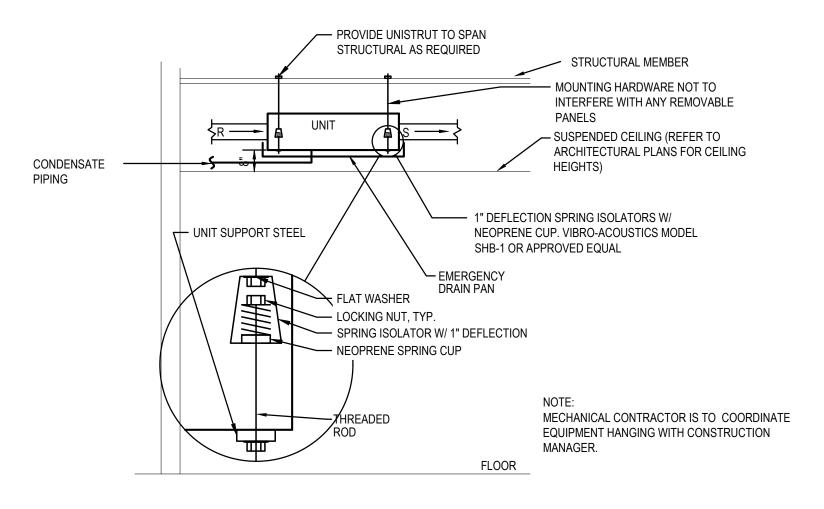
M-105 / SCALE: 1/8" = 1'-0"



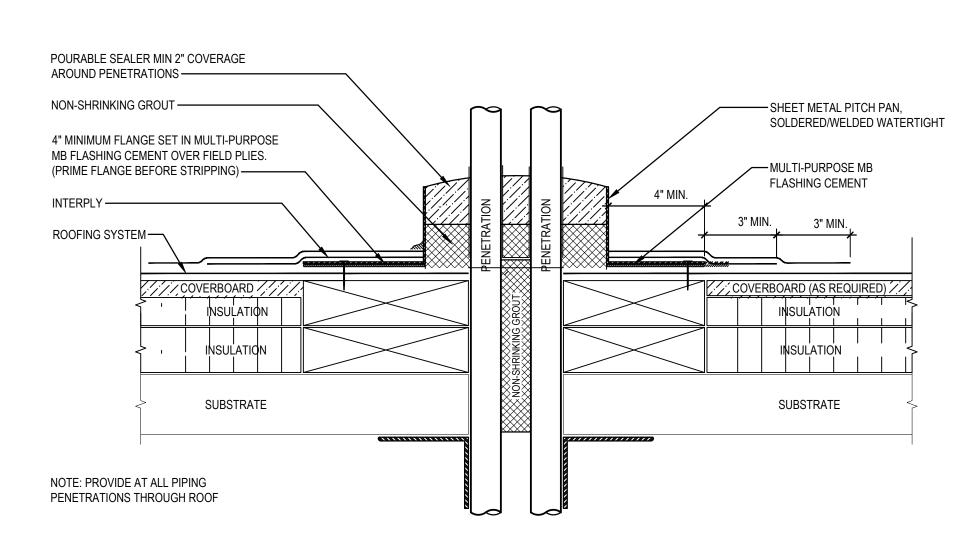
NOTE: CONTRACTOR TO PROVIDE A MOISTURE SENSOR AS SHOWN IN AUXILIARY DRAIN PAN. THIS MOISTURE SENSOR SHALL DE-ENERGIZE THE UNIT AND SEND AN ALARM TO THE BAS TERMINAL.

TYPICAL VRF DUCTED UNIT CONDENSATE DETAIL

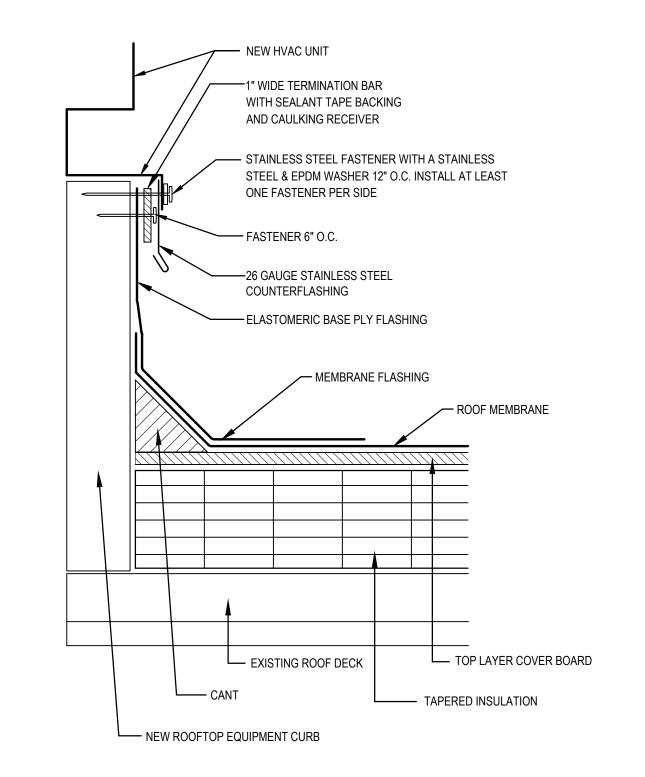
M-500 SCALE: NTS



TYPICAL FAN COIL / BLOWER COIL HANGING DETAIL M-500 SCALE: NTS

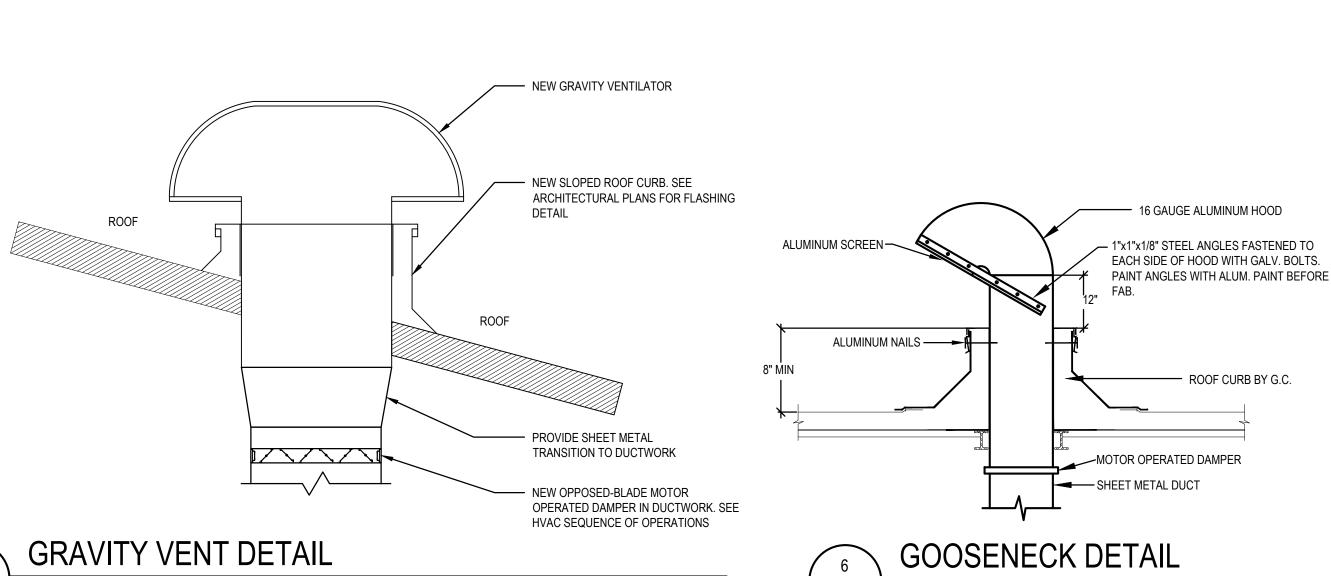


\ PITCH POCKET DETAIL M-500 SCALE: NTS

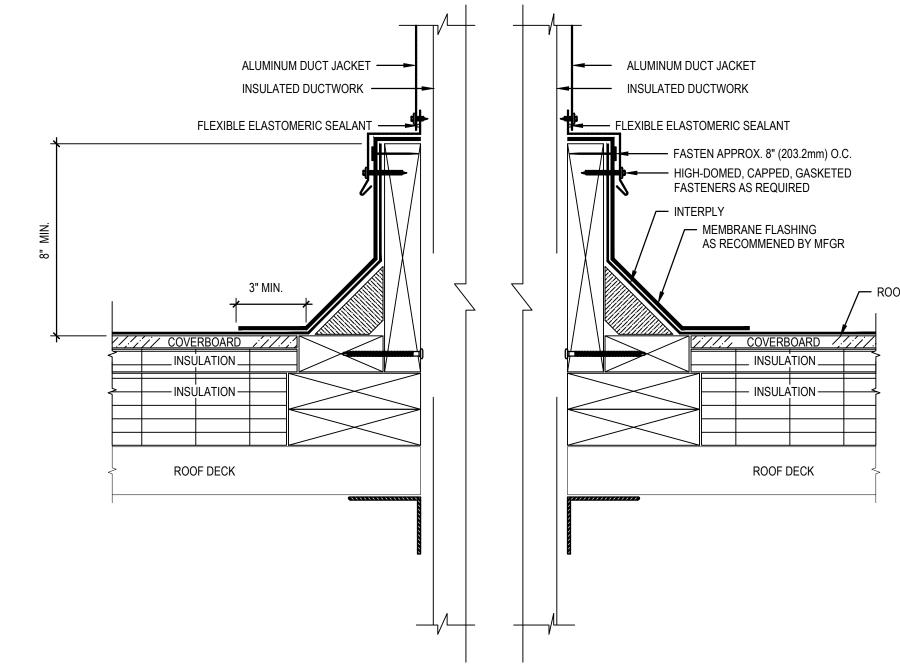


ROOF CURB FLASHING DETAIL

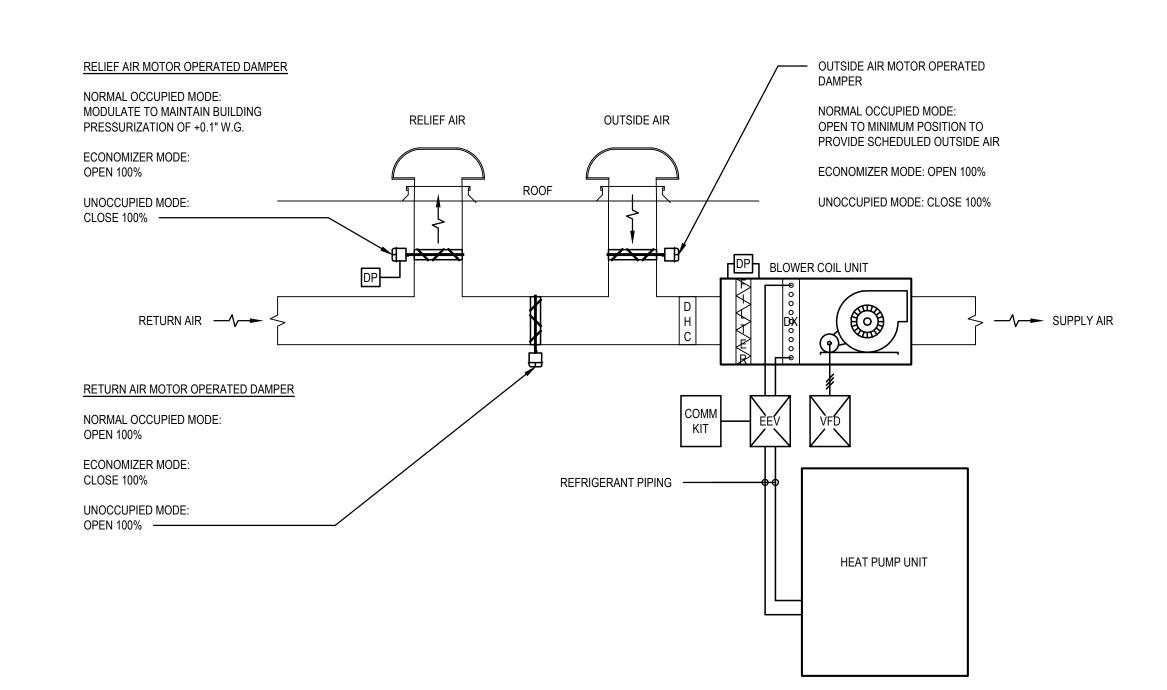
M-500 SCALE: NTS



M-500 SCALE: Not To Scale

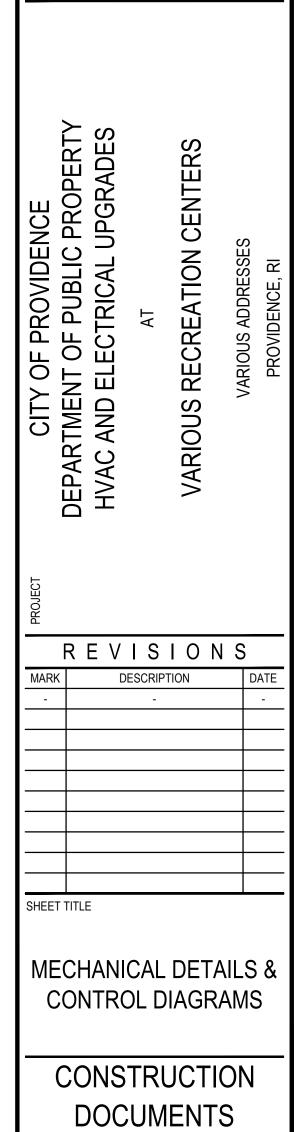


DUCT FLASHING DETAIL M-500 SCALE: NTS



BLOWER COIL / HEAT PUMP CONTROL DIAGRAM M-500 SCALE: NTS

M-500 SCALE: NTS



OCTOBER 15, 2024

M-500

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ARCHITECT / ENGINEER SEAL

ELECTRICAL SYMBOL LEGEND								
Power Devices								
Ф	GENERAL PURPOSE DUPLEX RECEPTACLE - 20AMP, 125VOLTS, NEMA5-20R, TAMPER RESISTANT. ELECTRICAL BOX TO BE 2-1/8" DEEP.							
WP/GFCI	GENERAL PURPOSE GFCI DUPLEX RECEPTACLE - 20AMP, 125VOLTS, NEMA5-20R, TAMPER RESISTANT. ELECTRICAL BOX TO BE 2-1/8" DEEP. OUTLETS INSTALLED OUTDOORS OR ON ROOF SHALL HAVE DIECAST ALUMINUM BOX 2-1/8" DEEP (MIN.), AND WHILE IN USE WEATHERPROOF COVER; THOMAS&BETTS CKMUV OR APPROVED EQUAL.							
SM	FRACTIONAL HORSEPOWER MOTOR STARTER WITH OVERLOAD IN NEMA 1 ENCLOSURE; SQ'D FG2P OR APPROVED EQUAL FOR INDOORS, FW2P FOR OUTDOORS WITH NEMA 4 ENCLOSURE							
잗	FUSED DISCONNECT SWITCH-HEAVY DUTY, 3POLE WITH FUSE CLIPS SUITABLE FOR CLASS "R" FUSES. NEMA1 UNLESS NOTED. WP-WEATHER PROOF-NEMA3R ENCLOSURE. (NOMENCLATURE: 30A/20A = SWITCH SIZE/FUSE SIZE). SQ D CLASS 3110 OR EQUAL							
⊠	COMBINATION MAGNETIC STARTER, FUSIBLE DISCONNECT SWITCH TYPE, 3POLE, FULL VOLTAGE NON-REVERSIBLE TYPE WITH: FUSED CONTROL TRANSFORMER, BI-METALLIC OVERLOAD RELAYS, ON/OFF PUSH BUTTONS OR HAND-OFF-AUTO.SELECTOR SWITCH, (1)N.O./(1)N.C., AUXILIARY CONTACTS AND LED PILOT LIGHT, CLASS "R" FUSE CLIPS. NEMA1 ENCLOSURE UNLESS NOTED- SQ D CLASS 8538 OR EQUAL. NEMA 1 - SIZE 1.							
Fire Alarm D	Pevices							
(D)	DETECTION DEVICE - SMOKE DETECTOR - DUCT DETECTOR (FURNISHED AND WIRED BY ELECTRICAL / FIRE ALARM CONTRACTOR, INSTALLED BY MECHANICAL CONTRACTOR)							
\$ _{DD}	DUCT DETECTOR REMOTE TEST SWITCH - SEE DUCT DETECTOR CONTROL WIRING DIAGRAM & DUCT DETECTOR CONTROL WIRING DETAIL ON SHEET E-500.							
MM	MONITORING MODULE - PROVIDE LOW VOLTAGE WIRING TO FACP							
CTR	CONTROL RELAY - PROVIDE LOW VOLTAGE WIRING TO FACP							

ELECTRICAL ABBREVIATIONS

(D) - DENOTES EQUIPMENT OR WIRING TO BE DEMOLISHED LSI - LONG TIME + SHORT TIME + INSTANTANEOUS (E) - DENOTES EXISTING EQUIPMENT OR WIRING TO REMAIN MCB - MAIN CIRCUIT BREAKER (N) - DENOTES NEW EQUIPMENT OR WIRING MCCB - MOLDED CASE CIRCUIT BREAKER MDP - MAIN DISTRIBUTION PANEL MFR - MANUFACTURER AC - ABOVE CEILING MTS - MANUAL TRANSFER SWITCH AF - AMPERE FRAME MVASC - MEGA VOLT AMPERE SHORT CIRCUIT AFF - ABOVE FINISHED FLOOR NTS - NOT TO SCALE AT - AMPERE TRIP OC - ON CENTER ATS - AUTOMATIC TRANSFER SWITCH PH - PHASE BLDG - BUILDING PNL - PANEL C - CONDUIT QO - QWIK OPEN PROTECTION **CB - CIRCUIT BREAKER** RM - ROOM **DISC - DISCONNECT** SP - SPEAKER **ENCL - ENCLOSURE** SPD - SURGE PROTECTIVE DEVICE SQ-D - SQUARE D FA - FIRE ALARM FACP - FIRE ALARM CONTROL PANEL SW - SWITCH G - GROUND SWBD - SWITCHBOARD GE - GENERAL ELECTRIC UG - UNDERGROUND GFCI - GROUND FAULT CIRCUIT INTERRUPTER UPS - UNINTERRUPTIBLE POWER SOURCE KA - KILO AMPERE V - VOLTS

W - WATTS OR WIRE

Z - IMPEDANCE

WP - WEATHERPROOF XFMR - TRANSFORMER

TYPE RK1

KV - KILO VOLT

KVA - KILO VOLT AMPERE

LI - LONG TIME + INSTANTANEOUS

HEIGHT UNLESS OTHERWISE NOTED

LG - LG CORPORATION

GRAPHIC CONVENTIONS Wiring Devices HOMERUN PANEL PLA-11 — BRANCH CIRCUIT DESIGNATION OUTLETS TO BE MOUNTED AT STANDARD Disconnects 30A, WP — DISCONNECT SIZE, WP: WEATHER PROOF FUSE SIZE,

ELECTRICAL GENERAL NOTES

- PROVIDE ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, COORDINATION, ADDITIONAL DESIGN AND ALL INCIDENTALS NECESSARY
 TO PROVIDE A COMPLETE AND OPERABLE SYSTEM AS DETAILED ON PLANS TO THE SATISFACTION OF THE ENGINEER AND THE
 OWNER. COORDINATE ALL WORK WITH THE ENGINEER BEFORE THE START OF WORK.
- 2. PRIOR TO SUBMITTING BID, THE CONTRACTOR SHALL VISIT THE SITE AND BE THOROUGHLY FAMILIAR WITH THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION. CONTRACTOR SHALL INCLUDE IN THEIR BID ALL MATERIAL, LABOR, AND ALL INCIDENTALS FOR A COMPLETE INSTALLATION WHETHER SPECIFICALLY INDICATED OR NOT. ALL ERRORS, DISCREPANCIES AND MISSED ITEMS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER DURING THE BIDDING PROCESS BY THE CONTRACTOR. THESE ITEMS SHALL BE INCLUDED IN THE BID PRICE. NO EXTRA COST WILL BE ALLOWED FOR ANY DISCREPANCY WHICH COULD HAVE BEEN NOTICED AT THE SITE VISIT BY THE CONTRACTOR.
- 3. PERFORM WORK AS REQUIRED BY APPLICABLE CODES, REGULATIONS, AND LAWS OF LOCAL, STATE, AND FEDERAL GOVERNMENTS AND OTHER AUTHORITIES WITH LAWFUL JURISDICTION. ALL WORK SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRIC CODE.
- 4. MATERIAL AND EQUIPMENT SHALL BE NEW (UNLESS NOTED), UL, NEMA, ANSI, IEEE, ADA & CMB APPROVED FOR INTENDED PURPOSE. MATERIAL AND INSTALLATION SHALL MEET REQUIREMENTS OF NATIONAL AND LOCAL ELECTRICAL CODE.
- 5. GIVE NOTICES, FILE PLANS, OBTAIN PERMITS, AND LICENSES, PAY FEES AND BACK CHARGES, AND OBTAIN NECESSARY APPROVALS FROM AUTHORITIES THAT HAVE JURISDICTION.
- 6. MAINTAIN RECORD DRAWINGS ON SITE. RECORD SET MUST BE COMPLETE AND CURRENT AND AVAILABLE FOR INSPECTION WHEN REQUISITIONS FOR PAYMENT ARE SUBMITTED.
- 7. GUARANTEE WORK IN WRITING PER SPECIFICATIONS, REPAIR OR REPLACE DEFECTIVE MATERIALS OR INSTALLATION AT NO COST TO OWNER DURING THE GUARANTEE PERIOD. CORRECT DAMAGE CAUSED IN MAKING NECESSARY REPAIRS AND REPLACEMENTS UNDER GUARANTEE AT NO COST TO OWNER. SUBMIT GUARANTEE TO OWNER BEFORE FINAL PAYMENT.
- 8. COORDINATE ALL ELECTRICAL ITEMS WITH EXISTING FIELD CONDITIONS. LOCATIONS SHOWN ARE APPROXIMATE AND MAY REQUIRE MINOR ADJUSTMENT IN THE FIELD TO SATISFY THE DESIGN INTENT.
- NO ADDITIONAL EXPENSE TO THE OWNER.

 10. THE LOCATIONS ON THESE PLANS ARE APPROXIMATE AND REQUIRE COORDINATION WITH ALL OTHER TRADES AND VERIFICATION OF EXISTING CONDITIONS. ROUTING OF CONDUIT IS DIAGRAMMATIC IN NATURE AND NOT INTENDED TO SHOW ALL REQUIRED OFFSETS AND DETAILS. THE CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFICATION OF ALL EXISTING ASSOCIATED EQUIPMENT AND CONDITIONS. COORDINATE THE LOCATION OF ALL EQUIPMENT WITH THE ENGINEER AND THE OWNER. CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL OTHER TRADE'S DRAWINGS AND SPECIFICATIONS AND COORDINATING WITH ALL OTHER TRADES DURING BIDDING AND CONSTRUCTION. THE CONTRACTOR IS TO INCLUDE CIRCUIT LENGTHS OF WIRE AND

9. DAMAGE TO EXISTING FACILITIES AND EQUIPMENT SHALL BE REPAIRED OR REPLACED IMMEDIATELY BY THE CONTRACTOR AT

11. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING CONTINUITY OF ALL POWER, CONTROL, FIRE ALARM, SECURITY SYSTEMS, AND COMMUNICATIONS FUNCTIONS TO ALL AREAS AFFECTED BY DEMOLITION AND/OR NEW CONSTRUCTION.

CONDUIT REQUIRED TO INSTALL CONNECTED DEVICES AND EQUIPMENT SUCH AS PANELBOARDS, SWITCHBOARDS,

12. REPAIR AND PATCH ANY DISTURBED AREAS TO MATCH ADJACENT CONSTRUCTION.

TRANSFORMERS, ETC. WITHIN 15 FEET OF THE LOCATION SHOWN.

- 13. DISCONNECT AND MAKE SAFE ANY EQUIPMENT TO BE REMOVED BY OTHERS. COORDINATE REMOVAL OF EQUIPMENT WITH OTHER TRADES PRIOR TO DEMOLITION.
- 14. IN ANY AREA REQUIRING THE PERFORMANCE OF ANY TRADE'S WORK, THIS CONTRACTOR SHALL CAREFULLY REMOVE AND STORE ANY OR ALL ELECTRICAL ITEMS IN PATH OF WORK, REINSTALLING, AND RECONNECTING SAME AS REQUIRED, IN ACCORDANCE WITH THE PLANS AND/OR AS DIRECTED AFTER COMPLETION OF OTHER TRADE'S WORK IN THAT AREA.
- 15. PRIOR TO THE START OF DEMOLITION, CONTRACTOR SHALL FIELD VERIFY ALL BRANCH CIRCUITS AND MAINTAIN THOSE CIRCUITS THAT EXTEND OUTSIDE THE SCOPE OF WORK.
- 16. AFTER RENOVATING EXISTING ELECTRICAL WORK, THE CONTRACTOR SHALL ENSURE THAT ALL REMAINING AND NEW EQUIPMENT WILL OPERATE PROPERLY, INCLUDING BUT NOT LIMITED TO BACKFEEDING OF EXISTING POWER AND LIGHTING CIRCUITS. REFER TO SINGLE LINE DIAGRAM.
- 17. ALL ELECTRICAL WORK INDICATED TO REMAIN SHALL BE SUITABLY PROTECTED TO PREVENT ANY DAMAGE.
- 18. WHERE ELECTRICAL SYSTEMS PASS THROUGH RENOVATED AREAS TO SERVE OTHER PORTIONS OF THE PREMISES, SYSTEMS SHALL BE SUITABLY PROTECTED TO PREVENT DAMAGE OR RELOCATED AND THE SYSTEMS RESTORED TO NORMAL OPERATION. ANY OUTAGES IN SYSTEMS SHALL BE COORDINATED WITH OWNER. RESTORE POWER TO EXISTING TO REMAIN EQUIPMENT IF INTERRUPTED BY DEMOLISHED CIRCUITS IN THE AREA.
- 19. CONTRACTOR SHALL SUBMIT FOR REVIEW, SHOP DRAWINGS FOR ALL EQUIPMENT AND MATERIALS USED ON THE PROJECT. SUBMITTALS SHALL BE REVIEWED BY THE ENGINEER BEFORE PURCHASE OF MATERIALS.
- 20. ALL WIRING SHALL BE COPPER, 600V, 75°/90° RATED WITH FLAME-RETARDENT, HEAT AND MOISTURE RESISTANT INSULATION. ALL NEW PANELBOARDS AND SWITCHBOARDS SHALL BE PROVIDED WITH COPPER BUSBARS, COPPER NEUTRAL BARS, AND COPPER GROUND BARS. ALL NEW TRANSFORMERS SHALL HAVE COPPER WINDINGS.
- 21. PERMANENTLY LABEL ALL NEW ELECTRICAL EQUIPMENT, INCLUDING BUT NOT LIMITED TO, DEVICE DESIGNATION AND SUPPLY CIRCUIT DESIGNATION. UPDATE OR REPLACE PANEL DIRECTORIES TO INCLUDE NEW CIRCUIT INFORMATION RESULTING FROM
- 22. PROVIDE TEMPORARY POWER AND LIGHTING FOR ALL TRADES AS REQUIRED TO COMPLETE THE PROJECT. ALL TEMPORARY AND INTERIM EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH ALL APPLICABLE CODES AND STANDARDS INCLUDING, BUT NOT LIMITED TO NFPA 110 AND NFPA 70.
- 23. REFER TO SPECIFICATIONS FOR ADDITIONAL INFORMATION THAT IS NOT SHOWN ON THE DRAWINGS.
- 24. OPENINGS IN EXISTING CONCRETE AND MASONRY WALLS AND FLOORS REQUIRED FOR CONDUIT INSTALLATION SHALL BE CORE DRILLED. MAXIMUM CORE DRILL SIZE SHALL BE 5" IN DIAMETER. CORE DRILL LOCATIONS SHALL BE SPACED A MINIMUM OF 6" FROM EACH OTHER MEASURED FROM THE OUTSIDE EDGE OF THE CORE DRILL. ALL CORE DRILL OPENINGS SHALL BE PROPERLY SEALED ACCORDING TO THEIR LOCATION AND APPLICATION.
- 25. ALL OUTAGES SHALL BE KEPT TO A MINIMUM. ALL WORK THAT REQUIRES A SUSTAINED EQUIPMENT OUTAGE SHALL BE PERFORMED CONTINUOUSLY AROUND THE CLOCK UNTIL WORK IS COMPLETED UNLESS NOTED OTHERWISE. COORDINATE OUTAGES WITH OWNER REPRESENTATIVE.
- 26. PROVIDE FOR EACH BRANCH CIRCUIT AND FEEDER CIRCUIT A DEDICATED EQUIPMENT GROUND WIRE. FOR SINGLE PHASE BRANCH CIRCUITS OF 120 V/1PH OR 277V/1 PH, PROVIDE DEDICATED HOT, DEDICATED NEUTRAL AND DEDICATED EQUIPMENT GROUND WIRES. SHARING OF NEUTRAL OR EQUIPMENT GROUND WIRES IS NOT PERMITTED. WIRING TO ALL HVAC EQUIPMENT OR OTHER TRADE EQUIPMENT SHALL BE IN CONDUIT. ALL EQUIPMENT AND FEEDER WIRING IN MECHANICAL ROOM/ELECTRICAL ROOM SHALL BE IN RIGID CONDUIT. USE OF MC CABLE IS LIMITED TO BRANCH CIRCUIT WIRING ABOVE RECESSED CEILING OR CONCEALED IN WALL. WIRING TO OUTLETS ON TABLE SHALL BE PROVIDE IN EITHER EMT CONDUIT OR FLEXIBLE METAL CONDUIT DO NOT USE PLASTIC TIE WRAPS TO SUPPORT CONDUITS AND MC CABLES. MC CABLES SHALL BE SUPPORTED AT MAXIMUM OF 6'-0" WITH SECURELY FASTENED MC CABLE SUPPORT CLAMPS, J-HOOKS, OR METAL CABLE BRACKETS.
- 27. PROVIDE IDENTIFICATION LABELS FOR ALL BRANCH CIRCUITS AND FEEDERS CIRCUITS AT JUNCTION BOXES, PANELBOARDS, TROUGHS, AND SPLICE BOXES.
- 28. PROVIDE UNSPLICED FEEDERS FROM PANELBOARD OR SWITCHBOARD TO ALL EQUIPMENT, INCLUDING ALL 20 AMPERE, SINGLE POLE BRANCH CIRCUIT WIRING.
- 29. ALL WIRING DEVICES ARE TO BE RECESSED WHERE POSSIBLE. WHERE RECESSING IS NOT POSSIBLE, WIRING DEVICES ARE TO BE SURFACE MOUNTED WITH CIRCUIT WIRING ROUTED IN SURFACE MOUNTED CONDUIT PER SPECIFICATIONS.
- 30. ELECTRICAL CONTRACTOR SHALL PROVIDE AND INSTALL (2) #14-3/4" FROM EACH VENDOR SUPPLIED DUCT SMOKE DETECTOR TO FACP. INSTALLATION OF DETECTOR BY MECHANICAL CONTRACTOR. ELECTRICAL CONTRACTOR SHALL PROVIDE ALL NECESSARY ELECTRICAL TERMINATIONS. EACH BLOWER COIL (BC) AND EACH ENERGY RECOVERY VENTILATOR (ERV) WILL HAVE (1) SUPPLY DUCT SMOKE DETECTOR AND (1) RETURN DUCT SMOKE DETECTOR.
- 31. VFD CABLE SHALL BE TYPE MC-HL (XHHW2). 3/C VFD CABLE SHALL BE RATED FOR 600 VAC WITH 2000 VOLT INSULATION WITHSTAND AND UL LISTED AS TYPE MC-HL CABLE PER UL2225(E38916). VFD CABLES SHALL HAVE UNCOATED SOFT COPPER STRANDED CONDUCTORS RATED FOR 90 DEG CENTIGRADE WET OR DRY, CROSS LINK POLYETHYLENE HIGH DIELECTRIC STRENGTH COLOR CODED INSULATION, AND THREE BARE SOFT STRANDED GROUND CONDUCTORS WITH NON-HYGROSCOPIC FILLER AND BINDER TAPE. SHEATH SHALL BE CLOSE FITTING, IMPERVIOUS, CONTINUOUS WELDED CORRUGATED ALUMINUM C-L-X PER UL1569. SHEATH SHALL BE PROTECTED WITH LOW TEMPERATURE BLACK PVC JACKET. CONTRACTOR SHALL PROVIDE PROPER FITTINGS FOR INSTALLATION OF VFD CABLE. VFD CABLE SHIELD TO BE GROUNDED WITH SHIELD TERMINATION KIT, SOUTHWIRE SPEC 4541 OR APPROVED EQUAL AT BOTH VFD END AND AT MOTOR END.
- 32. ALL CONDUIT PENETRATIONS THROUGH WALLS OR CEILINGS SHALL BE PATCHED AND SEALED WITH FIRE RATED FOAM SEALANT.
 33. PROVIDE INSULATING BUSHINGS ON CONDUIT THREADS OR CONNECTORS WHERE RACEWAYS WITH CONDUITS OR MC CABLES
- 34. PROVIDE FIRE ALARM RATED MC CABLE FOR CONNECTIONS BETWEEN FIRE ALARM DEVICES. MC CABLE SHALL RUN CONCEALED ABOVE CEILINGS AND IN DRYWALL. WHERE EXPOSED, PROVIDE EMT; NO EXPOSED MC CABLE IS PERMITTED.

ENTER A BOX OR ENCLOSURE. THIS BUSHING SHALL BE INSTALLED ON ALL CABLES AND CONDUITS.

35. CONTRACTOR TO PROVIDE A COORDINATION STUDY WHENEVER ANY FEEDER CIRCUITS ARE ADDED TO OR REMOVED FROM THE MAIN SWITCHBOARD / PANELBOARD OF A BUILDING. ADDITIONALLY, PROVIDE A COORDINATION STUDY WHENEVER A GENERATOR IS ADDED OR REPLACED. CONTRACTOR TO ADJUST THE TRIP OF THE MAIN CIRCUIT BREAKER AND/OR THE GENERATOR BREAKER ACCORDINGLY.

FIRE ALARM SYSTEM:

PROVIDE NEW FIRE ALARM SYSTEM DEVICES AND CONNECT TO EXISTING FIRE ALARM SYSTEM. ALL NEW DEVICES AND WIRING SHALL BE COMPATIBLE WITH EXISTING FIRE ALARM SYSTEM. PROVIDE REQUIRED TESTING AND INSPECTION AS REQUIRED BY STATE OF RHODE ISLAND FIRE MARSHALL'S OFFICE.

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ELECTRICAL

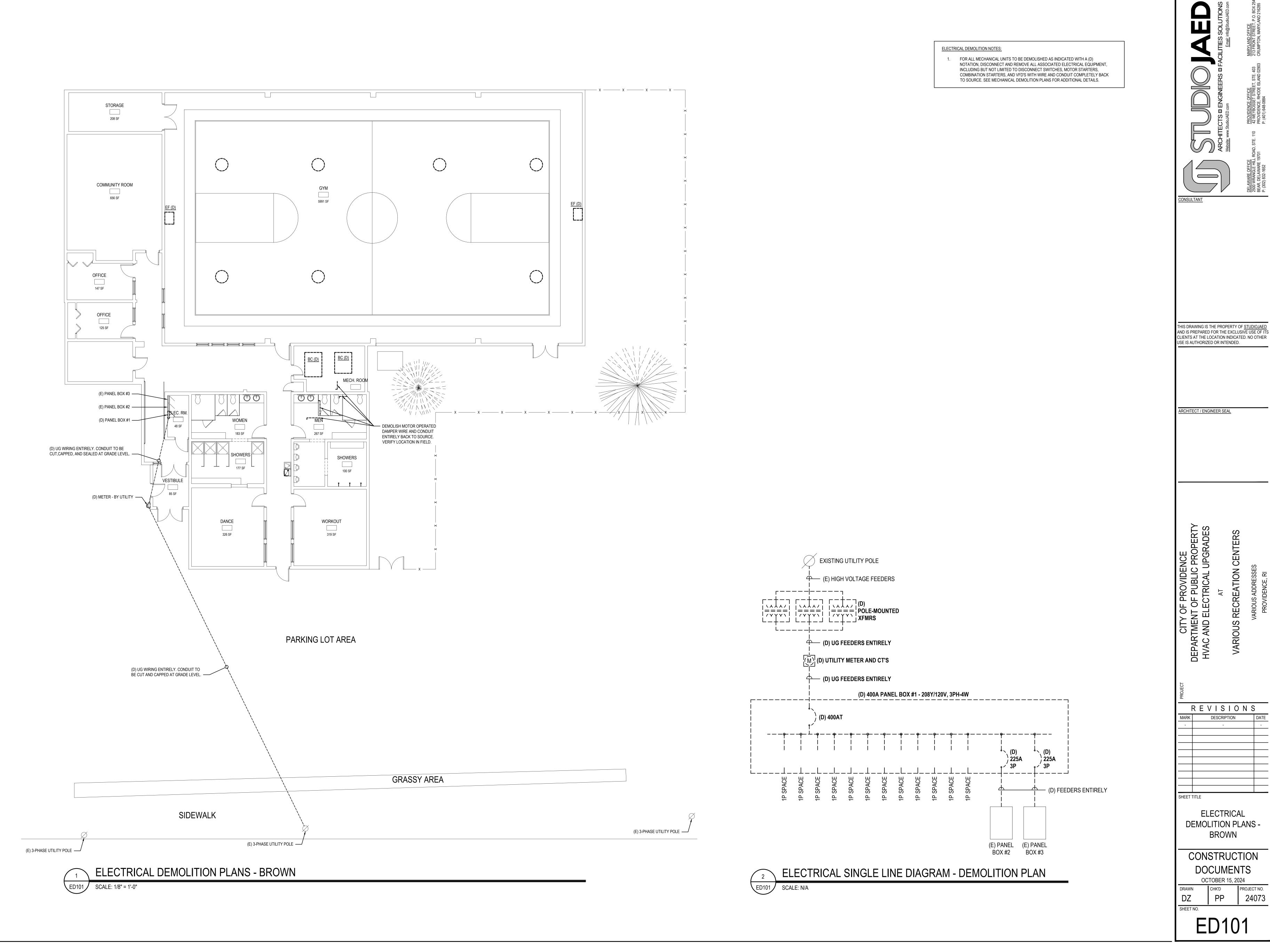
BROWN

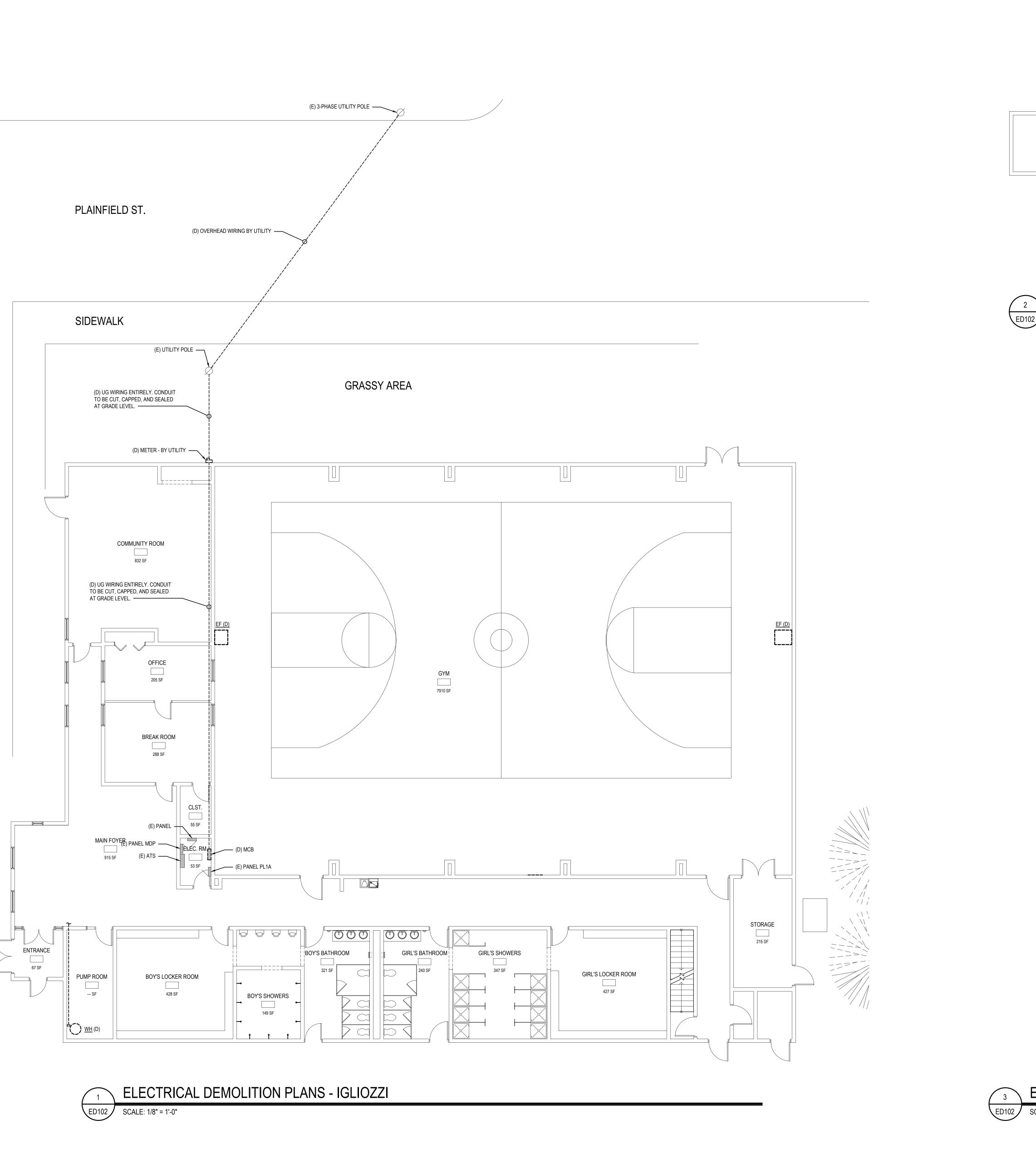
DOCUMENTS

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ED101



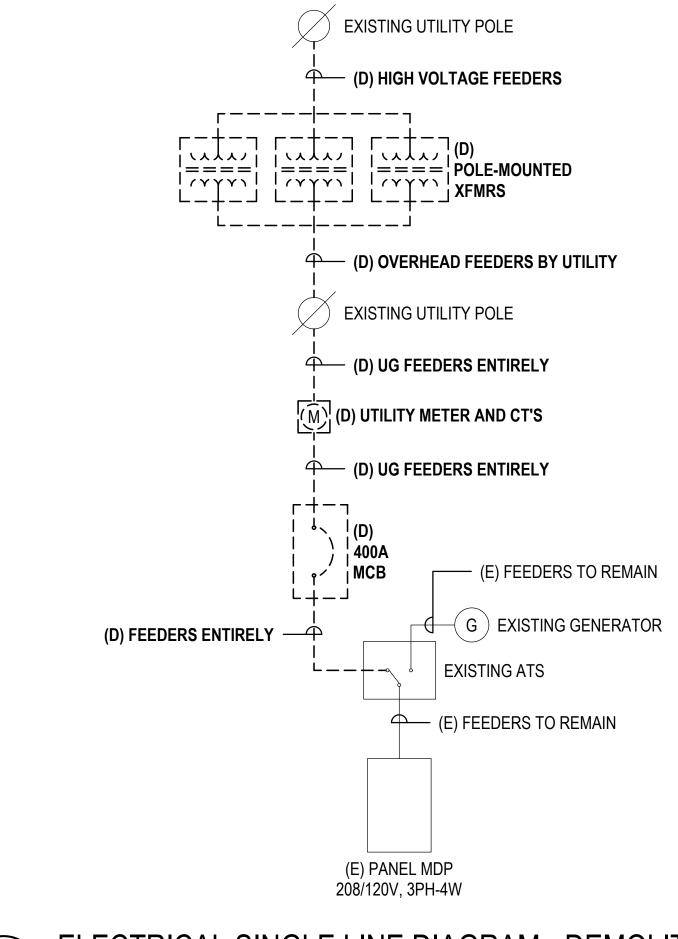


ELECTRICAL DEMOLITION NOTES:

1. FOR ALL MECHANICAL UNITS TO BE DEMOLISHED AS INDICATED WITH A (D)

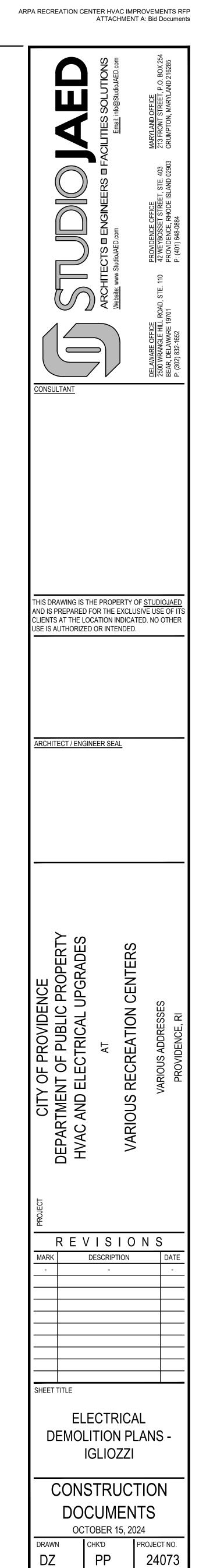
NOTATION, DISCONNECT AND REMOVE ALL ASSOCIATED ELECTRICAL EQUIPMENT, INCLUDING BUT NOT LIMITED TO DISCONNECT SWITCHES, MOTOR STARTERS, COMBINATION STARTERS, AND VFD'S WITH WIRE AND CONDUIT COMPLETELY BACK TO SOURCE. SEE MECHANICAL DEMOLITION PLANS FOR ADDITIONAL DETAILS.

ELECTRICAL DEMOLITION ATTIC PLANS - IGLIOZZI



ELECTRICAL SINGLE LINE DIAGRAM - DEMOLITION PLAN

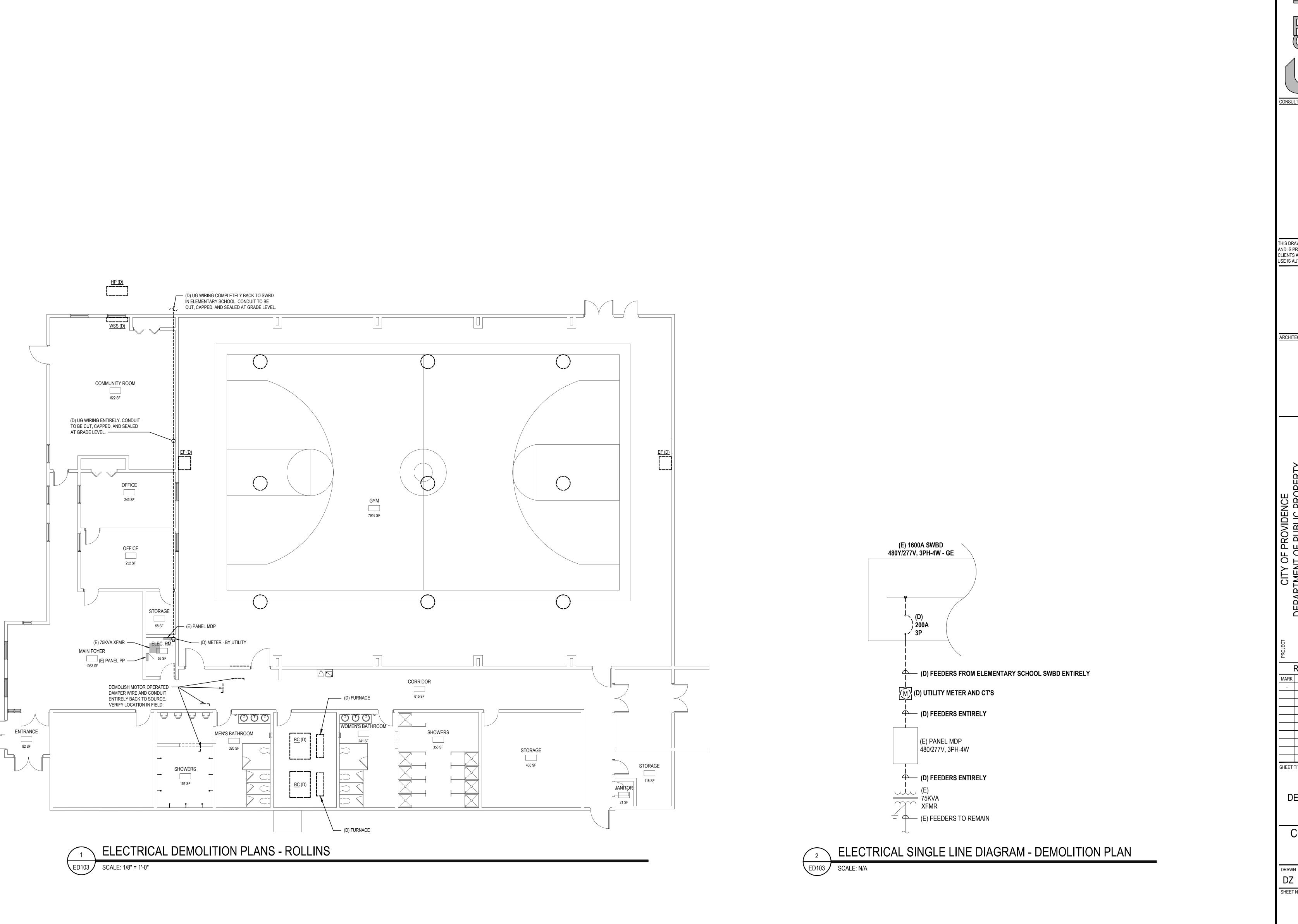
ED102 SCALE: N/A



ED102

ELECTRICAL DEMOLITION NOTES:

1. FOR ALL MECHANICAL UNITS TO BE DEMOLISHED AS INDICATED WITH A (D)
NOTATION, DISCONNECT AND REMOVE ALL ASSOCIATED ELECTRICAL EQUIPMENT,
INCLUDING BUT NOT LIMITED TO DISCONNECT SWITCHES, MOTOR STARTERS,
COMBINATION STARTERS, AND VFD'S WITH WIRE AND CONDUIT COMPLETELY BACK
TO SOURCE. SEE MECHANICAL DEMOLITION PLANS FOR ADDITIONAL DETAILS.



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PP

ED103

ELECTRICAL DEMOLITION NOTES: 1. FOR ALL MECHANICAL UNITS TO BE DEMOLISHED AS INDICATED WITH A (D) NOTATION, DISCONNECT AND REMOVE ALL ASSOCIATED ELECTRICAL EQUIPMENT, INCLUDING BUT NOT LIMITED TO DISCONNECT SWITCHES, MOTOR STARTERS, COMBINATION STARTERS, AND VFD'S WITH WIRE AND CONDUIT COMPLETELY BACK TO SOURCE. SEE MECHANICAL DEMOLITION PLANS FOR ADDITIONAL DETAILS. — (D) VFD WITH WIRING AND CONDUIT FROM POOL PUMP ENTIRELY BACK TO SOURCE. ELECTRICAL BASEMENT DEMOLITION PLANS - ZUCCOLO FIRST AID ROOM FURN (D) EXISTING UTILITY POLE 23 SF 23 SF (D) HIGH VOLTAGE FEEDERS CORRIDOR

255 SF OFFICE 114 SF (D) OVERHEAD FEEDERS BY UTILITY SNACK BAR — (D) METER - BY UTILITY (M) (D) UTILITY METER AND CT'S (D) FEEDERS ENTIRELY (D) OVERHEAD WIRING BY UTILITY **GRASSY AREA** (D) FEEDERS ENTIRELY SIDEWALK (E) PANEL (E) 1-PHASE UTILITY POLE ELECTRICAL SINGLE LINE DIAGRAM - DEMOLITION PLAN ELECTRICAL FIRST FLOOR DEMOLITION PLANS - ZUCCOLO

ED105 SCALE: 1/8" = 1'-0"

GRASSY AREA

GRASSY AREA

SIDEWALK

ED105 SCALE: 1/8" = 1'-0"

(E) 1-PHASE UTILITY POLE

PARKING LOT

ED105 SCALE: N/A

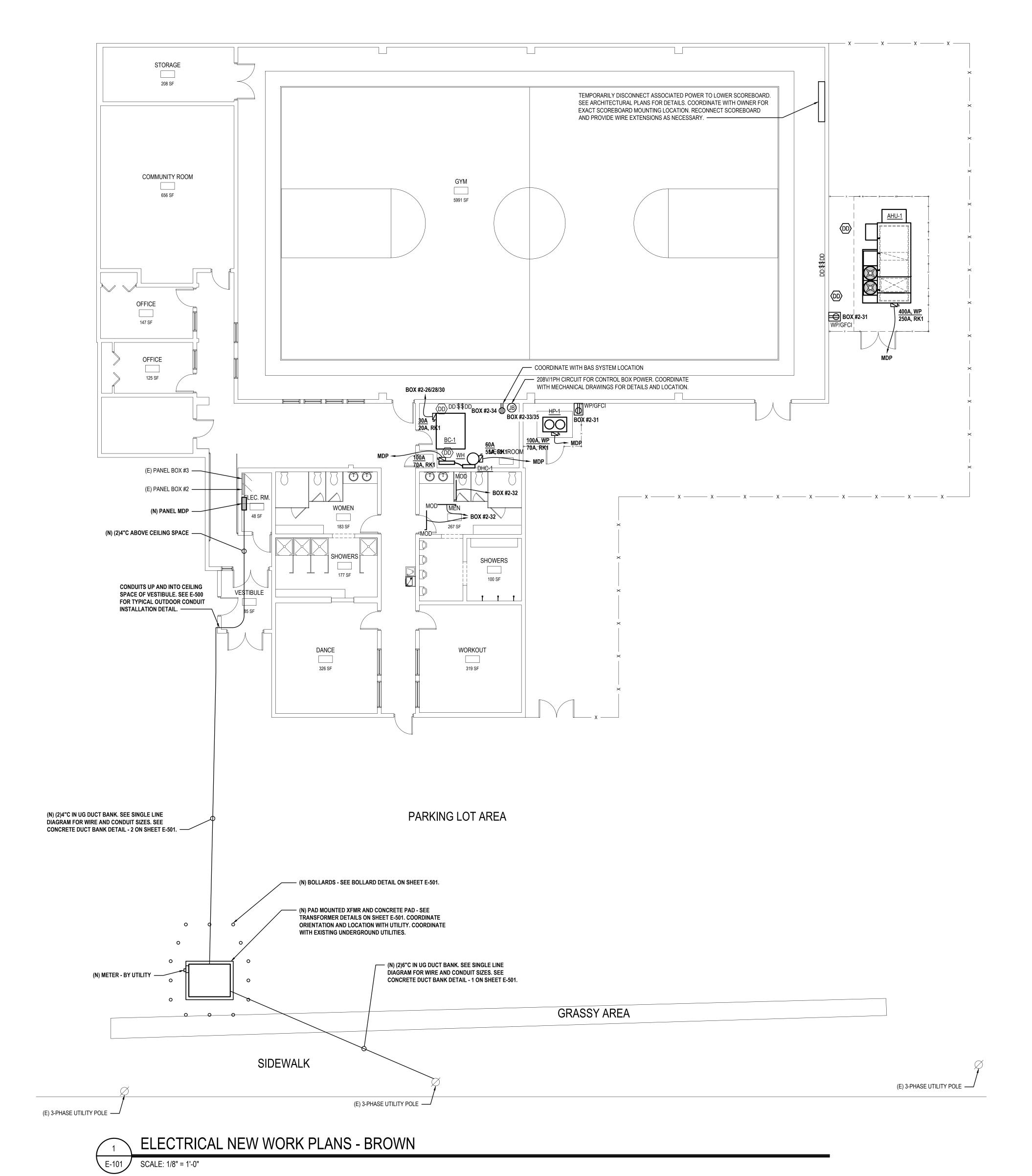
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OCTOBER 15, 2024

PP

ED105

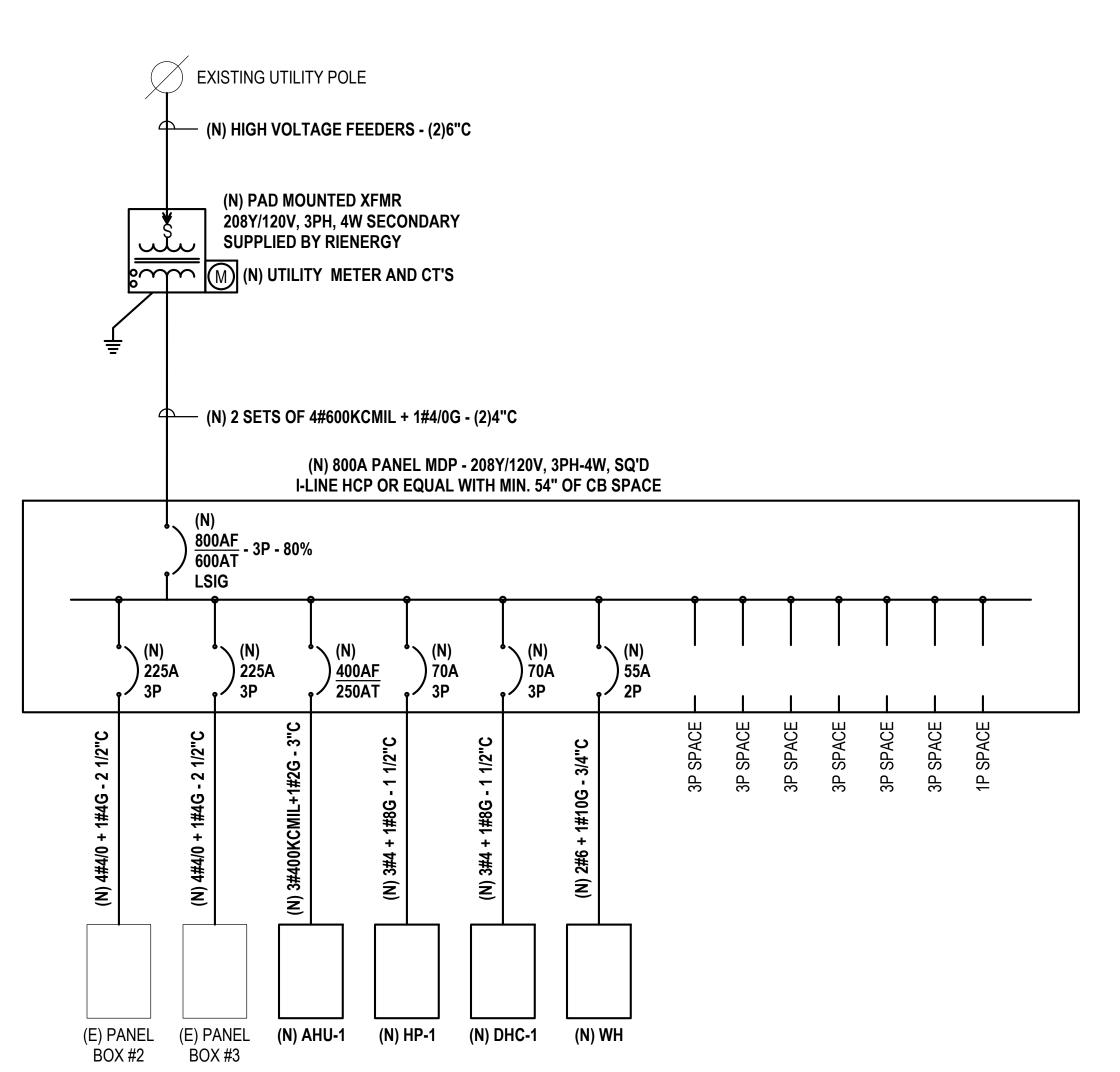
DΖ



ELECTRICAL NEW WORK NOTES:

- 1. FOR NEW HVAC EQUIPMENT, PROVIDE A FUSED DISCONNECT SWITCHES WITH RK1 FUSES AND FEED WITH NEW WIRING AND CONDUITS. SEE MECHANICAL SCHEDULES FOR ADDITIONAL HVAC EQUIPMENT INFORMATION. SEE ELECTRICAL SINGLE LINE DIAGRAM FOR WIRE AND CONDUIT SIZES. PROVIDE A WEATHERPROOF 120V RECEPTACLE AT EACH NEW OUTDOOR HVAC UNIT. SEE E-000 FOR MORE DETAILS.
- 2. SEE MECHANICAL PLANS AND E-500 FOR DUCT DETECTOR LOCATIONS AND WIRING

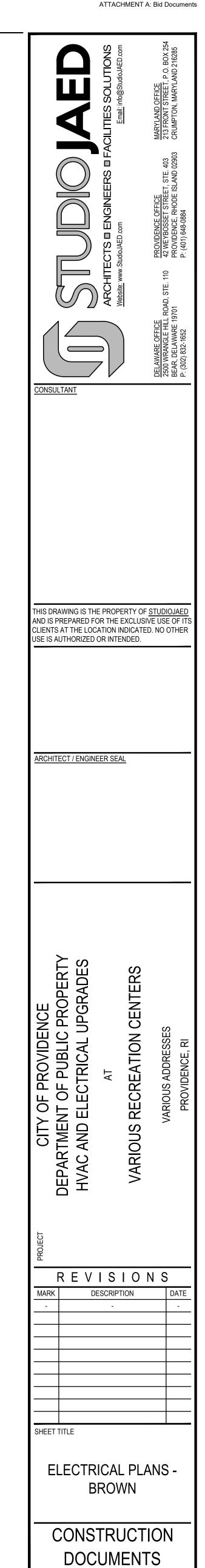
PANEL: LOCATI BUS:		BOX #2 ELECTRICAL ROOM 250A	EXISTING PANEL										208/120V, 3PH-4W NEMA-1					
MAIN: 225A												MFR:	SIEMENS - S1					
kt Br	Pole	DESCRIPTION	WIRE & CONDUIT SIZE	ØA kVA	ØB kVA	ØC kVA		Ø	c_	ØA kVA	ØB kVA	ØC kVA	WIRE & CONDUIT SIZE	DESCRIPTION		Pole	Br	CI
1 20	1	EXISTING LOAD	-	-			├ ॔¶		т -	-			-	EXISTING	LOAD	1	20	2
3 20	1	EXISTING LOAD	-		-		$\vdash \cap \vdash$	-	$+ \cap$		-		-	EXISTING	LOAD	1	20	4
5 20	1	EXISTING LOAD	-			-	$\vdash \cap \vdash$	_	$+$ \cap			-	-	EXISTING	LOAD	1	20	
7 20	1	EXISTING LOAD	-	-			├╲┪	+	$+ \cap$	-			-	EXISTING	LOAD	1	20	
9 20	1	EXISTING LOAD	-		-		$\vdash \cap \vdash$	-	$+ \cap$		-		-	EXISTING	LOAD	1	20	ŀ
1 20	1	EXISTING LOAD	-			-	$\vdash \cap \vdash$	_	+			-	-	EXISTING	LOAD	1	20	ŀ
3 20	1	EXISTING LOAD	-	-			├╲┪	+	$+ \cap$	-			-	EXISTING	LOAD	1	20	
5 20	1	EXISTING LOAD	-		-		$\vdash \cap \vdash$	-	$+ \cap$		-		-	EXISTING	LOAD	1	20	
7 20	1	EXISTING LOAD	-			-	$\vdash \cap \downarrow$		$+$ \frown			-	-	EXISTING	LOAD	1	20	Ī
9 20	1	EXISTING LOAD	-	-			├╲┪	+	$+ \cap$	-			-	EXISTING	LOAD	1	20	
1 20	1	EXISTING LOAD	-		-		$\vdash \cap \downarrow$		$+ \smallfrown$		-		-	EXISTING	LOAD	1	20	
3 20	1	EXISTING LOAD	-			-	$\vdash \cap \downarrow$	_	┿ ⌒-			-	-	EXISTING	LOAD	1	20	
5 20	1	EXISTING LOAD	-	-			├─┪	+	- 1	1.08			3#12 + 1#12G - 3/4"C	BC-1 - EQUIPMENT	ROOM	3	20	
7 20	1	EXISTING LOAD	-		-		$\vdash \cap \vdash$		- 1		1.08							
9 20	1	EXISTING LOAD	-			-	$\vdash \cap \vdash$		+			1.08						
31 20	1	OUTDOOR RECEPTS - HVAC UNITS	2#10 + 1#10G - 3/4"C	0.36			$\vdash \cap \downarrow$	+		0.30			2#12 + 1#12G - 3/4"C	MOD'S - CORRIDOR & SHO	WERS	1	20	;
33 20	2	MECHANICAL CONTROL BOX	2#12 + 1#12G - 3/4"C		0.25		$+ \cap +$	- ∳-	$+ \cap$		0.25		2#12 + 1#12G - 3/4"C	BAS SYSTEM RECEPT	TACLE	1	20	(
55						0.25	$\vdash \cap \vdash$	+	+			-	-	S	SPACE	-	-	3
7 -	-	SPACE	-	-			┟╱┪	+	+॒	-			-	S	SPACE	-]	-	(
9 -	-	SPACE	-		-		$\vdash \cap \vdash$	-	$+ \cap$		-		-	S	SPACE	- [-	4
1 -	-	SPACE	-			-]-\-	+	$\downarrow \frown$			ı	-	S	SPACE	- [-	4
ONNE PHASE PHASE PHASE	A: _ B: _	_ kVA												PANEL LOAD TOTAL CONNEC TOTAL LOAD %	CTED LO	ITY: AD:	k	V



ELECTRICAL SINGLE LINE DIAGRAM - NEW WORK PLAN E-101 SCALE: N/A

SINGLE LINE DIAGRAM NOTES:

- ALL CIRCUIT BREAKERS AND DISCONNECT SWITCHES ARE 3 POLES UNLESS NOTED OTHERWISE.
- ALL FEEDER CIRCUIT BREAKERS 400A AND GREATER SHALL HAVE ELECTRONIC TRIP INCLUDING LONG, SHORT, AND INSTANTANEOUS SETTINGS AND SHALL HAVE FIELD REPLACEABLE TRIP SETTINGS.



OCTOBER 15, 2024

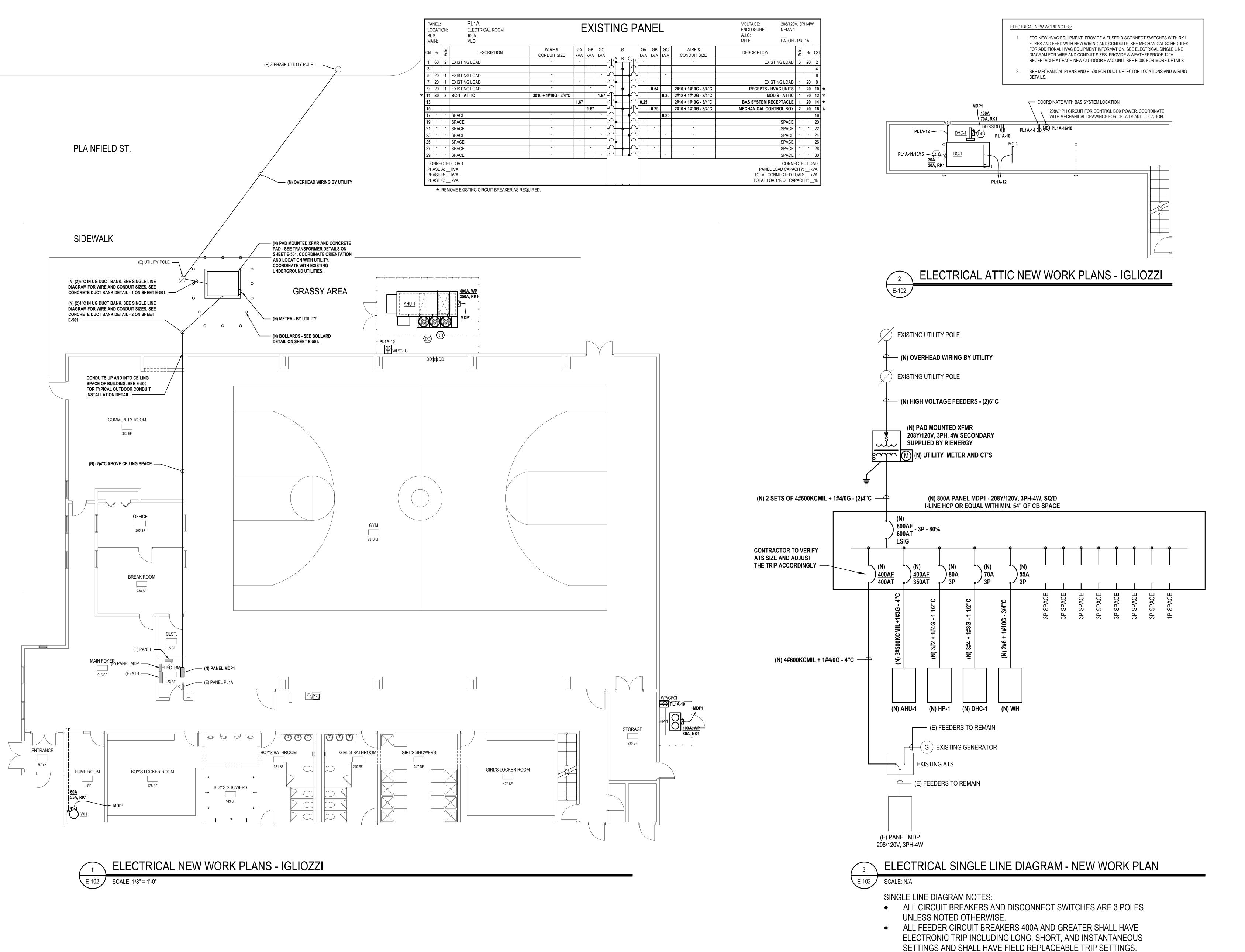
PP

E-101

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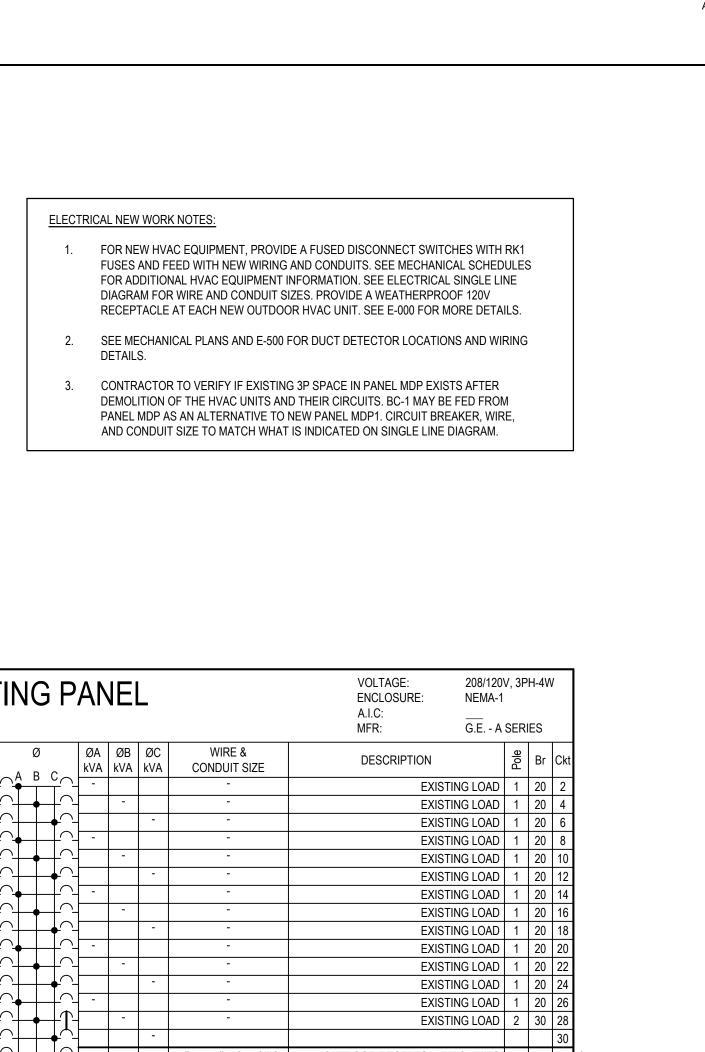
SHEET NO.



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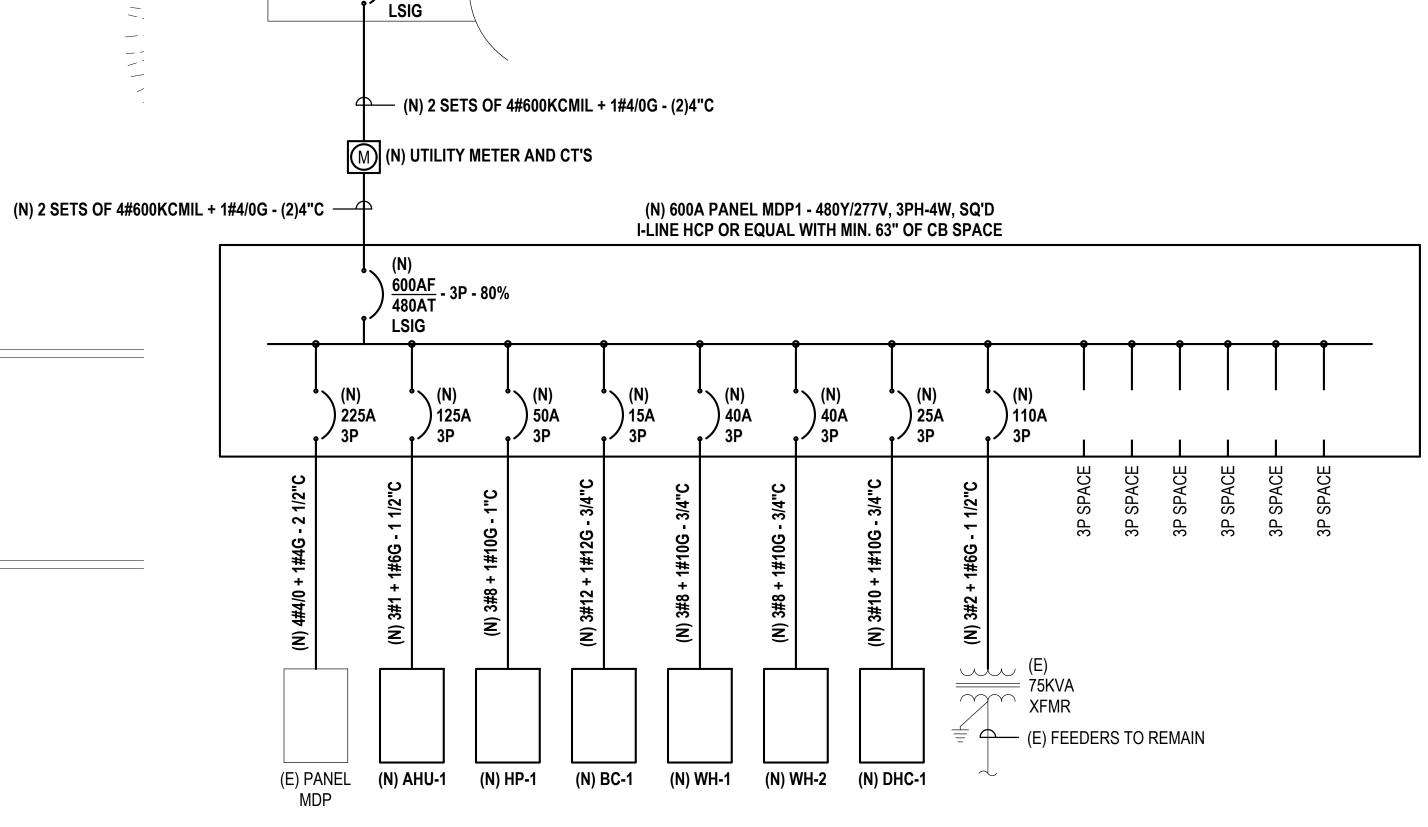
E-102



EXISTING PANEL LOCATION: ELECTRICAL ROOM MAIN: 225A DESCRIPTION 1 20 1 EXISTING LOAD
3 20 1 EXISTING LOAD
5 20 1 EXISTING LOAD
7 20 1 EXISTING LOAD
9 20 1 EXISTING LOAD
11 20 1 EXISTING LOAD
 13
 20
 1
 EXISTING LOAD

 15
 20
 1
 EXISTING LOAD

 17
 20
 1
 EXISTING LOAD
 19 20 1 EXISTING LOAD
21 20 1 EXISTING LOAD
23 20 1 EXISTING LOAD
25 20 1 EXISTING LOAD
27 20 1 EXISTING LOAD 29 20 1 EXISTING LOAD 31 20 1 EXISTING LOAD 33 20 2 EXISTING LOAD 37 20 2 MECHANICAL CONTROL BOX PHASE B: __ kVA PHASE C: __ kVA TOTAL CONNECTED LOAD: __ kVA TOTAL LOAD % OF CAPACITY: __% * PROVIDE NEW CIRCUIT BREAKER AND WIRING AS INDICATED. ** REMOVE 30A/3P SPARE CIRCUIT BREAKER AND PROVIDE NEW CIRCUIT BREAKER AND WIRING AS INDICATED.



ELECTRICAL SINGLE LINE DIAGRAM - NEW WORK PLAN E-103 SCALE: N/A SINGLE LINE DIAGRAM NOTES:

(E) 1600A SWBD 480Y/277V, 3PH-4W - GE

• ALL CIRCUIT BREAKERS AND DISCONNECT SWITCHES ARE 3 POLES UNLESS NOTED OTHERWISE.

 ALL FEEDER CIRCUIT BREAKERS 400A AND GREATER SHALL HAVE ELECTRONIC TRIP INCLUDING LONG, SHORT, AND INSTANTANEOUS SETTINGS AND SHALL HAVE FIELD REPLACEABLE TRIP SETTINGS.

ARPA RECREATION CENTER HVAC IMPROVEMENTS RFP ATTACHMENT A: Bid Documents THIS DRAWING IS THE PROPERTY OF STUDIOJAED AND IS PREPARED FOR THE EXCLUSIVE USE OF IT CLIENTS AT THE LOCATION INDICATED. NO OTHER USE IS AUTHORIZED OR INTENDED. ARCHITECT / ENGINEER SEAL REVISIONS **ELECTRICAL PLANS -ROLLINS**

CONSTRUCTION

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PP

E-103

DRAWN

DΖ

SHEET NO.

Page 45 of 393

115 SF

21 SF

CONDUITS ABOVE CEILING FROM EXISTING ELEMENTARY SCHOOL SWBD TO PENETRATE INTO CEILING SPACE OF ROLLINS BUILDING. SEE E-500 FOR TYPICAL PENETRATION IN WALL.

COMMUNITY ROOM

STORAGE

58 SF

E-103 SCALE: 1/8" = 1'-0"

7916 SF

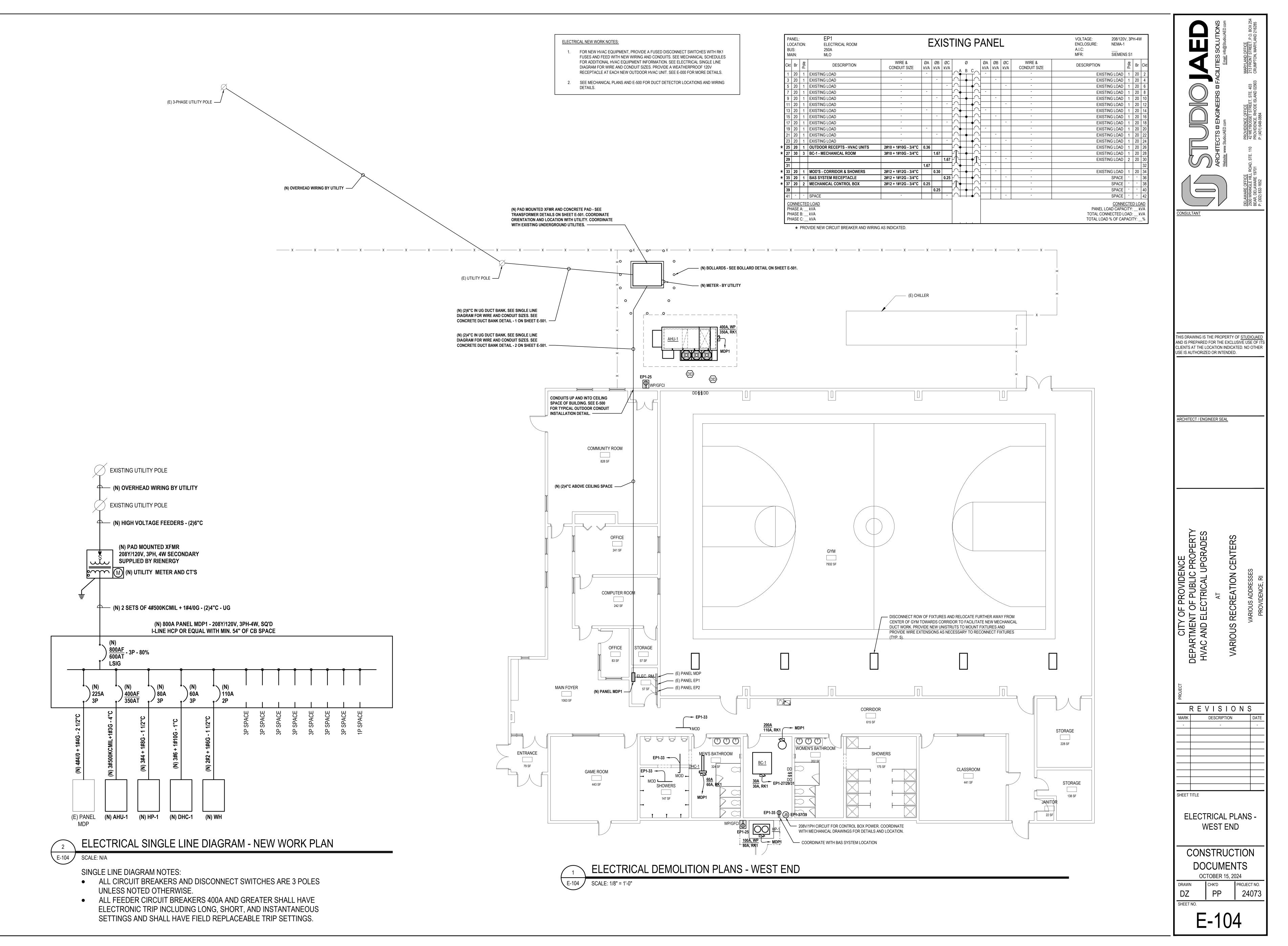
- 208V/1PH CIRCUIT FOR CONTROL BOX POWER. COORDINATE WITH MECHANICAL DRAWINGS FOR DETAILS AND LOCATION.

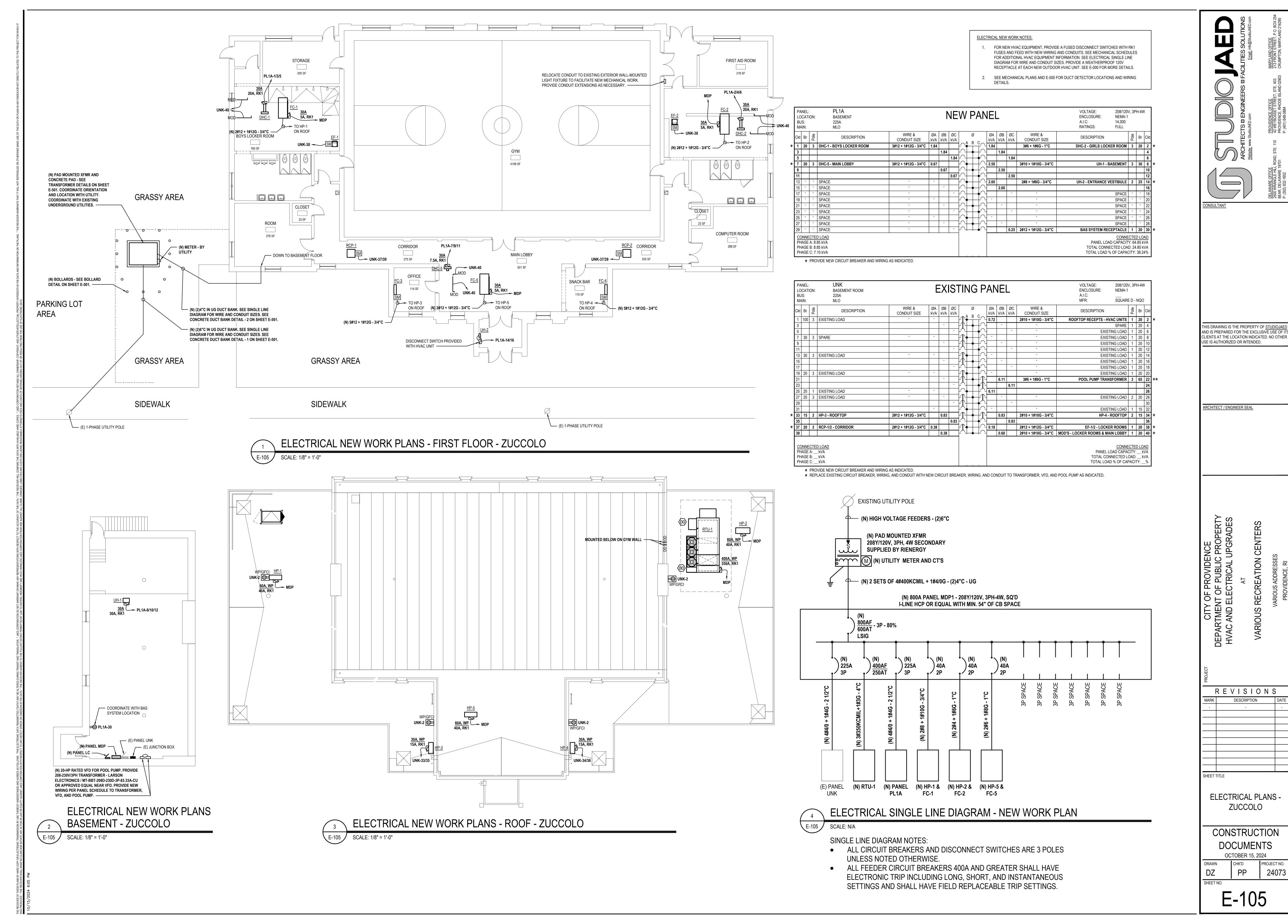
COORDINATE WITH BAS SYSTEM LOCATION

60A, WP MDP 1

ELECTRICAL DEMOLITION PLANS - ROLLINS

(N) (2)4"C ABOVE CEILING SPACE —



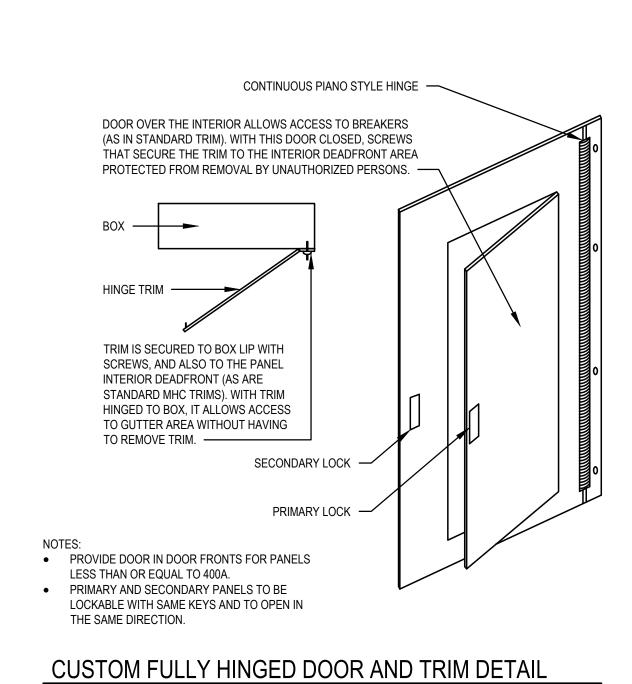


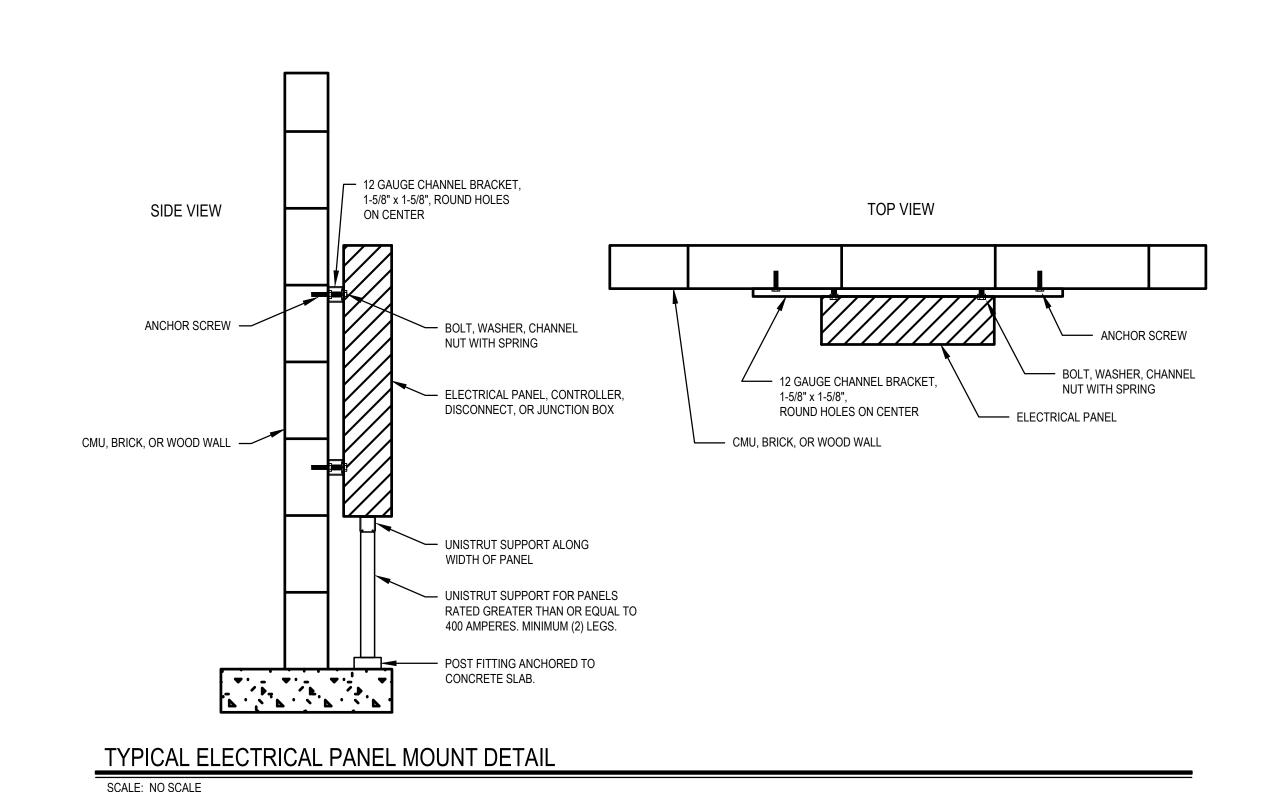
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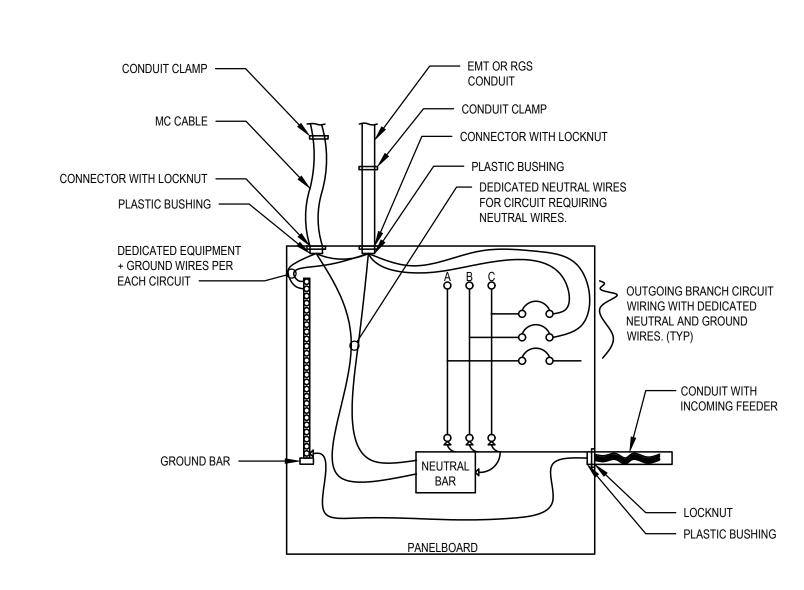
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ARCHITECT / ENGINEER SEAL

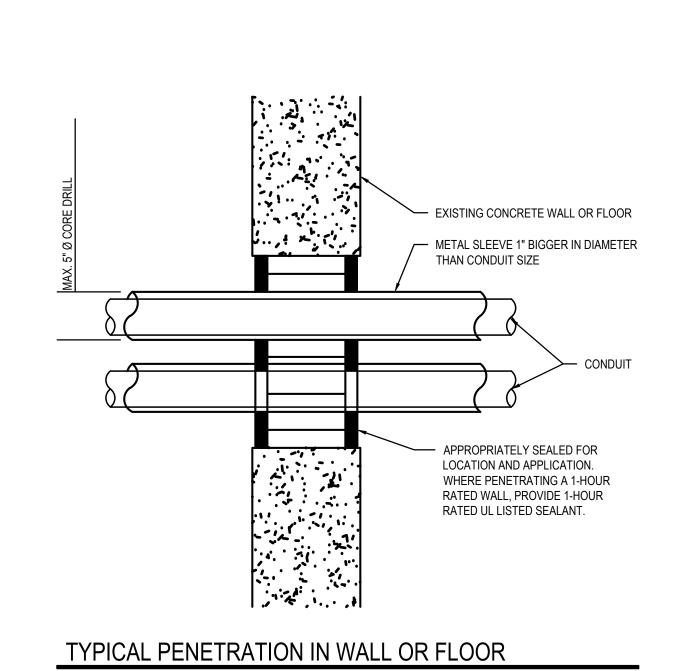




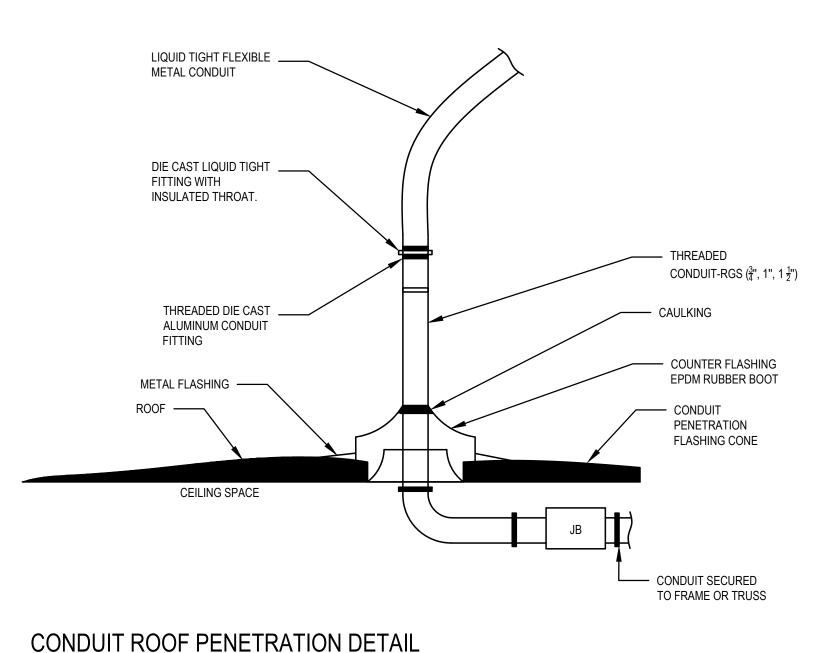


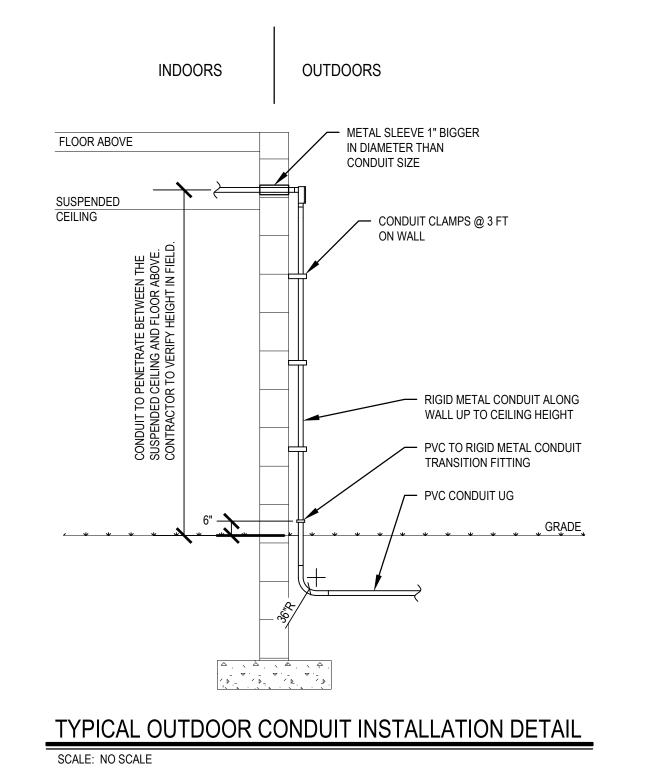
PROVIDE GROUND BAR WITH ADEQUATE TERMINALS FOR EQUIPMENT GROUND WIRES. DOUBLE LUGGING OF NEUTRAL OR EQUIPMENT GROUND WIRES IS NOT PERMITTED. NUMBER OF NEUTRAL AND EQUIPMENT GROUND WIRES VARY BY PANEL AND BRANCH CIRCUITS.

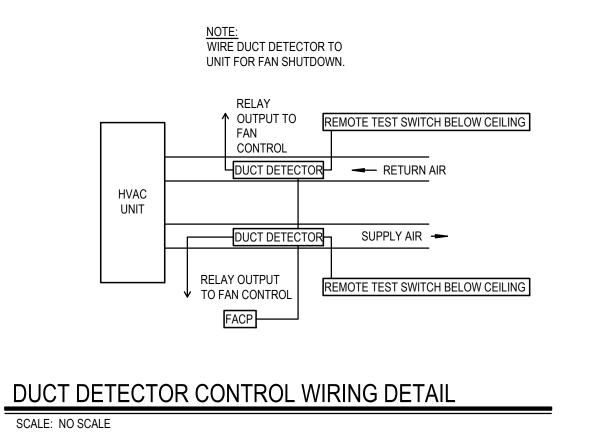
EQUIPMENT GROUND AND NEUTRAL WIRING IN PANELBOARD (TYP)

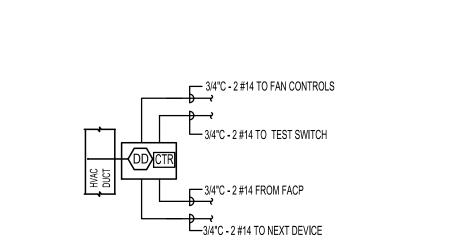


SCALE: NO SCALE









DUCT DETECTOR CONTROL WIRING DIAGRAM

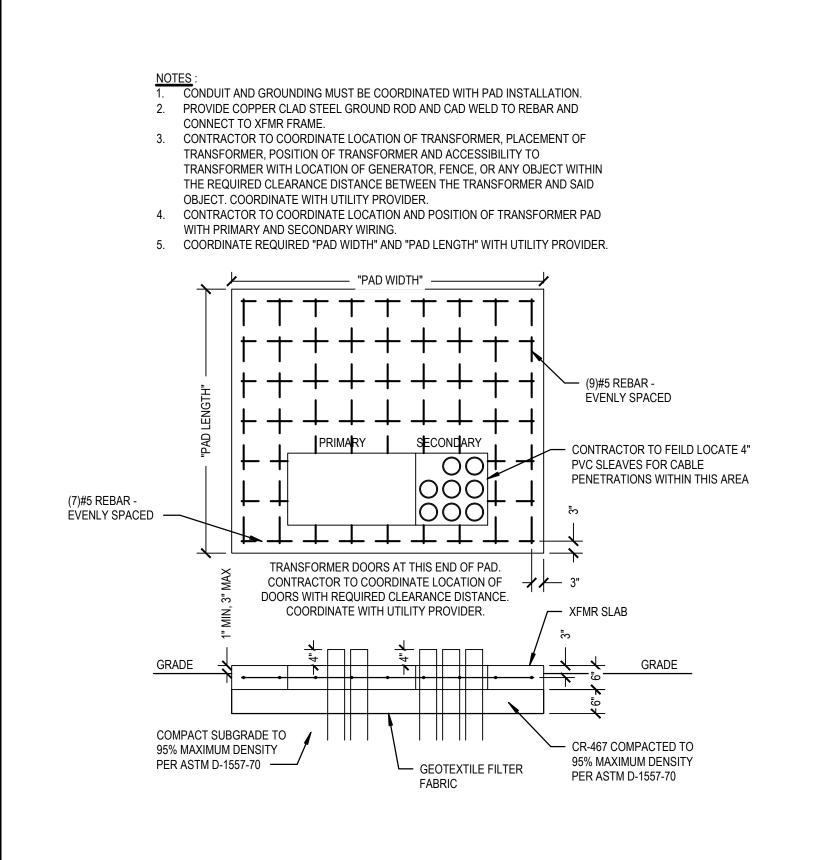
SCALE: NO SCALE

CONDUIT ROOF PENETRATION DETAIL SCALE: NO SCALE

ELECTRICAL DETAILS CONSTRUCTION DOCUMENTS OCTOBER 15, 2024 E-500

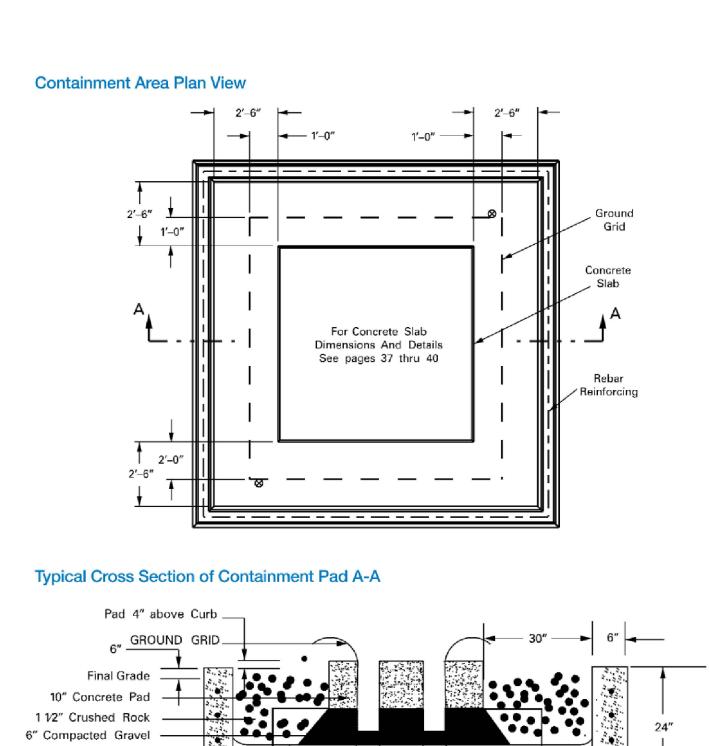
REVISIONS

SHEET TITLE



TRANSFORMER PAD DETAIL

SCALE: NO SCALE

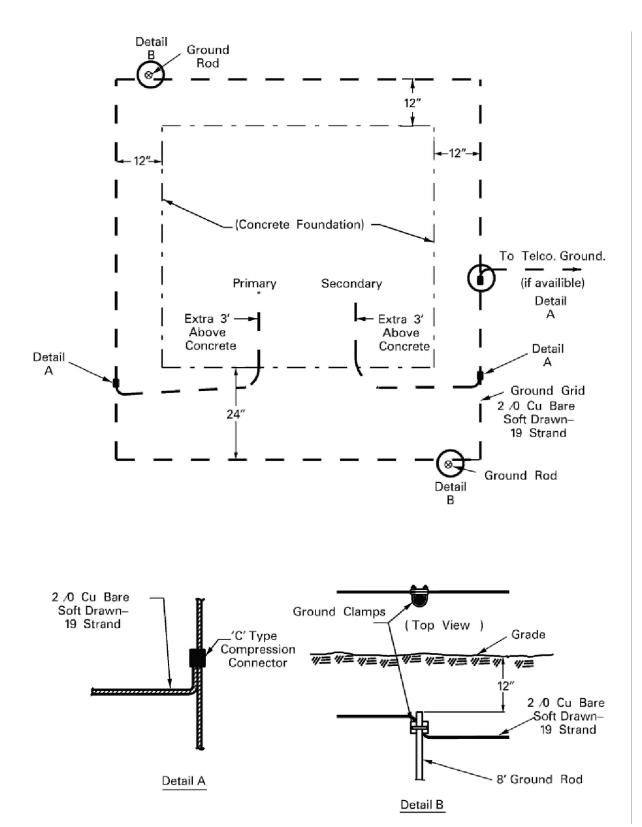


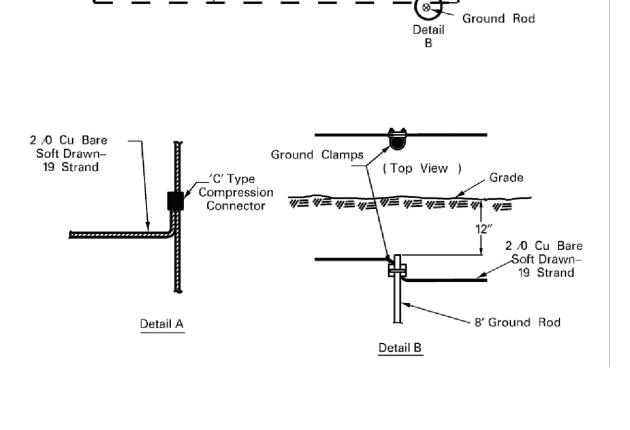
Concrete Wall

Conduit Sweep

TRANSFORMER PAD CONTAINMENT AREA DETAIL

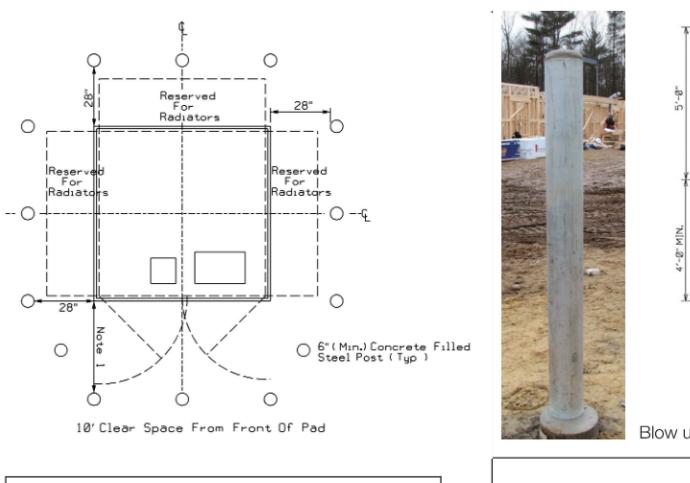
Geotextile Fabric

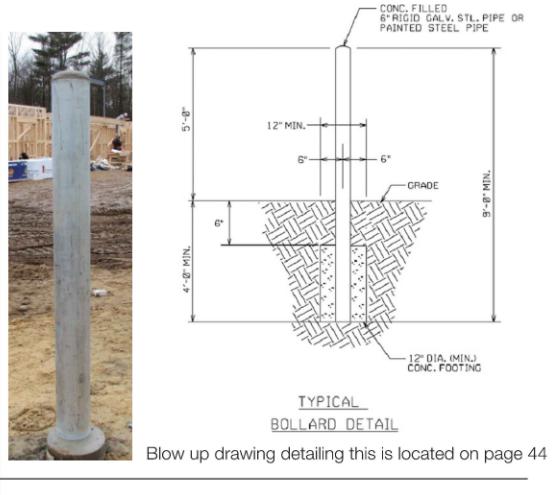




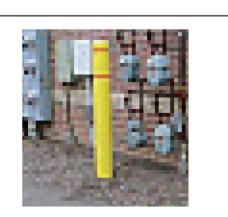
TRANSFORMER PAD GROUNDING AND BONDING DETAIL

SCALE: NO SCALE





Bollards Required Bollards Not Required



Picture of Bollard cover, use for when Bollards can not be painted.

1. Six foot minimum clearance from front of pad.

2. Distribution Design/Planning shall designate the number and location of Bollards by marking the Bollards of this drawing as follows:

3. Bollards shall be supported with a 12" minimum diameter concrete footing 6" below grade to base of the bollard.

4. For installations around oil containment curbs, install bollards six feet minimum on all applicable sides.

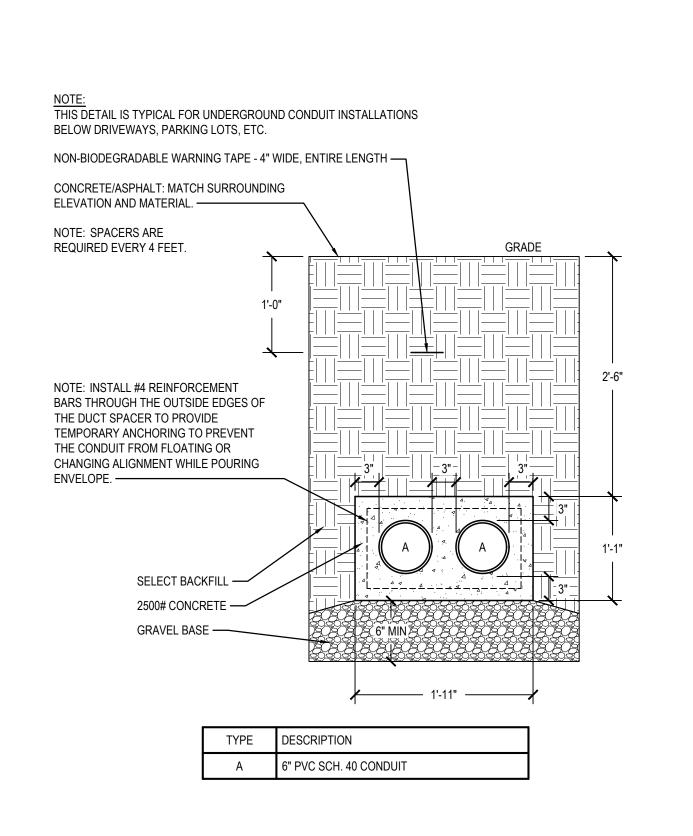
BOLLARD DETAIL

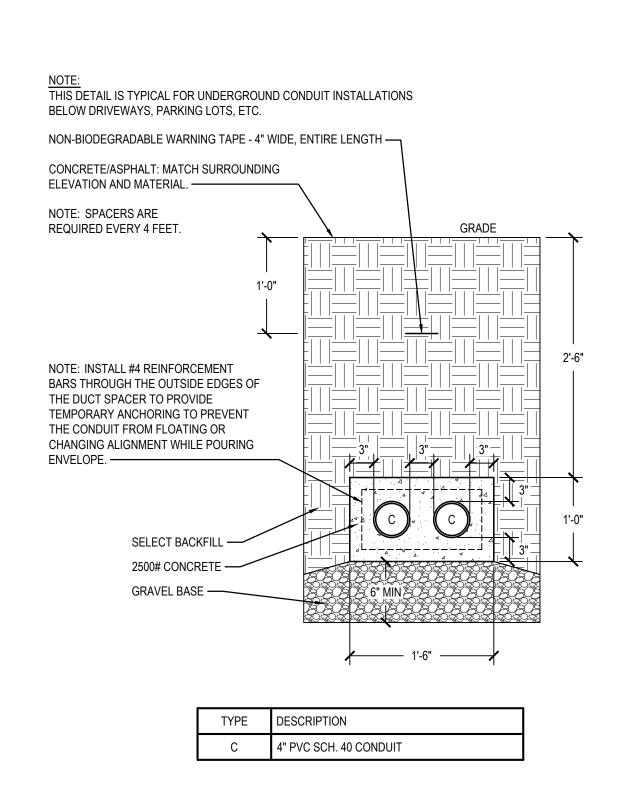
SCALE: NO SCALE

THIS DETAIL IS TYPICAL FOR UNDERGROUND CONDUIT INSTALLATIONS IN GRASSY AREAS OR BELOW SIDEWALKS. NON-BIODEGRADABLE WARNING TAPE - 4" WIDE, ENTIRE LENGTH ———— CONCRETE/ASPHALT (WHERE PRESENT): MATCH SURROUNDING ELEVATION AND MATERIAL. SIZES AND QUANTITIES OF CONDUITS VARY -SEE SITE PLANS. SELECT BACKFILL — GRAVEL BASE ——— 1'-0" MIN.

NON-CONCRETE DUCT BANK DETAIL

SCALE: NO SCALE





CONCRETE DUCT BANK DETAIL -1

SCALE: NO SCALE

CONCRETE DUCT BANK DETAIL - 2

SCALE: NO SCALE

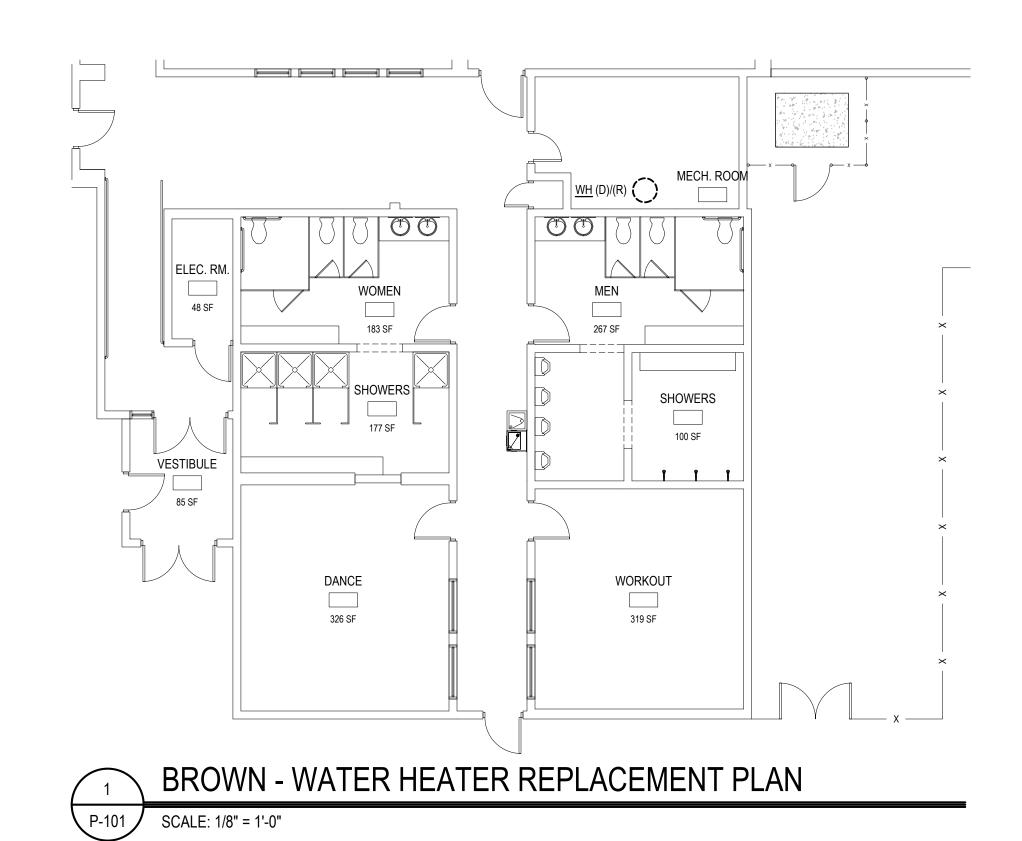
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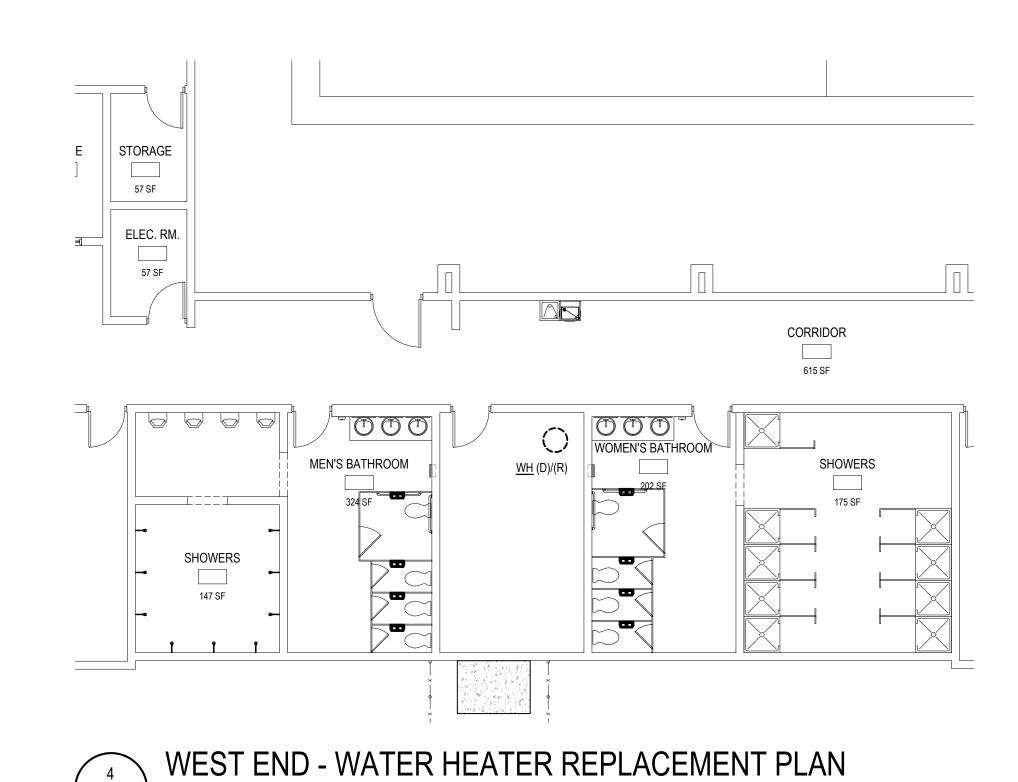
> REVISIONS DESCRIPTION

ELECTRICAL DETAILS

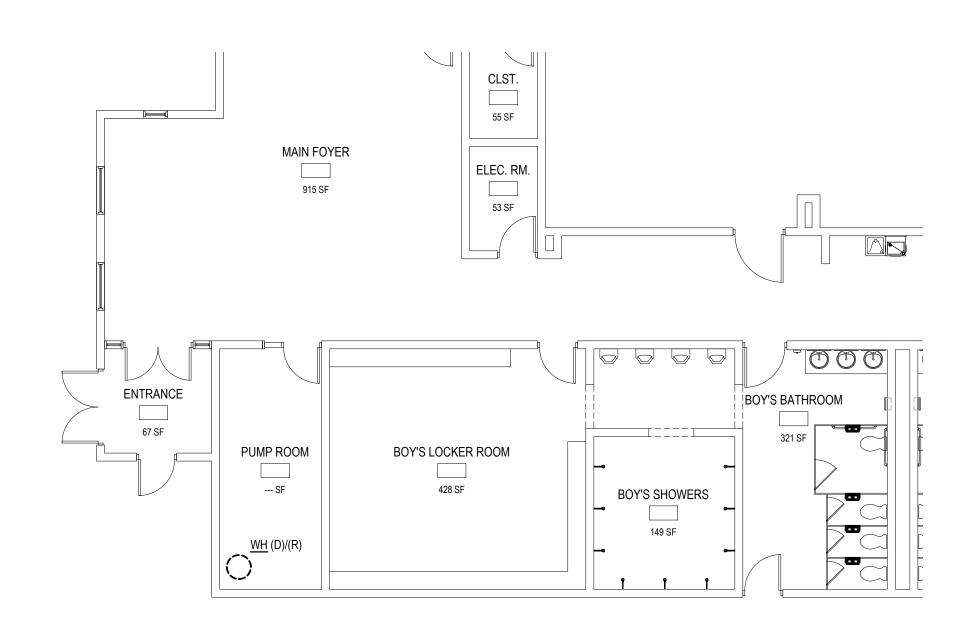
CONSTRUCTION DOCUMENTS OCTOBER 15, 2024

E-501





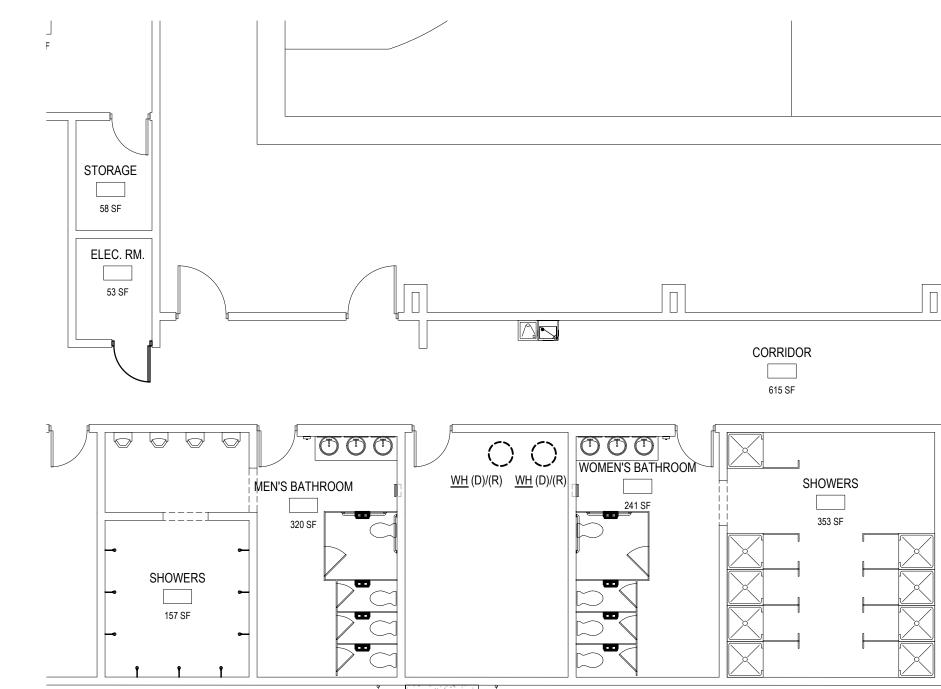
P-101 SCALE: 1/8" = 1'-0"





WATER HEATER REPLACEMENT NOTES:
 (D)/(R) NOTATION ON THE PLANS INDICATES DEMOLITION AND REPLACEMENT
 DEMOLISH EXISTING GAS FIRED WATER HEATERS AND REPLACE WITH NEW ELECTRIC WATER HEATERS.
 PROVIDE NEW ISOLATION BALL VALVE AT COLD WATER AND HOT WATER CONNECTIONS AT EACH UNIT.
 RECONNECT EXISTING PIPING TO EACH UNIT.
 MODIFY EXISTING PIPING CONFIGURATION AS REQUIRED TO CONNECT NEW UNITS.
 DEMOLISH AND REPLACE INSULATION ON ALL DOMESTIC WATER PIPING VISIBLE IN ROOMS WHERE WATER HEATERS ARE LOCATED. REPLACEMENT

INSULATION SHALL BE PER THE SPECIFICATIONS



ROLLINS - WATER HEATER REPLACEMENT PLAN

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

ELECTRIC WATER HEATER SCHEDULE												
BUILDING	MANUFACTURER	MODEL#	NOMINAL STORAGE CAPACITY (GAL)	FIRST HOUR RATING (GAL)	RECOVERY @ 90°F RISE	TOTAL KW	VOLTAGE	REMARKS				
BROWN	BRADFORD WHITE	LE350S3-3	50	72	41	9	208V/1PH					
IGLIOZZI	BRADFORD WHITE	LE350S3-3	50	72	41	9	208V/1PH					
ROLLINS	BRADFORD WHITE	CEHD80(A)243*CF	80	200	110	24	480V/3PH					
ROLLINS	BRADFORD WHITE	CEHD80(A)243*CF	80	200	110	24	480V/3PH					
WEST END	BRADFORD WHITE	E32-80R-3	80	138	82	18	208V/1PH					

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SECTION 02 41 00 DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.
- B. Legal disposal of demolished items.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1926 Safety and Health Regulations for Construction.
- B. NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.03 SUBMITTALS

 Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.04 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of ten years of documented experience.

1.05 PROJECT CONDITIONS

A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 3 EXECUTION

3.01 SCOPE

- A. As indicated on Drawings and herein specified.
- B. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of the public.
 - 1. Obtain required permits.
 - Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary dust proof partitions/wall assembly barriers and security devices.
 - 4. Use adequate physical barriers and wall assemblies to prevent access to areas that could be hazardous to workers or the public.
 - 5. Conduct operations to minimize effects on and interference with adjacent construction and occupants.
 - 6. Do not close or obstruct means of egress corridors, roadways or sidewalks without permit.
 - Conduct operations to minimize obstruction of public and private entrances and exits; do
 not obstruct required exits at any time; protect persons using entrances and exits from
 removal operations.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Do not begin removal until built elements to be salvaged or relocated have been removed.
- D. Protect existing structures and other elements that are not to be removed.
 - 1. Prevent movement or settlement of adjacent structures.
 - 2. Stop work immediately if adjacent structures appear to be in danger.

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- E. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- F. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not close, shut off, or disrupt existing life safety systems that are in use without permission from the Owner.
- D. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without permission from the Owner.
- E. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary. Call "Miss Utility" at least 48 hours prior to starting work.
- F. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- G. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 - Provide, erect, and maintain temporary dustproof partitions and wall assemblies during demolition and construction.
- C. Remove existing work as indicated and as required to accomplish new work.
 - 1. At areas of demolition and transition, remove materials and finishes including, but not limited to, rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Remove items indicated on drawings and notes.
- D. Services (Including but not limited to HVAC, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removal neatly and as specified for cutting new work.

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- 3. Repair adjacent construction and finishes damaged during removal work.
- 4. Patch as specified for patching new work.
- 5. Patch to match existing at areas of transition and demolition unless noted and/or scheduled otherwise.

3.05 EXISTING SITE IMPROVEMENTS DEMOLITION

- A. Existing Subsurface Conditions: Verify existing pavement materials and respective thicknesses during pre-bid inspection. Obtain written authorization from the Owner before conducting test hole explorations of existing pavements within the project site. Conditions existing during prebid inspections will not be altered or modified.
- B. Existing Pavements: Demolish existing pavements to limits indicated. Neatly cut existing bituminous concrete pavement to straight, smooth and sharp edges perpendicular to pavement surface.
- Existing Walks: Demolish existing walks to the nearest joint to limits indicated on the contract documents.
- D. Existing Curbing: Demolish existing curbing to the nearest joint to limits indicated on the contract documents.
- E. Miscellaneous: Demolish additional miscellaneous existing site improvements indicated, specified and required to construct project.

3.06 EXISTING UNDERGROUND UTILITY DEMOLITION

A. Excavate and expose existing underground utilities and related structures designated for, or as required to implement, removals. Remove existing utility structure castings. Backfill excavations, upon completion of utility demolition operations.

3.07 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 41 00

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SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 03 20 00 Concrete Reinforcing.
- B. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 117 Specification for Tolerances for Concrete Construction and Materials.
- B. ACI 301 Specifications for Concrete Construction.
- C. ACI 347R Guide to Formwork for Concrete.
- D. PS 1 Structural Plywood.

1.04 SUBMITTALS

A. Product Data: Provide data on materials.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 347, ACI 301, and ACI 318.

1.06 DELIVERY, STORAGE, AND HANDLING

- Deliver prefabricated forms and installation instructions in manufacturer's packaging.
- B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Comply with applicable State and local codes with respect to design, fabrication, erection, and removal of formwork.

2.02 WOOD FORM MATERIALS

A. Lumber: HEM-FIR species; #2 grade; with grade stamp clearly visible.

2.03 REMOVABLE PREFABRICATED FORMS

A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

2.04 FORMWORK ACCESSORIES

- A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
- B. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

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CONCRETE FORMING AND ACCESSORIES

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PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Align joints and make watertight. Keep form joints to a minimum.
- E. Obtain approval before framing openings in structural members that are not indicated on drawings.
- F. Provide fillet strips on external corners of beams, joists, and columns.
- G. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- H. Coordinate this section with other sections of work that require attachment of components to formwork.
- I. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.03 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

3.04 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.06 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

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C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION 03 10 00

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SECTION 03 20 00 CONCRETE REINFORCING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 Concrete Forming and Accessories.
- B. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 301 Specifications for Concrete Construction.
- B. ACI SP-66 ACI Detailing Manual.
- C. ASTM A185/A185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- D. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- E. ASTM A1064/A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- F. CRSI (DA4) Manual of Standard Practice.

1.04 SUBMITTALS

- A. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
 - Prepare shop drawings under supervision of a Professional Structural Engineer experienced in design of work of this type and licensed in the State in which the Project is located.
- B. Manufacturer's Certificate: Certify that reinforcing steel and accessories, products supplied for this project meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.
 - 1. Maintain one copy of each document on project site.
- B. Provide Architect with access to fabrication plant to facilitate inspection of reinforcement.

 Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
 - 1. Plain billet-steel bars.
 - 2. Unfinished.
 - 3. Galvanized in accordance with ASTM A767/A767M, Class I.
 - 4. Continuously galvanized in accordance with ASTM A1094/A1094M.
- B. Steel Welded Wire Reinforcement: Galvanized ASTM A 185/A 185M, plain type.
 - 1. Flat Sheets.
 - 2. Mesh Size and Wire Gage: As indicated on drawings.
- C. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gage.

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- 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
- 3. Provide galvanized components for placement within 1-1/2 inches of weathering surfaces.

2.02 RE-BAR SPLICING:

- A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.
- B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for connecting dowels; capable of developing full steel reinforcing design strength in tension and compression.
- C. Grout: Cementitious, non-metallic, non-shrink grout for use with manufacturer's grout sleeve reinforcing bar coupler system.

2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) Manual of Standard Practice.
- B. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 - 1. Review locations of splices with Architect.

PART 3 EXECUTION

3.01 PLACEMENT

- Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Do not displace or damage vapor barrier.
- C. Accommodate placement of formed openings.
- D. Conform to applicable code for concrete cover over reinforcement.

3.02 FIELD QUALITY CONTROL

A. Inspect installed reinforcement for conformance to contract documents before concrete placement.

END OF SECTION 03 20 00

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SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Slabs on grade.
- B. Joint devices associated with concrete work.
- C. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 Concrete Forming and Accessories
- B. Section 03 20 00 Concrete Reinforcing.

1.03 REFERENCE STANDARDS

- A. ACI 117 Specification for Tolerances for Concrete Construction and Materials.
- B. ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide.
- C. ACI 211.2 Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
- D. ACI 301 Specifications for Concrete Construction.
- E. ACI 302.1R Guide to Concrete Floor and Slab Construction.
- F. ACI 304R Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- G. ACI 305R Guide to Hot Weather Concreting.
- H. ACI 308R Guide to External Curing of Concrete.
- I. ACI 318 Building Code Requirements for Structural Concrete.
- J. ACI 347R Guide to Formwork for Concrete.
- K. ASTM C33/C33M Standard Specification for Concrete Aggregates.
- ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- M. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete.
- N. ASTM C143/C143M Standard Test Method for Slump of Hydraulic-Cement Concrete.
- O. ASTM C150/C150M Standard Specification for Portland Cement.
- P. ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete.
- Q. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- R. ASTM C330/C330M Standard Specification for Lightweight Aggregates for Structural Concrete.
- S. ASTM C494/C494M Standard Specification for Chemical Admixtures for Concrete.
- T. ASTM C618 Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- U. ASTM C881/C881M Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- V. ASTM C1059/C1059M Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- W. ASTM C1107/C1107M Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- X. ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete.

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- Y. ASTM C1315 Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- Z. ASTM D994/D994M Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- AA. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types).
- AB. ASTM E1155 Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.
- AC. COE CRD-C 513 Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops.
- AD. NSF 61 Drinking Water System Components Health Effects.
- AE. NSF 372 Drinking Water System Components Lead Content.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
- B. Mix Design: Submit proposed concrete mix design.
 - Indicate proposed mix design complies with requirements of ACI 301, Section 4 Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 Concrete Quality, Mixing and Placing.
- C. Test Reports: Submit report for each test or series of tests specified.
- D. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.
- C. For slabs required to include moisture vapor reduction admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.

1.06 WARRANTY

- A. Slabs with Moisture Vapor Reducing Admixture (MVRA): Provide warranty to cover the cost of flooring failures due to moisture migration from slabs for life of the concrete.
 - 1. Include cost of repair or removal of failed flooring, placement of topical moisture remediation system, and replacement of flooring with comparable flooring system.
 - 2. Provide warranty by manufacturer of MVRA matching terms of flooring adhesive or primer manufacturer's material defect warranty.
- B. Moisture Emission Reducing Curing and Sealing Compound: Provide warranty to cost of flooring delamination failures for 10 years.
 - Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.

PART 2 PRODUCTS

2.01 FORMWORK

A. Comply with requirements of Section 03 10 00.

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CAST-IN-PLACE CONCRETE

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2.02 REINFORCEMENT

A. Comply with requirements of Section 03 20 00.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I Normal Portland type.
 - 1. Acquire all cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C 33.
 - 1. Acquire all aggregates for entire project from same source.
- C. Lightweight Aggregate: ASTM C330/C330M.
- D. Fly Ash: ASTM C618, Class C or F.
- E. Water: Clean and not detrimental to concrete.

2.04 ADMIXTURES

- Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. Moisture Vapor Reduction Admixture (MVRA): Liquid, inorganic admixture free of volatile organic compounds (VOCs) and formulated to close capillary systems formed during curing to reduce moisture vapor emission and transmission, with no adverse effect on concrete properties.
 - 1. Provide admixture in all slabs to receive adhesively applied flooring .
 - 2. Products:
 - a. Barrier One, Inc; Barrier One Moisture Vapor Reduction Admixture: www.barrierone.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
- E. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.
 - 1. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
 - 2. Potable Water Contact Approval: NSF certification for use on structures holding potable water, based on testing in accordance with NSF 61 and NSF 372.
 - 3. Products:
 - a. PENETRON International, Ltd, distributed by GCP Applied Technologies; PENETRON Admix: www.penetron.com; www.gcpat.com/#sle.

2.05 ACCESSORY MATERIALS

- A. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
 - 1. ASTM C1107/C1107M; Grade A, B, or C.
 - 2. Flowable Products:
 - Dayton Superior Corporation; Sure-Grip High Performance Grout: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.

2.06 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
 - 1. Products:
 - a. Kaufman Products Inc.; SureBond: www.kaufmanproducts.net/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
- B. Epoxy Bonding System:

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- C. Waterproofing Admixture Slurry: Slurry coat of Portland cement, sand, and crystalline waterproofing additive, mixed with water in proportions recommended by manufacturer to achieve waterproofing at cold joints in concrete.
- D. Waterstops: Rubber, complying with COE CRD-C 513.
- E. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
- F. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
 - 1. Material: ASTM D1751, cellulose fiber.
- G. Slab Contraction Joint Device: Preformed linear strip intended for pressing into wet concrete to provide straight route for shrinkage cracking.
- H. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with minimum 1 inch diameter holes for conduit or rebars to pass through at 6 inches on center; ribbed steel stakes for setting.

2.07 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
- C. Curing and Anti-Spalling Compound: Boiled linseed oil compound.
 - 1. Application: Use on roadway, bridge deck, parking deck, and ramps.
 - 2. Products:
 - a. Dayton Superior Corporation; Anti Spall J33: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
- D. Resin Curing Compound: Solvent-based liquid, white pigmented, membrane-forming.
 - 1. For use on exterior slabs. When slab will be painted, sealed, topped, or receive other applied finish, completely remove curing compound after curing is complete and before finish coatings are applied.
 - 2. Products:
 - a. Dayton Superior Corporation; White Resin Cure J10W: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
- E. Curing and Sealing Compound, Moisture Emission Reducing: Liquid, membrane-forming, clear sealer, for application to newly placed concrete; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission.
 - 1. Use this product to cure and seal all slabs to receive adhesively applied flooring or roofing.
 - 2. Comply with ASTM C309 and ASTM C1315 Type I Class A.
 - 3. VOC Content: Less than 100 g/L.
 - 4. Solids Content: 25 percent, minimum.
 - 5. Products:
 - a. Floor Seal Technology, Inc; VaporSeal 309 System: www.floorseal.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
- F. Curing and Sealing Compound: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C309.
 - 1. Products:
 - a. BRICKFORM; BRICKFORM Gem Cure and Seal 309 100 VOC: www.brickform.com/#sle.

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2.08 CONCRETE MIX DESIGN

- A. Proportioning Structural Lightweight Concrete: Comply with ACI 211.2 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- D. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.

2.09 MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
 - 2. Use latex bonding agent only for non-load-bearing applications.
- B. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- C. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- D. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
 - Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as shown on the drawings. Do not use sand.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- D. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- E. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

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3.04 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
 - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- D. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.
- E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- F. Contraction Joint Devices: Use preformed joint device, with top set flush with top of slab.
- G. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Maximum Variation of Surface Flatness:
 - 1. Exposed Concrete Floors: 1/4 inch in 10 ft.
 - 2. Under Seamless Resilient Flooring: 1/4 inch in 10 ft.
 - 3. Under Carpeting: 1/4 inch in 10 ft.
- B. Correct the slab surface if tolerances are less than specified.
- C. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 CONCRETE FINISHING

- A. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
 - 1. Other Surfaces to Be Left Exposed: "Steel trowel" as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.07 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - 2. Final Curing: Begin after initial curing but before surface is dry.

3.08 FIELD QUALITY CONTROL

- A. Provide free access to concrete operations at project site and cooperate with appointed firm.
- B. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- C. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- D. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.

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- E. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- F. Slab Testing: Cooperate with manufacturer of specified moisture vapor reduction admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.

3.09 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances
 or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction
 of Architect for each individual area.

3.10 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 03 30 00

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SECTION 04 05 11 MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mortar for masonry.

1.02 RELATED REQUIREMENTS

A. Section 04 20 00 - Unit Masonry: Installation of mortar and grout.

1.03 REFERENCE STANDARDS

- A. TMS 402/602 Building Code Requirements and Specification for Masonry Structures.
- B. ASTM C91/C91M Standard Specification for Masonry Cement.
- C. ASTM C144 Standard Specification for Aggregate for Masonry Mortar.
- D. ASTM C270 Standard Specification for Mortar for Unit Masonry.
- E. ASTM C387/C387M Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar.
- F. ASTM C979/C979M Standard Specification for Pigments for Integrally Colored Concrete.

1.04 SUBMITTALS

- A. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used. Also include required environmental conditions and admixture limitations.
- Samples: Submit two samples of mortar, illustrating mortar color and color range.

1.05 QUALITY ASSURANCE

 Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

 Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MORTAR AND GROUT APPLICATIONS

- A. Mortar Mix Designs: ASTM C270, Property Specification.
 - 1. Exterior Masonry Pointing Mortar: Type O; color to match existing.

2.02 MATERIALS

- A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C387/C387M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Type: Type N.
 - 2. Color: Mineral pigments added as required to produce approved color sample.
- B. Mortar Aggregate: ASTM C144.
- C. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
 - 1. Color(s): As selected by Architect from manufacturer's full range.
- D. Water: Clean and potable.

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2.03 MORTAR MIXING

- A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
- B. Maintain sand uniformly damp immediately before the mixing process.
- C. Do not use anti-freeze compounds to lower the freezing point of mortar.
- D. If water is lost by evaporation, re-temper only within two hours of mixing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install mortar to requirements of section(s) in which masonry is specified.

3.02 GROUTING

- A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.
- B. Low-Lift Grouting:
 - 1. Limit height of pours to 12 inches.
 - 2. Limit height of masonry to 16 inches above each pour.
 - 3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
 - 4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.
- C. High-Lift Grouting:
 - 1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
 - 2. Place grout for spanning elements in single, continuous pour.

END OF SECTION 04 05 11

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SECTION 04 20 00 UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- Concrete Block.
- B. Common Brick.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 04 05 11 Mortar and Masonry Grout.
- B. Section 07 90 05 Joint Sealers: Backing rod and sealant at control and expansion joints.

1.03 REFERENCE STANDARDS

- A. TMS 402/602 Building Code Requirements and Specification for Masonry Structures.
- B. ACI 530.1/ASCE 6/TMS 602 Specification For Masonry Structures; American Concrete Institute International.
- C. ASTM A82/A82M Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- D. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A580/A580M Standard Specification for Stainless Steel Wire.
- F. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- G. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
- H. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- J. ASTM B370 Standard Specification for Copper Sheet and Strip for Building Construction.
- K. ASTM C62 Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).
- L. ASTM C67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
- M. ASTM C90 Standard Specification for Loadbearing Concrete Masonry Units.
- N. ASTM C129 Standard Specification for Nonloadbearing Concrete Masonry Units.
- O. ASTM C140/C140M Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- P. ASTM C216 Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
- Q. ASTM C270 Standard Specification for Mortar for Unit Masonry.
- R. ASTM C780 Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- S. TMS 402/602 Building Code Requirements and Specification for Masonry Structures.
- T. IMIAWC (CW) Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.
- U. IMIAWC (HW) Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.
- V. UL (FRD) Fire Resistance Directory.

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1.04 SUBMITTALS

- A. Product Data: Provide data for masonry units, mortar, and masonry accessories.
- Samples: Submit four samples of brick units to illustrate color, texture, and extremes of color range.
- C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.
 - 1. Maintain one copy of each document on project site.

1.06 MOCK-UP

A. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
 - 2. Non-Loadbearing Units: ASTM C129.
 - a. Both hollow and solid block, as indicated.
 - b. Normal weight.

2.02 BRICK UNITS

- A. Manufacturers:
 - 1. Belden Brick Company: www.boralbricks.com.
 - 2. Endicott Clay Products Co: www.endicott.com/#sle.
 - 3. General Shale Brick: www.generalshale.com/#sle.
 - 4. Glen Gery Brick . www.glengerybrick.com
- B. Facing Brick: ASTM C216, Type FBX, Grade SW.
 - 1. Type, color and texture: to match exisitng brick.
 - 2. Actual size: to match existing brick.
 - 3. Compressive strength: Min. 2,500 p.si.; 5 brick average = 3,000 p.s.i, measured in accordance with ASTM C 67.

2.03 MORTAR AND GROUT MATERIALS

A. Mortar and grout: As specified in Section 04 05 11.

2.04 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers of Joint Reinforcement and Anchors:
 - 1. Dur-O-Wal: www.dur-o-wal.com.
 - 2. Hohmann & Barnard, Inc: www.h-b.com.
 - 3. WIRE-BOND: www.wirebond.com/#sle.

- B. Single Wythe Joint Reinforcement: Truss or Ladder type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B-2; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.
- C. Strap Anchors: Bent steel shapes configured as required for specific situations, 2 in width, 0.1875 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B-2 or stainless steel.
- D. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
 - 1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B-2.
- E. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B-2, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.
- F. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B-2; stainless steel.
 - 1. Anchor channel: Not less than 0.120 inch thick, designed for fastening to structural backup by non corrodeable fasteners; Design Basis = Hohman & Barnard #362-C.
 - 2. Wire ties: Triangular; Trapezoidal; Rectangular or Manufacturer's standard shape, 0.1875 inch thick
 - 3. Vertical adjustment: Not less than 3-1/2 inches.
 - 4. Seismic Feature: Provide lip, hook, or clip on end of wire ties to engage or enclose not less than one continuous horizontal joint reinforcement wire of 0.1875 inch diameter.

2.05 FLASHINGS

- A. Metal Flashing Materials: Polymer modified asphalt coated copper, 7oz/sq.ft. Provide "C-Coat" flashing by Hohmann & Bernard, or Architect approved equal.
- B. Lap Sealant: recommended by flashing manufacturer type.

2.06 ACCESSORIES

- A. Preformed Control Joints: Rubber or neoprene material.
 - Manufacturers:
 - a. Dur-O-Wal: www.dur-o-wal.com.
 - Hohmann & Barnard, Inc (including Dur-O-Wal brand); Product RS or VS: www.h-b.com/#sle.
 - c. WIRE-BOND: www.wirebond.com/#sle.
- B. Joint Filler: Closed cell polyethylene; polyurethane or rubber oversized 50 percent to joint width; self expanding; 1 inch wide design width x by maximum lengths available.
 - 1. Manufacturers:
 - a. Dur-O-Wal; Product Mortar Net: www.dur-o-wal.com.
 - b. Hohmann & Barnard, Inc (including Dur -O-Wal brand); Product P.E. Foam Expansion unit fuller: www.h-b.com/#sle.
- C. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.07 MORTAR AND GROUT MIXES

A. Mortar and Grout mixes as specified in Section 04 05 11.

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PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

- A. Direct and coordinate placement of items supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
 - 1. Bond: Running; Match existing brand.
 - 2. Coursing: One unit and one mortar joint to equal 8 inches.
 - 3. Mortar Joints: Concave struck or to match existing unless noted otherwise below.
 - 4. Moartar Joints: Grooved struck on interior at ground face only.
 - Use flush joint on cavity side face of C.M.U. where fluid applied air and vapor barrier is applied.

D. Brick Units:

- Bond: Running; As indicated for different locations with soldier coursing as noted on drawings.
- 2. Vertical Coursing: Three units and three mortar joints to equal 8 inches.
- Mortar Joints: Concave or to match existing.

3.04 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Interlock intersections and external corners.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Set reglets as shown on plans.
- H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- I. Cut mortar joints flush where wall tile is scheduled, cement parging is required, or resilient base is scheduled. Block exposed cavity space with raiseable steel guard of correct width.
- Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

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3.05 WEEPS

A. Install weeps in veneer walls at 32 inches on center horizontally above opening, above shelf angles and lintels and at bottom of walls.

3.06 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 16 inches horizontally and 16 inches vertically.

3.07 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.
- E. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
- F. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.08 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 8 inches into adjacent masonry and turn up at least 2 inches to form watertight pan at non-masonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Extend metal flashings through exterior face of masonry and turn down to form drip. Hemedge Install joint sealer below drip edge to prevent moisture migration under flashing.
- C. Lap end joints of flashings at least 4 inches and seal watertight with mastic or elastic sealant, type as recommended by flashing manufacturer.

3.09 GROUTED COMPONENTS

- A. Reinforce bond beams as shown on plans.
- B. Lap splices minimum 40 bar diameters.
- C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- D. Place and consolidate grout fill without displacing reinforcing.
- E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.10 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control and expansion joints.
- B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- D. Size control joint in accordance with Section for sealant performance.

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- E. Form expansion joint as detailed.
- F. Locate per drawings.

3.11 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, glazed frames, fabricated metal frames, window frames, anchor bolts, plates, and boxes and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.12 TOLERANCES

- A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft.
- C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 20ft.
- E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
- F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.13 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, and grounds. Coordinate with other sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.14 FIELD QUALITY CONTROL

- A. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140 for conformance to requirements of this specification.
- B. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.15 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.16 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 04 20 00

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SECTION 05 50 00 METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel items, including:
 - 1. Bollards.
 - 2. Ledge angles, shelf angles, channels and plates.
 - 3. Loose lintels.
- B. Structural supports for miscellaneous attachments

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- B. Section 09 90 00 Painting and Coating: Paint finish.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M Standard Specification for Carbon Structural Steel.
- B. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- D. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- E. ASTM A283/A283M Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- F. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
- G. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- H. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- I. AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Examination.
- J. AWS D1.1/D1.1M Structural Welding Code Steel.
- K. SSPC-Paint 15 Steel Joist Shop Primer/Metal Building Primer.
- L. SSPC-Paint 20 Zinc-Rich Coating (Type I Inorganic, and Type II Organic).
- M. SSPC-SP 2 Hand Tool Cleaning.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- B. Mill certification for pre-consumer and post-consumer recycled content percentage; request at time of order. Include total weight of material provided.

1.05 QUALITY ASSURANCE

A. Design under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.

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PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M; or ASTM A 572 / A 572M Grade 50.
- B. Plates: ASTM A283; or A 36.
- C. Pipe: ASTM A53/A53M, Grade B Schedule 40, black and hot-dip galvanized finish, as indicated. All exterior fabrications to be hot-dip galvanized.
- D. Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, galvanized to ASTM A153/A153M where connecting galvanized components.
- E. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- F. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- G. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I Inorganic; SSPC-Paint 20, Type II Organic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- Continuously seal joined members by intermittent welds and plastic filler at interior; or continuous welds at exterior.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

- A. Ledge Angles, Shelf Angles, Channels, and Plates not attached to Structural Framing: For support of metal decking, joists, and masonry; prime paint or galvanized finish. Galvanized at all exterior locations.
- B. Loose Lintels: As detailed; prime paint; galvanized; or de-scaled mill finish. Galvanized at all exterior locations.
- C. Structural supports for miscellaneous attachments: As detailed; prime paint; galvanized finish.

2.04 FINISHES - STEEL

- A. Prime paint all steel items.
 - 1. Exceptions: Galvanize all fabrications on the exterior of the building.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: Two coats.
- E. Galvanizing of Structural Steel Members exposed to the exterior: Galvanize after fabrication to ASTM A 123/A 123M requirements. Provide minimum 2.0 oz/sq ft galvanized coating.

2.05 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.

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- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal and aluminum, where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated on drawings and on shop drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 50 00

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SECTION 06 10 00 ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rough opening framing for roof openings.
- B. Roofing nailers.
- C. Preservative treated wood materials.
- D. Fire retardant treated wood materials.
- E. Miscellaneous framing and sheathing.
- F. Wood nailers and curbs for roofing and items installed on roof.
- G. Concealed wood blocking, nailers, and supports.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AFPA (WFCM) Wood Frame Construction Manual for One- and Two-Family Dwellings; American Forest and Paper Association.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. AWPA U1 Use Category System: User Specification for Treated Wood.
- E. PS 2 Performance Standard for Wood Structural Panels.
- F. PS 20 American Softwood Lumber Standard.
- G. SPIB (GR) Standard Grading Rules.

1.04 SUBMITTALS

- A. Product Data: Provide technical data on wood preservative materials and application instructions.
- B. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
 - Lumber of other species or grades, or graded by other agencies, is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
- C. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

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PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Douglas Fir-Larch, unless otherwise indicated.
 - 2. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
 - Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber fabricated from old growth timber is not permitted.
- C. Provide sustainably harvested wood.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.
- E. Miscellaneous Blocking, Furring, Nailers, and Curbs:
 - 1. Lumber: S4S, No. 1 or Construction Grade.
 - 2. Boards: Standard.

2.03 CONSTRUCTION PANELS

- A. Roof Sheathing: PS 2 type, rated Structural I Sheathing. Fire Treated.
 - 1. Bond Classification: Exterior.
 - 2. Span Rating: 60.
 - 3. Performance Category: 3/4 PERF CAT.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M; or Stainless Steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
 - 3. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Fire Retardant Treatment:
 - Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com/#sle.
 - b. Hoover Treated Wood Products, Inc: www.frtw.com/#sle.

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- c. Osmose. Inc: www.osmose.com/#sle.
- d. Substitutions: Not permitted.
- 2. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as scheduled; or as indicated.
 - Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:

- Manufacturers:
 - a. Arch Wood Protection, Inc.: www.wolmanizedwood.com.
 - b. Viance, LLC: www.treatedwood.com.
 - c. Osmose, Inc: www.osmose.com.
 - d. Substitutions: Not permitted.
- D. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
 - 1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - 2. Treat lumber in contact with roofing, flashing, or waterproofing.
 - 3. Treat lumber in contact with masonry or concrete.
 - 4. Treat lumber less than 18 inches above grade.
 - a. Treat lumber in other locations as indicated.
 - 5. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.
 - a. Kiln dry plywood after treatment to maximum moisture content of 15 percent.
 - b. Treat plywood in contact with masonry or concrete.
 - c. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
 - B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
 - C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.02 FRAMING INSTALLATION

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- D. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- E. Install structural members full length without splices unless otherwise specifically detailed.

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F. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA Wood Frame Construction Manual.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- C. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- D. Specifically, provide the following non-structural framing and blocking:
 - Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Visual display and marker boards.
 - 8. Wall paneling and trim.
 - 9. Joints of rigid wall coverings that occur between studs.

3.04 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

3.05 INSTALLATION OF ACCESSORIES AND MISCELLANEOUS WOOD

- A. Curb roof openings except where prefabricated curbs are provided. Form corners by alternating lapping side members.
- B. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant, and parapet construction.

3.06 INSTALLATION OF CONSTRUCTION PANELS

- A. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing; staples are not permitted.
- B. Miscelaneous Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

3.07 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Surface Flatness of Floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
- C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.08 CLEANING

- A. Waste Disposal: Comply with the requirements of Section 01 7419 Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.

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- B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 10 00

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SECTION 07 01 50 PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The existing roof at Zuccolo Rec Center is new and under warranty. Any and all roof work associated with this project is to be completed by A&M Sheet Metal & Roofing, Riverside, RI tel: 401 654 4128. The general contractor is responsible for this sub contractor. All other recreation center roofs are NOT under warrantee.
- B. Removal of asphalt shingle roofing to be coordinated to maintain a weather tight roof assembly. New asphalt shingles to match existing shingles were applicable.

1.02 PRE-INSTALLATION CONFERENCE

A. Review installation procedures and coordination required with related work.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Do not remove existing roofing system when weather conditions threaten the integrity of the building contents or intended continued occupancy. Maintain continued temporary protection prior to installation of the new roofing system. Provide temporary weather protection to insure that the building is weather tight and that no damage occurs to the building, interior contents, furnishings, equipment and finished during re-roofing operations.

1.04 PROTECTION

A. It shall be the Contractor's responsibility to respond immediately to correction of roof leakage during construction. A four (4) hour time limit shall be given from the time of notification of emergency conditions. In the event of water penetration during rain or a storm, the Contractor shall provide for repair of the building contents and interior including, but not limited to, all interior contents, furnishings, equipment, building systems and finishes. If the Contractor does not respond or cannot be contacted, the Owner will affect repairs or emergency action and the Contractor shall be back charged for all expenses and damages, if any.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Temporary protection; Sheet Polyethylene. Provide weights or fasteners to retain sheeting in position.
- B. Other materials that satisfy warranty such as flashings and membrane to tie in and/or modify existing and/or new roof curbs.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Roofing Contractor to verify existing site conditions, including roof dimensions. The Owner and Architect assume no responsibility for the existing actual conditions that the Contractor may encounter during the course of work that can be reasonably foreseen during the Pre-Bid inspection. The building layout was taken from existing drawings. The Contractor shall verify all dimensions and conditions in the field prior to demolition and notify the Architect should any conditions encountered vary from the Contract Documents.
- B. Verify that existing roof surface is clear and ready for work.

3.02 ROOF WORK ASSOCIATED WITH NEW HVAC SYSTEM

- A. Remove and replace all membrane, cant strips, insulation, expansion joints, base flashings, and any other items required for installation of the new roof. In addition, completely remove all nails and other debris to leave a smooth, even surface for re-roofing.
- B. Perform all demolition and/or roof/curb modification work in such a manner as to not damage or affect the load carrying capacity of the existing structural system.

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- C. Contractor shall provide cut off (night tie in) at the end of each day's work.
- D. All curbs are to be raised to a minimum height that satisfies the manufacturer's warranties.

END OF SECTION 07 01 50

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SECTION 07 42 00 METAL WINDOW PANELS

PART 1 - GENERAL

1.01 SCOPE

A. Panels consist of metal skins laminated to stabilizer substrates with an insulating core material. Panels are designed to be glazed into a window system.

1.02 QUALITY ASSURANCE

- A. Panel manufacturer shall have a minimum of 25 years experience.
- B. Field measurements shall be taken prior to completion of manufacturing and cutting.

1.03 SUBSTITUTIONS

A. The materials and products specified in this section establish a minimum standard of required function, design, appearance quality and warranty to be met by any proposed substitution.

1.04 SUBMITTALS

- A. Samples:
 - 1. Two samples of each color and finish texture 3"x5"
- B. Submission Drawings: Indicate thickness, dimension and components of parts. Detail glazing methods, framing and tolerances to accommodate thermal movement.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect finish and edge in accordance with panel manufacturer's recommendations.
- B. Store materials in accordance with panel manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 PANELS - LAMINATED

- A. Laminated metal faced Mapes-R panels as manufactured by Mapes Industries, Inc.
- B. Acceptable alternatives: Panels having similar composite construction and finish providing manufacturer has a minimum of 25 years panel laminating experience and comparable published warranties.

2.02 2.02 - FINISH

- A. Finishes
- B. Exterior: Standard Kynar
- C. Interior: Standard Kynar
- D. Color as selected by architect.

2.03 PANEL FABRICATION

- A. Exterior Substrate: Tempered Hardboard
- B. Core: Isocyanurate
- C. Interior Substrate: Tempered Hardboard
- D. Tolerances .8% of panels dimension length and width (+/-) 1/16" thickness
- E. Panel Thickness 2"

2.04 ACCESSORIES

- A. Recommended for use as an infill panel component in window and curtain wall systems. Related material to complete installation as recommended by the manufacturer.
- B. Seals against moisture intrusion as recommended by the manufacturer. Polyurethane and silicone based sealant with a 20 year life are recommended.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Panel surfaces shall be free from defects prior to installation.

3.02 EXECUTION

- A. Erect panels plumb, level and true.
- B. Glaze panels securely and in accordance with approved shop drawings and manufacturers instructions to allow for necessary thermal movement and structural support.
- C. Do not install panels that are observed to be defective including warped, bowed, dented, scratched and delaminating components.
- D. Weatherseal all joints as required using methods and materials as previously specified.
- E. Separate dissimilar metals using gasketed fasteners and blocking to eliminate the possibility of electrolytic reaction.

3.03 ADJUSTING AND CLEANING

- A. Remove masking film as soon as possible after installation. Masking intentionally left in place after panel installation will be the responsibility of the contractor.
- B. Weep holes and drainage channels must be unobstructed and free from dirt and sealant.

END OF SECTION 07 42 00

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SECTION 07 62 00 SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Sealants for joints within sheet metal fabrications.
- C. Reglets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 Rough Carpentry: Wood nailers.
- B. Section 07 90 05 Joint Sealers

1.03 REFERENCE STANDARDS

- A. AAMA 2603 Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C920 Standard Specification for Elastomeric Joint Sealants.
- D. SMACNA (ASMM) Architectural Sheet Metal Manual.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- B. Samples: Submit two samples 6 by 6 inch in size illustrating metal finish color.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sheet Metal Flashing and Trim Manufacturers:
 - 1. OMG Roofing Products: www.omgroofing.com/#sle.
 - 2. Petersen Aluminum Corporation: www.pac-clad.com/#sle.
 - 3. Tamlyn: www.tamlyn.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Exterior Penetration Flashing Panel Manufacturers:
 - 1. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.

2.02 SHEET MATERIALS

- A. Pre-Finished Aluminum: ASTM B209 (ASTM B209M);.050 inch thick; plain finish shop pre-coated with modified silicone coating.
 - Modified Silicone Polyester Coating: Pigmented Organic Coating System, AAMA 2603; baked enamel finish system.
 - 2. Color: As selected by Architect from manufacturer's standard colors.

2.03 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

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- B. Primer: Zinc chromate type.
- C. Protective Backing Paint: Zinc molybdate alkyd.
- D. Sealant: Type specified in Section 07 90 05 Joint Sealers.
- E. Plastic Cement: ASTM D4586, Type I.

2.04 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Fabricate cleats of same material as sheet, minimum 6 inches wide, interlocking with sheet.
- C. Form pieces in longest possible lengths.
- D. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- F. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

2.05 EXTERIOR PENETRATION FLASHING PANELS

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.06 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Slip Sheet: Rosin sized building paper.
- C. Primer: Zinc chromate type.
- D. Protective Backing Paint: Zinc molybdate alkyd.
- E. Concealed Sealants: Non-curing butyl sealant.
- F. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- G. Plastic Cement: ASTM D4586/D4586M, Type I.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION

- Conform to drawing details.
- B. Insert flashings into reglets to form tight fit. Secure in place with lead wedges. Pack remaining spaces with lead wool. Seal flashings into reglets with sealant.
- Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

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SHEET METAL FLASHING AND TRIM

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- D. Apply plastic cement compound between metal flashings and felt flashings.
- E. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- F. Seal metal joints watertight.

END OF SECTION 07 62 00

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SECTION 07 84 00 FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

A. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems.
- C. ASTM E1966 Standard Test Method for Fire-Resistive Joint Systems.
- D. ASTM E2837 Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- E. ITS (DIR) Directory of Listed Products.
- F. FM 4991 Approval Standard of Firestop Contractors.
- G. FM P7825 Approval Guide; Factory Mutual Research Corporation.
- H. SCAQMD 1168 Adhesive and Sealant Applications.
- I. UL 2079 Standard for Tests for Fire Resistance of Building Joint Systems.
- J. UL (FRD) Fire Resistance Directory.

1.04 SUBMITTALS

- A. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Certificate from authority having jurisdiction indicating approval of materials used.
- F. Qualification statements for installing mechanics.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:.
 - 2. With minimum 5 years documented experience installing work of this type.

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- 3. Able to show at least 3 satisfactorily completed projects of comparable size and type.
- 4. Licensed by authority having jurisdiction.
- 5. Approved by firestopping manufacturer.
- D. Installing Mechanic's Qualifications: Trained by firestopping manufacturer and able to provide evidence thereof.

1.06 MOCK-UP

- A. Install one firestopping assembly representative of each fire rating design required on project.
 - 1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
 - 2. Where firestopping is intended to fill a linear opening, install minimum of 2 linear ft.
- B. Obtain approval of authority having jurisdiction before proceeding.
- C. If accepted, mock-up will represent minimum standard for the Work.
- D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.07 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Manufacturers:
 - 1. A/D Fire Protection Systems Inc: www.adfire.com.
 - 2. 3M Fire Protection Products: www.3m.com/firestop.
 - 3. Hilti, Inc: www.us.hilti.com.
 - 4. Nelson FireStop Products: www.nelsonfirestop.com.
- B. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Head-of-Wall Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
 - 1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
- B. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
 - 1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
 - 2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
 - Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

- C. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
 - Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
 - 3. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

2.03 FIRESTOPPING FOR FLOOR-TO-FLOOR, WALL-TO-FLOOR, AND WALL-TO-WALL JOINTS

- A. Concrete and Concrete Masonry Walls and Floors:
 - Top of Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal Deck Floor:
 - a. 2 Hour Construction: UL System HW-D-0181; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 - 2 Hour Construction: UL System HW-D-1037; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 - 2. Concrete/Concrete Masonry Wall to Wall Joints:
 - a. 2 Hour Construction: UL System WW-D-0017; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
 - b. 2 Hour Construction: UL System WW-D-0032; Hilti CP 606 Flexible Firestop Sealant.
- B. Gypsum Board Walls:
 - 1. Wall to Wall Joints:
 - a. 2 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
 - b. 1 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.

2.04 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A. Blank Openings:
 - 1. In Walls:
 - a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE Intumescent Firestop Sealant.
- B. Penetrations Through Walls By:
 - 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-1421; Hilti FS-ONE Intumescent Firestop Sealant or CP 604 Self-Leveling Firestop Sealant.
 - b. 2 Hour Construction: UL System C-AJ-1498; Hilti CP 680-P/M Cast-In Device.
 - 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
 - b. 2 Hour Construction: UL System C-BJ-2021; Hilti CP 643N Firestop Collar.
 - 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System C-AJ-3216; Hilti CP 658 Firestop Plug.
 - b. 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
 - c. 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.
 - 5. Cable Trays with Electrical Cables:
 - a. 3 Hour Construction: UL System C-AJ-4035; Hilti FS-ONE Intumescent Firestop Sealant.
 - 6. Insulated Pipes:

- 2 Hour Construction: UL System C-AJ-5048; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 604 Self-Leveling Firestop Sealant.
- 7. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2 Hour Construction: UL System C-AJ-7084; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 604 Self-Leveling Firestop Sealant.
- C. Penetrations Through Walls By:
 - 1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-J-3060; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
 - . 2 Hour Construction: UL System W-J-3143; Hilti CP 658T Firestop Plug.
 - 3. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-J-5041; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-J-5042; Hilti FS-ONE Intumescent Firestop Sealant.
 - c. 2 Hour Construction: UL System W-J-5028; Hilti FS-ONE Intumescent Firestop Sealant.
 - 4. HVAC Ducts, Uninsulated:
 - a. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.
 - 5. HVAC Ducts, Insulated:
 - a. 2 Hour Construction: UL System W-J-7112; Hilti FS-ONE Intumescent Firestop Sealant.

2.05 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Blank Openings:
 - 1. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
- B. Penetrations Bv:
 - 1. Multiple Penetrations in Large Openings:
 - a. 2 Hour Construction: UL System W-L-1389; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2 Hour Construction: UL System W-L-1408; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2 Hour Construction: UL System W-L-8071; Hilti FS-ONE Intumescent Firestop Sealant.
 - d. 2 Hour Construction: UL System W-L-8079; Hilti FS-ONE Intumescent Firestop Sealant.
 - e. 2 Hour Construction: UL System W-L-8087; Hilti FS 657 Fire Block.
 - 2. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-1164; Hilti FS-ONE Intumescent Firestop Sealant.
 - 2 Hour Construction: UL System W-L-1206; Hilti FS-ONE Intumescent Firestop Sealant
 - 3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:

- a. 2 Hour Construction: UL System W-L-2078: Hilti CP 643N/644 Firestop Collar.
- b. 2 Hour Construction: UL System W-L-2411; Hilti CP 648-E Firestop Wrap Strip.
- 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE Intumescent Firestop Sealant.
- 4. Electrical Cables Not In Conduit:
 - a. 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
 - b. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
 - c. 2 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
 - d. 2 Hour Construction: UL System W-L-3394; Hilti CFS-SL SK Firestop Sleeve Kit.
 - e. 2 Hour Construction: UL System W-L-3395; Hilti CP653 Speed Sleeve.
- 5. Cable Trays with Electrical Cables:
 - a. 2 Hour Construction: UL System W-L-4011; Hilti FS 657 Fire Block.
 - b. 2 Hour Construction: UL System W-L-4060; Hilti FS-ONE Intumescent Firestop Sealant.
- 6. Insulated Pipes:
 - a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE Intumescent Firestop Sealant.
 - b. 2 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant
 - 2 Hour Construction: UL System W-L-5096; Hilti FS-ONE Intumescent Firestop Sealant.
 - d. 2 Hour Construction: UL System W-L-5257; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, or CP 601S Elastomeric Firestop Sealant.
 - e. 2 Hour Construction: UL System W-L-5244; Hilti CP 648-E Firestop Wrap Strip.
- HVAC Ducts. Insulated:
 - a. 2 Hour Construction: UL System W-L-7156; Hilti FS-ONE Intumescent Firestop Sealant.

2.06 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements. Foam, caulk, putty or manufactured device.
 - Fire Ratings: Use any system listed by UL, FM, or ITS (Warnock Hersey) or that has F Rating equal to fire rating of penetrated assembly and minimum T Rating of 0 and that meets all other specified requirements.
 - 2. Fire Ratings: See Drawings for required systems and ratings.
- B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- C. Firestopping at Cable Tray Penetrations: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- D. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Any material meeting requirements. Foam, caulk, putty or manufactured device.
- E. Firestopping at Control and Expansion Joints (without Penetrations): Any material meeting requirements and caulk.

2.07 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
- C. Foam Firestoppping: Single component silicone foam compound.

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- Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
- E. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening.
- F. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labeling required by code.

CLEANING

4.01 CLEAN ADJACENT SURFACES OF FIRESTOPPING MATERIALS.

4.02 PROTECTION

- A. Clean adjacent surfaces of firestopping materials.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 84 00

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SECTION 07 90 05 JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sealants and joint backer rods.
- B. Precompressed foam sealers.

1.02 REFERENCE STANDARDS

- A. ASTM C834 Standard Specification for Latex Sealants.
- B. ASTM C920 Standard Specification for Elastomeric Joint Sealants.
- C. ASTM C1193 Standard Guide for Use of Joint Sealants.
- D. ASTM D1056 Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- E. ASTM D1667 Standard Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with other sections referencing this section.

1.04 SUBMITTALS

- A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
- B. Samples: Submit two samples, 2 x 1/2 in size illustrating sealant colors for selection.
- C. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each referenced document covering installation requirements on site.

1.06 MOCK-UP

A. Construct a mock-up panel of size, detail and configuration indicated on the drawings. Mock-up shall include all components of the exterior wall construction.

1.07 FIELD CONDITIONS

 Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.08 COORDINATION

A. Coordinate the work with all sections referencing this section.

1.09 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion.
- B. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Type 1 General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.

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- c. Joints between metal frames and other materials.
- d. Other exterior joints for which no other sealant is indicated.
- 3. Polyurethane Products:
 - a. Pecora Corporation: www.pecora.com.
- B. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
 - Products:
 - a. Pecora Corporation; AC-20 + Silicone Acrylic Latex Caulking Compound: www.pecora.com.
- C. Acoustical Sealant: acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
 - 1. Applications: Use for concealed locations only:
 - a. Sealant bead between top stud runner and structure and between bottom stud track and floor and where shown on plans.
 - 2. Products:
 - a. Pecora Corporation; AIS-919: www.pecora.com.

2.02 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces and joint openings are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

- Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Protect elements surrounding the work of this section from damage or disfigurement.
- E. Exposed Concrete Floor Joints: Test joint filler in inconspicuous area of floor slab. Verify specified product does not stain or discolor slab.

3.03 INSTALLATION

- Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.

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- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker where joint backing is not used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Tool joints concave.
- I. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.
- J. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch below adjoining surface.
- K. Concrete Floor Joint Filler: Install concrete floor joint filler per manufacturer's written instructions. After floor joint filler is fully cured, shave joint filler flush with top of concrete slab.

3.04 CLEANING

A. Clean adjacent soiled surfaces.

3.05 PROTECTION

A. Protect sealants until cured.

END OF SECTION 07 90 05

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SECTION 08 11 13 HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Steel frames for wood doors.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 Door Hardware.
- B. Section 09 90 00 Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

- A. ANSI/ICC A117.1 American National Standard for Accessible and Usable Buildings and Facilities; International Code Council.
- B. ANSI/SDI A250.4 Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
- C. ANSI/SDI A250.8 Specifications for Standard Steel Doors and Frames (SDI-100).
- D. ANSI/SDI A250.10 Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- E. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. BHMA A156.115 Hardware Preparation in Steel Doors and Frames.
- G. DHI A115 Series Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute (ANSI/DHI A115 Series).
- H. NAAMM HMMA 840 Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames.
- NAAMM HMMA 861 Guide Specifications for Commercial Hollow Metal Doors and Frames.

1.04 SUBMITTALS

- A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- C. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Steel Door and Frames:
 - 1. Assa Abloy Ceco, Curries, or Fleming: www.assaabloydss.com/#sle.
 - 2. Republic Doors: www.republicdoor.com.
 - 3. Steelcraft: www.steelcraft.com.
 - 4. Phillip Manufacturing Company

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2.02 DOORS AND FRAMES

- A. Requirements for All Door Frames:
 - 1. Accessibility: Comply with ANSI/ICC A117.1.
 - 2. Finish: Factory primed, for field finishing.

2.03 STEEL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Interior Doors, Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - Fire Rating: As indicated on Door and Frame Schedule, As indicated on drawings, 1-1/2
 hours tested in accordance with UL 10C ("positive pressure"), UL 10B or NFPA 252
 ("neutral pressure").
 - a. Provide units listed and labeled by UL or WH.
 - b. Attach fire rating label to each fire rated unit.
 - 3. Core: Mineral fiberboard.
 - 4. Texture: Smooth faces.
 - Finish: Factory primed, for field finishing.

2.04 STEEL FRAMES

- A. General:
 - 1. Comply with the requirements of grade specified for corresponding door.
 - a. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gage
 - 2. Finish: Factory primed, for field finishing.
 - 3. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into frame head, flush with top.
- B. Door Frames, Fire-Rated: Face welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch, maximum, above floor at 45 degree angle.
 - 3. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
 - 4. Finish: Factory primed, for field finishing.
- C. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
- D. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.

2.05 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORY MATERIALS

- A. Silencers: Resilient rubber or vinyl, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- B. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.07 FINISH MATERIALS

- A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard, baked on.
- B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

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PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Coordinate installation of hardware.
- F. Touch up damaged factory finishes.

3.03 TOLERANCES

A. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.04 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION 08 11 13

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SECTION 08 43 13

ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with insulated panel and/or louver for exterior applications
- B. Weatherstripping.
- C. Perimeter sealant.

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 07 42 00 Metal Window Panels

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 Care and Handling of Architectural Aluminum from Shop to Site.
- B. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum.
- C. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- E. ASTM E283/E283M Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- F. ASTM E330/E330M Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- C. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
- E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- F. Manufacturer Qualifications Statement.
- G. Installer Qualifications Statement.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

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1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum 20 years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least 10 years of documented experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN -- FRAMING FOR EXTERIOR INSULATING METAL PANEL & NEW LOUVERS

- A. Front-Set Style, Thermally-Broken:
 - 1. Basis of Design: Kawneer TriFab VG 451T.
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

2.02 MANUFACTURERS

- A. Aluminum-Framed Storefront and Doors:
 - 1. EFCO Corporation: www.efcocorp.com/#sle.
 - 2. Kawneer North America: www.kawneer.com.
 - 3. Oldcastle BuildingEnvelope: www.oldcastlebe.com.
 - 4. YKK AP America Inc: www.ykkap.com.

2.03 STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: Class I color anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 2. Finish Color: As selected from manufacturer's standards.
 - 3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

- 6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
- 7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
- 8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
 - 1. Design Wind Loads: Comply with the requirements of IBC 2012 code.

C. Performance Requirements

- 1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
- 2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.04 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Glazing stops: Flush.

2.05 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Fasteners: Stainless steel.
- C. Perimeter Sealant: Type specified in Section 07 90 05

2.06 FINISHES

 Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Coordinate attachment and seal of perimeter air and vapor barrier materials.

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ALUMINUM-FRAMED STOREFRONTS

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- Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- J. Set thresholds in bed of mastic and secure.
- K. Install hardware using templates provided.
- L. Install glass and infill panels in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.
- M. Install perimeter sealant in accordance with Section 07 90 05.
- N. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- C. Remove excess sealant by method acceptable to sealant manufacturer.

3.05 PROTECTION

A. Protect installed products from damage during subsequent construction.

END OF SECTION 08 43 13

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Various Recreation Centers

SECTION 08 71 00 DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hardware for fire-rated doors.

1.02 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

1.03 REFERENCE STANDARDS

- A. ADA Standards 2010 ADA Standards for Accessible Design.
- B. BHMA A156.1 Standard for Butts and Hinges.
- C. BHMA A156.2 Bored and Preassembled Locks and Latches.
- D. BHMA A156.3 Exit Devices.
- E. BHMA A156.4 Door Closers and Pivots.
- F. BHMA A156.5 Cylinders and Input Devices for Locks.
- G. BHMA A156.6 Standard for Architectural Door Trim.
- H. BHMA A156.7 Template Hinge Dimensions.
- I. BHMA A156.8 Door Controls Overhead Stops and Holders.
- J. BHMA A156.16 Standard for Auxiliary Hardware.
- K. BHMA A156.17 Self Closing Hinges & Pivots.
- L. BHMA A156.18 Standard for Materials and Finishes.
- M. BHMA A156.22 Standard for Gasketing.
- N. BHMA A156.26 Standard for Continuous Hinges.
- O. BHMA A156.31 Electric Strikes and Frame Mounted Actuators.
- P. DHI (LOCS) Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.
- Q. ICC A117.1 Accessible and Usable Buildings and Facilities.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Keying meeting: Coordinate keying with Owner requirements.

1.05 SUBMITTALS

- A. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- B. Shop Drawings Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Provide complete description for each door listed.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

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- D. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- E. Keying Schedule:
 - 1. Submit three (3) copies of Keying Schedule in compliance with requirements established during Keying Requirements Meeting unless otherwise indicated.
- F. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least five years of documented experience.
- C. Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC) to assist in work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.08 WARRANTY

- A. Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
 - 1. Closers: Five years, minimum.
 - 2. Exit Devices: Three years, minimum.
 - 3. Locksets and Cylinders: Three years, minimum.
 - 4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.

2.02 HINGES

- A. Manufacturers:
 - 1. McKinney; an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Bommer Industries, Inc: www.bommer.com/#sle.
 - 3. Hager Companies: www.hagerco.com/#sle.
- B. Hinges: Complying with BHMA A156.1, Grade 1.
 - I. Continuous Hinges: Comply with BHMA A156.26.

2.03 CYLINDRICAL LOCKS

- A. Manufacturers:
 - 1. Basis of Design: Schlage.
 - 2. Corbin Russwin, Sargent, or Yale; an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Best, dormakaba Group: www.bestaccess.com/#sle.
 - 4. Schlage, an Allegion brand: www.allegion.com/us/#sle.
- B. Cylindrical Locks (Bored): Complying with BHMA A156.2, Grade 1, 4000 Series.

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- 1. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.
- 2. Provide a lock for each door, unless otherwise indicated that lock is not required.
- 3. Provide an office lockset for swinging door where hardware set is not indicated.
- 4. Trim: Provide lever handle or pull trim on outside of each lock, unless otherwise indicated.
- 5. Keying: Grand master keyed.
- C. Cores and Keys: Match University standard Schage. No substitutions.

2.04 CLOSERS

- A. Manufacturers; Surface Mounted:
 - 1. Corbin Russwin, Norton, Rixson, Sargent, or Yale; an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. DORMA, USA, INC.; www.dorma.com/#sle.
 - 3. Hager Companies: www.hagerco.com/#sle.
 - 4. LCN, an Allegion brand: www.allegion.com/us/#sle.
- B. Closers: Complying with BHMA A156.4, Grade 1.
 - 1. Type: Surface mounted to door.
 - 2. Provide door closer on each exterior door.

2.05 PROTECTION PLATES

- A. Protection Plates: Comply with BHMA A156.6.
- B. Metal Properties: Stainless steel.
- C. Edges: Beveled, on four sides unless otherwise indicated.
- D. Fasteners: Countersunk screw fasteners.

2.06 KICK PLATES

- A. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 - 1. Size: 8 inch high by 2 inch less door width (LDW) on push side of door.

2.07 MOP PLATES

- A. Manufacturers:
 - 1. Hiawatha, Inc, an Activar Construction Products Group company: www.activarcpg.com/hiawatha/#sle.
 - 2. Ives, an Allegion brand: www.allegion.com/us/#sle.
 - 3. Trimco: www.trimcohardware.com/#sle.
- B. Mop Plates: Provide along bottom edge of push side of doors to provide protection from cleaning liquids and equipment damage to door surface.
 - 1. Size: 6 inch high by 1-1/2 inch less door width (LDW) on pull side and 2 inch LDW on push side of door.

2.08 FLOOR STOPS

- A. Floor Stops: Complying with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Type: Manual hold-open, with bumper floor stop.
 - 2. Material: Steel housing with rubber insert.

2.09 WALL STOPS

- Wall Stops: Complying with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Type: Bumper, concave, wall stop.
 - 2. Material: Aluminum housing with rubber insert.

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2.10 SILENCERS

- A. Silencers: Provide at equal locations on door frame to mute sound of door's impact upon closing.
 - 1. Single Door: Provide three on strike jamb of frame.
 - 2. Pair of Doors: Provide two on head of frame, one for each door at latch side.
 - 3. Material: Rubber, gray color.

2.11 FINISHES

- A. Finishes: Provide door hardware of same finish, unless otherwise indicated.
 - 1. Primary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.
- C. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 - 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.

3.03 ADJUSTING

- A. Adjust work under provisions of Section 01 70 00 Execution and Closeout Requirements.
- B. Adjust hardware for smooth operation.

3.04 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.05 PROTECTION

- Protect finished Work under provisions of Section 01 70 00 Execution and Closeout Requirements.
- B. Do not permit adjacent work to damage hardware or finish.

END OF SECTION 08 71 00

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SECTION 09 21 16 GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- Metal stud wall framing.
- B. Gypsum wallboard.
- C. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 Rough Carpentry: Wood blocking product and execution requirements.
- B. Section 07 90 05 Joint Sealers: Acoustic sealant.

1.03 REFERENCE STANDARDS

- A. AISI S220 North American Standard for Cold-Formed Steel Nonstructural Framing.
- B. AISI S240 North American Standard for Cold-Formed Steel Structural Framing.
- C. ASTM A36/A36M Standard Specification for Carbon Structural Steel.
- D. AISI SG02-1 North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute. (replaced SG-971)
- E. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM A1003/A1003M Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- G. ASTM C475/C475M Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- H. ASTM C514 Standard Specification for Nails for the Application of Gypsum Board.
- I. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
- J. ASTM C665 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- K. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- L. ASTM C840 Standard Specification for Application and Finishing of Gypsum Board.
- M. ASTM C954 Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
- N. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- O. ASTM C1047 Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
- P. ASTM C1396/C1396M Standard Specification for Gypsum Board.
- Q. ASTM C1629/C1629M Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
- R. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- S. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- T. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

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- U. ASTM E413 Classification for Rating Sound Insulation.
- V. GA-214 Recommended Levels of Gypsum Board Finish; Gypsum Association.
- W. GA-216 Application and Finishing of Gypsum Panel Products.
- X. National Institute of Justice Ballistic Standards: NIJ Standard 0108.01 Type IIa.
- Y. UL 752 Standard for Bullet-Resisting Equipment.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate special details associated with vertical deflection joints and acoustic seals. Provide special details for suspended ceilings. Indicate layout, anchorage to structure, type and location of fasteners, framed openings, accessories, and items of related work.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
- B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum five years of documented experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for fire rated assemblies as indicated on drawings.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies per drawings.

2.02 METAL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
- B. Manufacturers Metal Framing, Connectors, and Accessories:
 - 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com/#sle.
 - 2. Dietrich Metal Framing: www.dietrichindustries.com.
 - 3. Marino: www.marinoware.com/#sle.
- C. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/360 at 5 psf.
 - Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - a. Acceptable Products:
 - 1) Dietrich Metal Framing; UltraSteel (tm): www.dietrichindustries.com.
 - 2) Clark Western Building Systems; UltraSteel (tm): www.clarkwestern.com.
 - 2. Studs: "C" shaped with flat or formed webs with knurled faces.
 - 3. Runners: U shaped, sized to match studs.
 - 4. Ceiling Channels: C shaped.
 - 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
- D. Non-structural Framing Accessories:

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- Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: ASTM A36/A36M formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 - b. Products:
 - 1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 Product Requirements.
- 2. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
 - a. Products:
 - 1) ClarkDietrich; FastBridge Clip (FB33): www.clarkdietrich.com/#sle.
 - 2) Substitutions: See Section 01 60 00 Product Requirements.

2.03 BOARD MATERIALS

- A. Manufacturers Gypsum-Based Board:
 - CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 3. National Gypsum Company: www.nationalgypsum.com/#sle.
 - 4. USG Corporation: www.usg.com/#sle.
- B. Impact-Rated Wallboard: Tested to Level 3 soft-body and hard-body impact in accordance with ASTM C1629.
 - Application: Walls.
 - 2. Paper-Faced Type: Gypsum wallboard as defined in ASTM C1396/C1396M.
 - 3. Type: Fire resistance rated Type X, UL or WH listed.
 - 4. Thickness: 5/8 inch.
 - 5. Edges: Tapered.
 - 6. Products:
 - a. National Gypsum Company; Gold Bond Hi-Impact Brand XP Wallboard.
 - USG Corporation: Fiberock Brand Panels--VHI Abuse-Resistant.
- C. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Ceilings, unless otherwise indicated.
 - 2. Thickness: 1/2 inch.
 - 3. Edges: Tapered.

2.04 ACCESSORIES

- A. Finishing Accessories: ASTM C1047, rigid plastic, unless otherwise indicated.
 - 1. Types: As detailed or required for finished appearance.
 - 2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.
- B. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
- C. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
 - Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 - 2. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 3. Ready-mixed vinyl-based joint compound.
 - 4. Powder-type vinyl-based joint compound.
 - 5. Chemical hardening type compound.

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- D. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.
- E. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.
- F. Screws: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.
- G. Staples: ASTM C 840.
- H. Anchorage to Substrate: Tie wire, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/600.
 - 2. Laterally brace entire suspension system, to structure above.
 - 3. Install bracing as required at exterior locations to resist wind uplift.
- C. Studs: Space studs as indicated.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling framing in accordance with details.
 - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
 - 4. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Connections: Minimum (4) #12 screws per connection of cold formed metal framing members.
- F. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
 - 1. Orientation: Horizontal; or Vertical.
 - 2. Spacing: At 16 inches on center; or As permitted by standard.
- G. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - Wall-mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall-mounted door hardware.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install as follows:

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- Place two beads continuously on substrate before installation of perimeter framing members.
- 2. Place continuous bead at perimeter of each layer of gypsum board.
- 3. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes; and other penetrations.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C 840 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination or screwed.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as directed.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.06 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use fiberglass joint tape, bedded with ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound and finished with ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish or where FRP panel to be installed.
 - 3. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Finish gypsum board in scheduled areas in accordance with levels defined in GA-214; or ASTM C 840 and as scheduled below.
 - 1. Above Finished Ceilings Concealed From View: Level 1.
 - 2. Utility Areas and Areas Behind Cabinetry: Level 2.
 - 3. Walls and Ceilings to Receive Flat Paint Finish: Level 4.
- Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 - 2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
 - 3. Taping, filling and sanding is not required at base layer of double layer applications.

3.07 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 FINISH LEVEL SCHEDULE (SEE 1.03 REFERENCES FOR DEFIINITION)

- A. Level 1: Above finished ceilings concealed from view.
- B. Level 2: Utility areas and areas behind cabinetry.

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C. Level 4: Walls and ceilings scheduled to receive flat paint finish.

END OF SECTION 09 21 16

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SECTION 09 90 00 PAINTS AND COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints and other coatings.
- C. Scope: Finish all interior surfaces where indicated.
 - Exposed surfaces of steel lintels and ledge angles.
- D. Painting materials and methods for conduit identification specified in Section 26 05 53.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. ASTM D16 Standard Terminology for Paint, Related Coatings, Materials, and Applications.
- C. NACE (IMP) Industrial Maintenance Painting; NACE International; Edition date unknown.
- D. SSPC (PM1) Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings.

1.03 DEFINITIONS

A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.04 SUBMITTALS

- Product Data: Provide data on all finishing products and special coatings, including VOC content.
- B. Samples: Submit two paper chip samples, 1 X 1 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
- C. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on aluminum sheet, 6 x 6 inch in size.
- D. Documentation: By manufacturer that all paints and coatings comply with VOC limits specified.
- E. Documentation: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.
- F. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
- G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum 5 years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

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- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.

1.09 EXTRA MATERIALS

- A. See Section 01 60 00 Product Requirements, for additional provisions.
- B. Supply 1 gallon of each color; store where directed.
- C. Label each container with color, type, texture, and room locations in addition to the manufacturer's label.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. ICI Paints North America: www.icipaints.com
 - 2. Duron. Inc: www.duron.com/#sle.
 - 3. Sherwin Williams: www.sherwin-williams.com
 - 4. Benjamin Moore & Co: www.benjaminmoore.com/#sle.
- C. Field-Catalyzed Coatings:

2.02 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 - 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content: Comply with Section 01 61 16.
- D. Chemical Content: The following compounds are prohibited:
 - 1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 - 2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di (2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium,

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isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

- E. Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.
 - Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Paint E-OP All Exterior Surfaces Indicated to be Painted, Unless Otherwise Indicated: Including primed metal.
 - 1. Preparation as specified by manufacturer.
 - 2. Two top coats and one coat primer recommended by manufacturer.
- B. Paint ME-OP-2A Ferrous Metals, Primed, Alkyd, 2 Coat:
 - 1. Semi-gloss: Two coats of alkyd enamel.

2.04 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated: Including gypsum board and plaster.
 - 1. Two top coats and one coat primer.
 - 2. Primer(s): As recommended by manufacturer of top coats.
- B. Paint MI-OP-2A Ferrous Metals, Primed, Alkyd, 2 Coat:
 - 1. Touch-up with alkyd primer.
 - 2. Semi-gloss: Two coats of alkyd enamel; ____.
- C. Paint GI-OP-3L Gypsum Board/Plaster, Latex, 3 Coat:
 - 1. One coat of alkyd or latex primer sealer.
 - 2. Eggshell: Two coats of latex enamel.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
- E. Marks: Seal with shellac or stain blocker those which may bleed through surface finishes.

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- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- H. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Section 22 05 53, Section 23 05 53 and Section 26 05 53 for schedule of color coding of equipment, duct work, piping, and conduit.
- B. Paint shop-primed equipment, where indicated.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Finish equipment, piping, conduit, and exposed duct work in utility areas in colors according to the color coding scheme indicated.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finished coatings until completion of project.
- B. Touch-up damaged coatings after Substantial Completion.

3.07 SCHEDULE - SURFACES TO BE FINISHED

- A. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically noted.
 - 2. Fire rating labels, equipment serial number and capacity labels.
 - 3. Stainless steel items.
- B. Paint the surfaces described below under Schedule Paint Systems.
- C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
 - Where indicated as exposed to be painted, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment occurring in finished areas to match background surfaces.
 - 2. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.
 - 3. Paint shop-primed items occurring in finished areas.

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- 4. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
- 5. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- D. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

END OF SECTION 09 90 00

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SECTION 22 07 19 PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible elastomeric cellular insulation.
- B. Piping insulation.
- C. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 Firestopping.
- B. Section 22 10 05 Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- D. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- E. ASTM C195 Standard Specification for Mineral Fiber Thermal Insulating Cement.
- F. ASTM C449 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- G. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM C534/C534M Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- I. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation.
- J. ASTM C552 Standard Specification for Cellular Glass Thermal Insulation.
- K. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
- M. ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- N. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- O. ASTM D1056 Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- P. ASTM D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- Q. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- R. ASTM E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.
- T. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.

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1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Samples: Submit two samples of any representative size illustrating each insulation type.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience, or and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

 Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation; : www.certainteed.com.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 850 degrees F; 1200 degrees F; 1600 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 650 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Vapor Barrier Lap Adhesive:
 - 1. Compatible with insulation.

2.03 CELLULAR GLASS

- A. Manufacturers:
 - 1. Pittsburgh Corning Corporation: www.foamglasinsulation.com/#sle.
 - Substitutions: See Section 01 60 00 Product Requirements.
- B. Insulation: ASTM C552, Grade 1.
 - 1. 'K' value: 0.37 at 100 degrees F.

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- 2. Service Temperature: Up to 900 degrees F.
- 3. Water Vapor Permeability: 0.005 perm inch.
- 4. Water Absorption: 0.2 percent by volume, maximum.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International: www.armacell.com/#sle.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3;grade 2; grade 1 use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: -40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 20 mil; 30 mil.
 - e. Connections: Brush on welding adhesive, tacks, pressure sensitive color matching vinyl tape.
 - 3. Covering Adhesive Mastic:

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:

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- 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
- 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

3.03 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot, recirculated hot water.
 - 1. Operating Temperature: 60 to 140 deg F.
 - 2. Insulation Material: Flexible elastomeric or glass fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, All Sizes: 1.0 inch.
 - 4. Jacket:
 - a. Exposed Spaces (mechanical rooms, closets, etc.) = PVC
 - b. Concealed Spaces = None
 - 5. Vapor Retarder Required: No.
 - 6. Finish: None.
- B. Service: Domestic cold water.
 - 1. Operating Temperature: 35 to 60 deg F.
 - 2. Insulation Material: Flexible elastomeric or glass fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1" or less: 0.5 inch.
 - b. Pipe, 11/4" to 2": 0.5 inch.
 - c. Pipe, 2-1/2" to 4": 1.0 inch.
 - d. Pipe, 5" and up: 1.0 inch.
 - Jacket:
 - a. Exposed Spaces (mechanical rooms, closets, etc.) = PVC
 - b. Concealed Spaces = None
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.
- C. Service: Rainwater conductors.
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 3" and up: 1.0 inch.
 - 4. Jacket:
 - a. Concealed Piping None
 - b. Exposed Piping PVC
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

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- D. Service: Roof drain bodies.
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: 1.0 inch.
 - Jacket:
 - a. Concealed None
 - b. Exposed PVC
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None
- E. Service: Sanitary waste piping where heat tracing is installed.
 - 1. Operating Temperature: 35 to 100 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 3" and up: 1.0 inch.
 - 4. Jacket: Aluminum.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.
- F. Service: Condensate drain piping.
 - 1. Operating Temperature: 35 to 75 deg F.
 - 2. Insulation Material: Flexible elastomeric.
 - 3. Insulation Thickness: 0.5 inch.
 - 4. Jacket: None.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.
- G. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
 - 1. Operating Temperature: 35 to 120 deg F.
 - 2. Insulation Material: Molded closed cell vinyl.
 - 3. Insulation Thickness: 3/16 inch.
 - 4. Vapor Retarder Required: No.
 - 5. Finish: None.

END OF SECTION 22 07 19

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SECTION 22 10 05 PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Vacuum piping, above grade.
 - 4. Gas.
 - 5. Flanges, unions, and couplings.
 - 6. Pipe hangers and supports.
 - 7. Ball valves.
 - 8. Valves.
 - 9. Check.

1.02 REFERENCE STANDARDS

- A. ANSI Z21.22 American National Standard for Relief Valves for Hot Water Supply Systems.
- B. ASME B16.1 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- C. ASME B16.3 Malleable Iron Threaded Fittings: Classes 150 and 300.
- D. ASME B16.4 Gray Iron Threaded Fittings: Classes 125 and 250.
- E. ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- G. ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
- H. ASME B16.26 Cast Copper Alloy Fittings for Flared Copper Tubes.
- ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV.
- J. ASME B31.1 Power Piping.
- K. ASME B31.2 Fuel Gas Piping; The American Society of Mechanical Engineers.
- ASME B31.9 Building Services Piping.
- M. ASME BPVC-IV Boiler and Pressure Vessel Code, Section IV Rules for Construction of Heating Boilers.
- N. ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- O. ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings.
- P. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- Q. ASTM A74 Standard Specification for Cast Iron Soil Pipe and Fittings.
- R. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- S. ASTM B32 Standard Specification for Solder Metal.
- T. ASTM B42 Standard Specification for Seamless Copper Pipe, Standard Sizes.
- U. ASTM B43 Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- V. ASTM B68/B68M Standard Specification for Seamless Copper Tube, Bright Annealed.
- W. ASTM B68M Standard Specification for Seamless Copper Tube, Bright Annealed (Metric).
- X. ASTM B75/B75M Standard Specification for Seamless Copper Tube.

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- Y. ASTM B75M Standard Specification for Seamless Copper Tube (Metric).
- ASTM B88 Standard Specification for Seamless Copper Water Tube.
- AA. ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric).
- AB. ASTM B280 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- AC. ASTM B302 Standard Specification for Threadless Copper Pipe, Standard Sizes.
- AD. ASTM B306 Standard Specification for Copper Drainage Tube (DWV).
- AE. ASTM C4 Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile.
- AF. ASTM C14 Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
- AG. ASTM C14M Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
- AH. ASTM C76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- AI. ASTM C76M Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
- AJ. ASTM C425 Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- AK. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- AL. ASTM C443M Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
- AM. ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- AN. ASTM C700 Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- AO. ASTM C1053 Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
- AP. ASTM D1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- AQ. ASTM D2235 Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- AR. ASTM D2239 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
- AS. ASTM D2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- AT. ASTM D2447 Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter; 2003.
- AU. ASTM D2466 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- AV. ASTM D2513 Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
- AW. ASTM D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- AX. ASTM D2609 Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
- AY. ASTM D2661 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.

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- AZ. ASTM D2665 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- BA. ASTM D2680 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- BB. ASTM D2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- BC. ASTM D2729 Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- BD. ASTM D2751 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- BE. ASTM D2846/D2846M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
- BF. ASTM D2855 Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
- BG. ASTM D2996 Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- BH. ASTM D2997 Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- BI. ASTM D3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- BJ. ASTM D3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
- BK. ASTM D3517 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe.
- BL. ASTM D3754 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
- BM. ASTM D3840 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
- BN. ASTM F437 Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- BO. ASTM F438 Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
- BP. ASTM F439 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- BQ. ASTM F441/F441M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- BR. ASTM F442/F442M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
- BS. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- BT. ASTM F493 Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- BU. ASTM F628 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core.
- BV. ASTM F679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- BW. ASTM F708 Standard Practice for Design and Installation of Rigid Pipe Hangers.

- BX. ASTM F1281 Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
- BY. ASTM F1282 Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
- BZ. AWS A5.8M/A5.8 Specification for Filler Metals for Brazing and Braze Welding.
- CA. AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems.
- CB. AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings.
- CC. AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- CD. AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast.
- CE. AWWA C651 Disinfecting Water Mains.
- CF. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm).
- CG. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service.
- CH. AWWA C950 Fiberglass Pressure Pipe.
- CI. CISPI 301 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- CJ. CISPI 310 Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- CK. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation.
- CL. MSS SP-67 Butterfly Valves.
- CM. MSS SP-69 Pipe Hangers and Supports Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- CN. MSS SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends.
- CO. MSS SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends.
- CP. MSS SP-78 Gray Iron Plug Valves, Flanged and Threaded Ends.
- CQ. MSS SP-80 Bronze Gate, Globe, Angle, and Check Valves.
- CR. MSS SP-85 Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
- CS. MSS SP-89 Pipe Hangers and Supports Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- CT. MSS SP-110 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- CU. NFPA 54 National Fuel Gas Code; National Fire Protection Association.
- CV. NFPA 58 Liquefied Petroleum Gas Code; National Fire Protection Association.
- CW.NSF 61 Drinking Water System Components Health Effects.
- CX. NSF 372 Drinking Water System Components Lead Content.

1.03 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- B. Project Record Documents: Record actual locations of valves.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with local standards.
 - Maintain one copy on project site.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.

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C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.05 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with local plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

1.08 EXTRA MATERIALS

A. Provide two repacking kits for each size valve.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

2.02 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 for not less than 150 psi pressure rating.
 - 1. Fittings: ASTM D2466, PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 Solvent cement.

2.03 WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - 3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

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2.04 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Grooved and Shouldered Pipe End Couplings:
 - 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 2. Sealing gasket: "C" shape composition sealing gasket.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.05 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping Drain, Waste, and Vent:
 - 1. Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.
 - 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping Water:
 - Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 Inches to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 - 8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.

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- 10. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
- 11. Vertical Support: Steel riser clamp.
- 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- 13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
- 14. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
- 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.06 GATE VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Up To and Including 3 Inches:
 - 1. 1, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.
- C. 2 Inches and Larger:
 - Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.07 GLOBE VALVES

- A. Manufacturers:
 - Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Up To and Including 3 Inches:
 - 1. 1, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.
- C. 2 Inches and Larger:
 - 1. 1, Class 125, iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.08 BALL VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.
- C. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

2.09 PLUG VALVES

- A. Manufacturers:
 - 1. Conbraco Industries: www.conbraco.com.
 - 2. Nibco, Inc: www.nibco.com.

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- 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Construction 2-1/2 Inches and Larger: 1, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.10 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Crane Co.: www.cranevalve.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM, Buna N, or EPT seat, wafer, lug, or grooved ends, extended neck, 10 position lever handle.
- C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.11 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Nibco, Inc: www.nibco.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Up to 3 Inches:
 - 1. 1, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.
- C. Over 3 Inches:
 - 1, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

2.12 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Hammond Valve: www.hammondvalve.com.
 - 2. Crane Co.: www.cranevalve.com.
 - 3. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.

- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.
- H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting as shown on drawings. Refer to Section 09 90 00.
- L. Excavate in accordance with Section 31 23 16.
- M. Backfill in accordance with Section 31 23 23.
- N. Install bell and spigot pipe with bell end upstream.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Install water piping to ASME B31.9.
- Q. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- R. Sleeve pipes passing through partitions, walls and floors.
- S. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- T. Pipe Hangers and Supports:
 - Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.
 - 11. Support cast iron drainage piping at every joint.

3.04 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install globe valves for throttling, bypass, or manual flow control services.
- F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide plug valves in natural gas systems for shut-off service.
- I. Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with Section 33 01 10.58.
- B. Prior to starting work, verify system is complete, flushed and clean.
- C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SCHEDULES

- A. Pipe Hanger Spacing:
 - Metal Piping:
 - a. Pipe size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum hanger spacing: 6.5 ft.
 - 2) Hanger rod diameter: 3/8 inches.
 - b. Pipe size: 1-1/2 inches to 2 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 3/8 inch.
 - c. Pipe size: 2-1/2 inches to 3 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 1/2 inch.
 - d. Pipe size: 4 inches to 6 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 5/8 inch.
 - e. Pipe size: 8 inches to 12 inches:
 - 1) Maximum hanger spacing: 14 ft.
 - 2) Hanger rod diameter: 7/8 inch.
 - f. Pipe size: 14 inches and Over:

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- Maximum hanger spacing: 20 ft.
- 2) Hanger rod diameter: 1 inch.
- 2. Plastic Piping:
 - a. Pipe Size 1" to 6":

 - Maximum hanger spacing: 6 ft.
 Hanger rod diameter: 3/8 inch.
 - Pipe Size 8" and Over:
 - Maximum hanger spacing: 6 ft. 1)
 - Hanger rod diameter: 7/8 inch. 2)

END OF SECTION 22 10 05

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SECTION 23 05 13

MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIP

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.

1.02 REFERENCE STANDARDS

- A. ABMA STD 9 Load Ratings and Fatigue Life for Ball Bearings.
- B. IEEE 112 IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- C. NEMA MG 1 Motors and Generators.
- D. NFPA 70 National Electrical Code.
- E. National Grid "Motor-Up" Rebate Program/Initiative.

1.03 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
- B. Conform to applicable electrical code, NFPA 70 and local energy code.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 1/2 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group: www.baldor.com.
- B. Lincoln Motors: www.lincolnmotors.com/#sle.
- C. A. O. Smith Electrical Products Company: www.aosmithmotors.com/#sle.

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D. Reliance Electric/Rockwell Automation: www.reliance.com.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 26 27 17 for required electrical characteristics.
- B. Electrical Service, General. See drawings for specific details:
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz
 - 2. Motors Larger than 1/2 Horsepower: 460 volts, three phase, 60 Hz.

C. Construction:

- 1. Open drip-proof type except where specifically noted otherwise.
- 2. Design for continuous operation in 40 degrees C environment.
- 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- 4. All motors shall be premium efficiency type.
- 5. All motors which require variable speed operation shall be inverter duty or ECM type.
- D. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor.
- F. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.
- B. Single phase motors for shaft mounted fans and centrifugal pumps: Split phase type.
- C. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type or electronically commutated (ECM) type. See schedules for requirements.
- D. Single phase motors for fans, pumps, and blowers: Capacitor start type.
- E. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.
- F. Motors located in outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.

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D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: To NEMA MG 1.
- K. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- M. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.
- N. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

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PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. Provide detailed installation and purchase information for reimbursement by Utility for rebate program.

3.02 SCHEDULE - PREMIUM EFFICIENCY

- A. NEMA Open Motor Service Factors.
 - 1. 1/6-1/3 hp:
 - a. 3600 rpm: 1.35.
 - b. 1800 rpm: 1.35.
 - c. 1200 rpm: 1.35.
 - d. 900 rpm: 1.35.
 - 2. 1/2 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.25.
 - c. 1200 rpm: 1.25.
 - d. 900 rpm: 1.15.
 - 3. 3/4 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.25.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
 - 4. 1 hp:
 - a. 3600 rpm: 1.25.
 - b. 1800 rpm: 1.15.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
 - 5. 1.5-150 hp:
 - a. 3600 rpm: 1.15.
 - b. 1800 rpm: 1.15.
 - c. 1200 rpm: 1.15.
 - d. 900 rpm: 1.15.
- B. Three Phase Premium Efficiency, Open Drip-Proof Performance:
 - 1. Ratings.
 - a. 1 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 72.
 - Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5%@ 1800 RPM, 77% @ 3600 RPM
 - b. 1-1/2 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 73.
 - Minimum Percent Efficiency: 86.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84%
 @ 3600 RPM
 - c. 2 hp:
 - 1) NEMA Frame: 184T.
 - 2) Minimum Percent Power Factor: 75.

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- 3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM
- d. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 60.
 - 3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 89.5% @ 1800 RPM, 85.5% @ 3600 RPM
- e. 5 hp:
 - 1) NEMA Frame: 215T.
 - 2) Minimum Percent Power Factor: 65.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM
- f. 7-1/2 hp:
 - 1) NEMA Frame: 254T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 90.2% @ 1200 RPM, 91% @ 1800 RPM, 88.5% @ 3600 RPM
- g. 10 hp:
 - 1) NEMA Frame: 256T.
 - 2) Minimum Percent Power Factor: 74.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM
- h. 15 hp:
 - 1) NEMA Frame: 284T.
 - 2) Minimum Percent Power Factor: 77.
 - Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 90.2%
 @ 3600 RPM.
- i. 20 hp:
 - 1) NEMA Frame: 286T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 92.4% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM
- j. 25 hp:
 - 1) NEMA Frame: 324T.
 - 2) Minimum Percent Power Factor: 74.
 - Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7%
 @ 3600 RPM
- k. 30 hp:
 - 1) NEMA Frame: 326T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 93.6% @ 1200 RPM, 94.1% @ 1800 RPM, 91.7% @ 3600 RPM
- I. 40 hp:
 - 1) NEMA Frame: 364T.
 - 2) Minimum Percent Power Factor: 77.
 - 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1 @ 1800 RPM, 92.4% @ 3600 RPM
- m. 50 hp:
 - 1) NEMA Frame: 365T.
 - Minimum Percent Power Factor: 79.
 - Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM
- n. 60 hp:

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- 1) NEMA Frame: 404T.
- 2) Minimum Percent Power Factor: 82.
- 3) Minimum Percent Efficiency: 93.
- o. 75 hp:
 - 1) NEMA Frame: 405T.
 - 2) Minimum Percent Power Factor: 80.
 - 3) Minimum Percent Efficiency: 93.
- p. 100 hp:
 - 1) NEMA Frame: 444T.
 - 2) Minimum Percent Power Factor: 80.
 - 3) Minimum Percent Efficiency: 93.
- C. Three Phase Premuim Efficiency, Totally Enclosed, Fan Cooled Performance:
 - 1. 1200 rpm.
 - a. 1 hp:
 - 1) NEMA Frame: 145T.
 - 2) Minimum Percent Power Factor: 72.
 - 3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% 2 1800 RPM, 77% @ 3600 RPM
 - b. 1-1/2 hp:
 - 1) NEMA Frame: 182T.
 - 2) Minimum Percent Power Factor: 73.
 - 3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM
 - c. 2 hp:
 - 1) NEMA Frame: 184T.
 - 2) Minimum Percent Power Factor: 68.
 - 3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM
 - d. 3 hp:
 - 1) NEMA Frame: 213T.
 - 2) Minimum Percent Power Factor: 63.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM
 - e. 5 hp:
 - 1) NEMA Frame: 215T.
 - 2) Minimum Percent Power Factor: 66.
 - 3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 88.5% @ 3600 RPM
 - f. 7-1/2 hp:
 - 1) NEMA Frame: 254T.
 - 2) Minimum Percent Power Factor: 68.
 - Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5%
 @ 3600 RPM
 - g. 10 hp:
 - 1) NEMA Frame: 256T.
 - Minimum Percent Power Factor: 75.
 - Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 90.2% @ 3600 RPM
 - h. 15 hp:
 - 1) NEMA Frame: 284T.
 - 2) Minimum Percent Power Factor: 72.
 - Minimum Percent Efficiency: 91.7% @ 1200 RPM, 92.4% @ 1800 RPM, 91%
 @ 3600 RPM

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- i. 20 hp:
 - 1) NEMA Frame: 286T.
 - 2) Minimum Percent Power Factor: 76.
 - 3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM
- j. 25 hp:
 - 1) NEMA Frame: 324T.
 - 2) Minimum Percent Power Factor: 71.
 - Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7%
 @ 3600 RPM
- k. 30 hp:
 - 1) NEMA Frame: 326T.
 - 2) Minimum Percent Power Factor: 79.
 - Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM.
- I. 40 hp:
 - 1) NEMA Frame: 364T.
 - 2) Minimum Percent Power Factor: 78.
 - 3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1% @ 1800 RPM, 92.4% @ 3600 RPM
- m. 50 hp:
 - 1) NEMA Frame: 365T.
 - 2) Minimum Percent Power Factor: 81.
 - Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM
- Over 50 HP Refer to National Grid "Motor Up" Energy Efficiency requirements for reimbursement.

END OF SECTION 23 05 13

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SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

1.02 REFERENCE STANDARDS

- A. ASTM A269/A269M Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. EJMA (STDS) EJMA Standards.

1.03 SUBMITTALS

- A. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- B. Design Data: Indicate selection calculations.
- C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- E. Maintenance Data: Include adjustment instructions.

1.04 REGULATORY REQUIREMENTS

A. Conform to UL requirements.

1.05 EXTRA MATERIALS

A. Supply two sets of packing for each packed expansion joint.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. Mercer Rubber Company: www.mercer-rubber.com/#sle.
 - 2. Metraflex Company: www.metraflex.com.
- B. Inner Hose: Carbon Steel.
- C. Exterior Sleeve: Single braided, stainless steel or bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturer:
 - 1. Mercer Rubber Company: www.mercer-rubber.com/#sle.
 - 2. Metraflex Company: www.metraflex.com/#sle.

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- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.
- H. Application: Copper piping.

2.03 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

- A. Manufacturers:
 - 1. Mercer Rubber Company: www.mercer-rubber.com/#sle.
 - 2. Metraflex Company: www.metraflex.com/#sle.
- B. Construction: Bronze with anti-torque device, limit stops, internal guides.
- C. Pressure Rating: 125 psi and 400 degrees F.
- D. Maximum Compression: 1-3/4 inches.
- E. Maximum Extension: 1/4 inch.
- F. Joint: As specified for pipe joints.
- G. Size: Use pipe sized units.
- H. Application: Copper piping.

2.04 EXPANSION JOINTS - COPPER WITH PACKED SLIDING SLEEVE

- A. Working Pressure: 125 psi.
- B. Maximum Temperature: 250 degrees F.
- C. Joint: As specified for pipe joints.
- D. Size: Use pipe sized units.
- E. Application: Copper or steel piping 2 inches and over.

2.05 ACCESSORIES

- A. Stainless Steel Pipe: ASTM A269.
- B. Pipe Alignment Guides:
 - Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- C. Swivel Joints:
 - Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N)
 o-ring seals.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

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- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.
- G. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.

END OF SECTION 23 05 16

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SECTION 23 05 19 METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Positive displacement meters.
- B. Flow meters.
- C. Pressure gages and pressure gage taps.
- D. Thermometers and thermometer wells.
- Static pressure gages.
- F. Filter gages.

1.02 REFERENCE STANDARDS

- A. ASME B40.100 Pressure Gauges and Gauge Attachments.
- B. ASME MFC-3M Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi.
- C. ASTM E1 Standard Specification for ASTM Liquid-in-Glass Thermometers.
- D. ASTM E77 Standard Test Method for Inspection and Verification of Thermometers.
- E. AWWA C700 Cold-Water Meters -- Displacement Type, Metal Alloy Main Case.
- F. AWWA C701 Cold-Water Meters -- Turbine Type, for Customer Service.
- G. AWWA C702 Cold-Water Meters -- Compound Type.
- H. AWWA C706 Direct-Reading, Remote-Registration Systems for Cold Water Meters; American Water Works Association (ANSI/AWWA C706).
- I. AWWA M6 Water Meters -- Selection, Installation, Testing, and Maintenance.
- J. UL 393 Indicating Pressure Gauges for Fire-Protection Service.
- K. UL 404 Gauges, Indicating Pressure, for Compressed Gas Service.

1.03 SUBMITTALS

- A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- B. Project Record Documents: Record actual locations of components and instrumentation.
- C. Operation and Maintenance Data: Manufacturer's Standards and Operations and maintenance manuals and catalog cuts.

1.04 FIELD CONDITIONS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.05 EXTRA MATERIALS

- A. Supply two bottles of red gage oil for static pressure gages.
- B. Supply two pressure gages with pulsation damper or dial thermometers.

PART 2 PRODUCTS

2.01 POSITIVE DISPLACEMENT METERS (LIQUID)

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Venture Measurement Company: www.venturemeasurement.com/#sle.
 - 3. McCrometer: www.mccrometer.com.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.

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- B. AWWA C700, positive displacement disc type suitable for fluid with bronze case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading to AWWA C706.
- C. Meter: Brass body turbine meter with magnetic drive register.
 - 1. Service: Cold water, 122 degrees F.
 - 2. Service: Hot water, 200 degrees F.
 - 3. Accuracy: 1-1/2 percent.
 - 4. Maximum Counter Reading: 10 million gallons.
 - 5. Size: 1/2 inch.

2.02 PRESSURE GAGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Co., Inc: www.moellerinstrument.com/#sle.
 - 3. Omega Engineering, Inc: www.omega.com/#sle.
- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 2-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.03 PRESSURE GAGE TAPPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass or Stainless Steel, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40 or Brass, 1/4 inch angle or straight pattern.

2.04 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Thermometers Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 - 1. Size: 7 inch scale.
 - 2. Window: Clear glass or Lexan.
 - 3. Stem: Brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.
- C. Thermometers Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 7 inch scale.
 - 2. Window: Clear glass or Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.05 DIAL THERMOMETERS

A. Manufacturers:

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- 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
- 2. Omega Engineering, Inc: www.omega.com/#sle.
- 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Thermometers Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
 - 1. Size: 2-1/2 inch diameter dial.
 - 2. Lens: Clear glass or Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F.
- C. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3 inch diameter dial.
 - 2. Lens: Clear glass or Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F.
- D. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.
 - 1. Size: 2-1/2 inch diameter dial.
 - 2. Lens: Clear glass or Lexan.
 - 3. Length of Capillary: Minimum 5 feet.
 - 4. Accuracy: 2 percent.
 - 5. Calibration: Degrees F.

2.06 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.07 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.08 STATIC PRESSURE GAGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. 2-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

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PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- D. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.
- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Install thermometers in air duct systems on flanges.
- G. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- I. Coil and conceal excess capillary on remote element instruments.
- Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- L. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- M. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets or where indicated.

3.02 SCHEDULE

- A. Pressure Gages, Location:
 - 1. Pumps.
 - 2. Expansion tanks.
 - 3. Pressure tanks.
 - 4. Pressure reducing valves.
- B. Pressure Gage Tappings, Location:
 - 1. Control valves 3/4 inch & larger inlets and outlets.
 - 2. Major coils inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Headers to central equipment.
 - 2. Coil banks inlets and outlets.
 - 3. Water zone supply and return.
 - 4. After major coils.
- D. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger inlets and outlets.
 - 2. Reheat coils inlets and outlets.
 - 3. Cabinet heaters inlets and outlets.
 - 4. Unit heaters inlets and outlets.

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- E. Dial Thermometers, Location and Scale Range:
 - 1. ERV Outside air.
 - 2. ERV Return air.
 - 3. ERV Exhaust air.
 - 4. ERV Supply air.
- F. Static Pressure and Filter Gages, Location and Scale Range:
 - 1. Built up filter banks.
 - 2. Unitary filter sections.
 - 3. Supply fan discharge.
 - 4. Building static.

END OF SECTION 23 05 19

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SECTION 23 05 48

VIBRATION AND SEISMIC CON. FOR EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolators.
- B. Seismic restraints for suspended components and equipment.
- C. Roof curbs.
- D. Seismic restraints.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 03 30 00 Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Product Data: Provide schedule of vibration isolator type with location and load on each.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
- C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Isolation Technology, Inc: www.isolationtech.com.
- B. Kinetics Noise Control, Inc: www.kineticsnoise.com/#sle.
- C. Mason Industries: www.mason-ind.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
 - 2. Steel springs to function without undue stress or overloading.

2.03 VIBRATION ISOLATORS

- A. Non-Seismic Type:
 - 1. All Elastomeric-Fiber Glass Pads:
 - a. Configuration: Flat or molded.
 - b. Thickness: 0.25 inch minimum.
 - c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.
 - 2. Elastomeric Mounts:
 - a. Material: Oil, ozone, and oxidant resistant compounds.
 - b. Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
 - 3. Steel Springs:
 - a. Assembly: Freestanding, laterally stable without housing.
 - b. Leveling Device: Rigidly connected to equipment or frame.
 - 4. Restrained Steel Springs:
 - a. Housing: Rigid blocking during rigging prevents equipment installed and operating height from changing during temporary weight reduction.

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- b. Equipment Wind Loading: Adequate means for fastening isolator top to equipment and isolator base plate to supporting structure.
- 5. Elastomeric Hangers:
 - a. Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.
 - b. Incorporate steel load distribution plate sandwiching elastomeric element to housing.
- 6. Spring Hanger:
 - a. Housing: Steel construction containing stable steel spring and integral elastomeric element preventing metal to metal contact.
 - b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
- 7. Combination Elastomeric-Spring Hanger:
 - a. Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.
 - b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
- 8. Thrust Restraints:
 - a. Housing: Steel construction containing stable steel spring and integral elastomeric element installed in pairs to resist air pressure thrusts.
 - b. Bottom Openings: Sized to allow plus/minus 15 degrees rod misalignment.

B. Seismic Type:

- 1. Coil Springs Consisting of Single Elements:
 - a. Housing: Manufactured from cast iron material.
 - b. Ductile Material: Designed and rated for seismic applications.
 - c. Spring: Restrained by housing without significant degradation of vibration isolation capabilities during normal equipment operating conditions.
 - d. Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 0.25 inch in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.
 - e. Resilient Pad: Located in series with spring.
 - f. Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.
 - g. Finish: Suitable for the application.
- 2. All Directional Elastomeric:
 - a. Material: Molded from oil, ozone, and oxidant resistant compounds.
 - Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.
 - c. Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
 - d. Rating: Cast iron and aluminum housings rated for seismic restraint applications.
 - e. Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.04 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

- A. Comply with:
 - 1. ASHRAE (HVACA) Handbook HVAC Applications.
 - 2. FEMA 412.
 - 3. FEMA 413.
 - 4. FEMA 414.
 - 5. FEMA E-74.
 - 6. SMACNA (SRM).
- B. Cable Restraints:
 - Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.
 - 2. Protective Thimbles: Eliminates potential for dynamic cable wear and strand breakage.

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- 3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
- 4. Connections:
 - a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
 - b. Internally brace clevis hanger bracket cross bolt to prevent deformation.
- 5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

C. Rigid Restraints:

- 1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
- 2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
- 3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
- 4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
- 5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.05 ROOF CURBS

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1.	Vib	ration-Isolated and/or Seismically Engineered Roof Curbs:		
	a.	Kinetics Noise Control, Inc;: www.kineticsnoise.com/#sle.		
	b.	Mason Industries;: www.mason-ind.com/#sle.		
	C.	Vibro-Acoustics;: www.vibro-acoustics.com/#sle.		
	d.	Cambridgeport; www.cambridgeport.net		

- B. Vibration Isolation Curbs:
 - 1. Non-Seismic Curb Rail:
 - a. Location: Between roof curb and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to conform to requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
 - Non-Seismic Curb:
 - a. Location: Between structure and rooftop equipment.
 - b. Construction: Aluminum.
 - c. Integral vibration isolation to conform to requirements of this section.
 - d. Weather exposed components consist of corrosion resistant materials.
- C. Seismic Type Non-Isolated Curb and Fabricated Equipment Piers:
 - 1. Location: Between structure and rooftop equipment.
 - 2. Construction: Steel.
 - 3. Weather exposed components consist of corrosion resistant materials.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Bases:
 - 1. Set steel bases for one inch clearance between housekeeping pad and base.
 - Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
 - 3. Adjust equipment level.
- C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

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- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Provide pairs of horizontal limit springs on fans with more than 6.0 inches WC static pressure, and on hanger supported, horizontally mounted axial fans.
- F. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.
- G. Support piping connections to equipment mounted on isolators using isolators or resilient hangers as follows:
 - 1. Up to 4 Inches Pipe Size: First three points of support.
 - 2. 5 to 8 Inches Pipe Size: First four points of support.
 - 3. 10 inches Pipe Size and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.03 SCHEDULE

- A. Pipe Isolation Schedule.
 - 1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.
 - 2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.
 - 3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.
 - 4. 4 Inch Pipe Size: Isolate 75 diameters from equipment.
 - 5. 6 Inch Pipe Size: Isolate 60 diameters from equipment.
 - 6. 8 Inch Pipe Size: Isolate 60 diameters from equipment.
 - 7. 10 Inch Pipe Size: Isolate 54 diameters from equipment.
 - 8. 12 Inch Pipe Size: Isolate 50 diameters from equipment.
 - 9. 16 Inch Pipe Size: Isolate 45 diameters from equipment.10. 24 Inch Pipe Size: Isolate 38 diameters from equipment.
 - 11. Over 24 Inch Pipe Size: As indicated.

END OF SECTION 23 05 48

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe Markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 09 90 00 Painting and Coating: Identification painting.

1.03 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS

- A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Samples: Submit two labels or tags 1/2 x 4 inch in size.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Energy Recovery Ventilators: Nameplates.
- G. Heat Pumps: Nameplates.
- H. Heat Transfer Equipment: Nameplates.
- Instrumentation: Tags.
- J. Major Control Components: Nameplates.
- K. Piping: Tags.
- L. Pumps: Nameplates.
- M. Relays: Tags.
- N. Small-sized Equipment: Tags.
- O. Tanks: Nameplates.
- P. Thermostats: Nameplates or labels.

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Q. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.
- B. Champion America, Inc: www.Champion-America.com.
- C. Seton Identification Products: www.seton.com/aec.

2.03 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch.
 - 3. Background Color: Black.

2.04 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B. Metal Tags: Aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.05 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Green/White.

2.06 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 - 6. Ductwork and Equipment: 2-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to ASME A13.1.

2.07 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. For refrigerant piping, provide pipe markers to identify the following:
 - 1. Refrigerant state (high pressure gas, low pressure gas, or liquid)
 - 2. Connected equipment, HP or FC.
 - 3. Connected room number(s), where applicable.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

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- E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- F. Color code as follows:
 - Coordinate with owner.

2.08 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - Coordinate with owner.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion.
- B. Install tags with corrosion resistant chain.
- C. Refrigerant piping shall be labeled with the refrigerant state (high pressure gas, low pressure gas, or liquid) as well as the connected fan coil and associated room served.
- D. Apply stencil painting in accordance with Section 09 90 00.
- E. Install plastic pipe markers in accordance with manufacturer's instructions.
- F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- H. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify thermostats relating to terminal boxes or valves with nameplates.
- K. Identify valves in main and branch piping with tags.
- L. Identify air terminal units and radiator valves with numbered tags.
- M. Tag automatic controls, instruments, and relays. Key to control schematic.
- N. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers or stencilled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- O. Identify ductwork with plastic nameplates or stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- P. Locate ceiling tacks to locate valves, units, or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 23 05 53

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.
- E. Vibration measurement of equipment operating conditions.
- F. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 23 08 00 Mechanical Systems Commissioning

1.03 REFERENCE STANDARDS

- A. AABC MN-1 AABC National Standards for Total System Balance; Associated Air Balance Council.
- B. ASHRAE Std 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. NEBB (TAB) Procedural Standard for Testing Adjusting and Balancing of Environmental Systems.
- D. SMACNA (TAB) HVAC Systems Testing, Adjusting and Balancing.

1.04 SUBMITTALS

- A. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit to the Commissioning Authority, Construction Manager, and HVAC controls contractor.
 - 3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 4. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 5. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).

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- 2) Diffuser proportioning.
- 3) Branch/submain proportioning.
- 4) Total flow calculations.
- 5) Rechecking.
- 6) Diversity issues.
- h. Expected problems and solutions, etc.
- i. Criteria for using air flow straighteners or relocating flow stations and sensors.
- j. Details of how TOTAL flow will be determined; for example:
 - Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
- k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
- Confirmation of understanding of the outside air ventilation criteria under all conditions.
- m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
- n. Method of checking building static and exhaust fan and/or relief damper capacity.
- o. Proposed selection points for sound measurements and sound measurement methods.
- p. Methods for making coil or other system plant capacity measurements, if specified.
- q. Time schedule for TAB work to be done in phases (by floor, etc.).
- r. Description of TAB work for areas to be built out later, if any.
- s. Time schedule for deferred or seasonal TAB work, if specified.
- t. False loading of systems to complete TAB work, if specified.
- u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- v. Interstitial cavity differential pressure measurements and calculations, if specified.
- Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- x. Procedures for formal progress reports, including scope and frequency.
- y. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Field Logs: Submit at least once a week to Commissioning Authority and Construction Manager.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit to the Commissioning Authority, Construction Manager, and HVAC controls contractor within two weeks after completion of testing, adjusting, and balancing.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 4. Provide reports electronically. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 6. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.

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- 7. Units of Measure: Report data in I-P (inch-pound) units only.
- 8. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
- G. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC MN-1, AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 - 4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.
 - 5. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.

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- 7. Fire and volume dampers are in place and open.
- 8. Air coil fins are cleaned and combed.
- 9. Access doors are closed and duct end caps are in place.
- 10. Air outlets are installed and connected.
- 11. Duct system leakage is minimized.
- 12. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities .
- Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.

- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive and sheave changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- O. On fan powered VAV boxes, adjust air flow switches for proper operation.
- P. For laboratories, lab classrooms, and prep rooms, offset CFM values (differential between exhaust/return and supply airflows) shall be required to maintain a plus 10% minus 5% offset.

3.07 COMMISSIONING

- A. Perform prerequisites prior to starting commissioning activities.
- B. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Refrigeration systems
 - 3. Packaged rooftop units.
 - 4. Kitchen ventilation systems.
 - 5. VRF systems.
 - 6. Energy recovery ventilators.
 - 7. Exhaust fans.
- C. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- D. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 10 percent of the air handlers plus a random sample equivalent to 5 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.

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- 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
- 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- E. In the presence of the Commissioning Authority, verify that:
 - Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.

3.08 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Air Cooled Refrigerant Condensers
 - 2. Fan Coils, Including VRF Fan Coils
 - 3. Blower Coils
 - 4. Packaged Roof Top Heating/Cooling Units.
 - 5. Terminal Heat Transfer Units
 - 6. Air Handling Units/Rooftop Mounted Air handling units
 - 7. Fans
 - 8. Air Filters
 - 9. Air Inlets and Outlets

3.09 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer
 - 2. Model/Frame
 - 3. HP/BHP
 - 4. Phase, voltage, amperage; nameplate, actual, no load
 - 5. RPM
 - 6. Service factor
 - 7. Starter size, rating, heater elements
 - 8. Sheave Make/Size/Bore
- B. V-Belt Drives:
 - 1. Identification/location
 - 2. Required driven RPM
 - 3. Driven sheave, diameter and RPM
 - 4. Belt, size and quantity
 - 5. Motor sheave diameter and RPM
 - 6. Center to center distance, maximum, minimum, and actual

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C. Pumps:

- 1. Identification/number
- 2. Manufacturer
- 3. Size/model
- 4. Impeller
- 5. Service
- 6. Design flow rate, pressure drop, BHP
- 7. Actual flow rate, pressure drop, BHP
- 8. Discharge pressure
- 9. Suction pressure
- 10. Total operating head pressure
- 11. Shut off, discharge and suction pressures
- 12. Shut off, total head pressure

D. Air Cooled Condensers:

- Identification/number
- 2. Location
- 3. Manufacturer
- 4. Model number
- 5. Serial number
- 6. Entering DB air temperature, design and actual
- 7. Leaving DB air temperature, design and actual
- 8. Number of compressors

E. Cooling Coils:

- 1. Identification/number
- 2. Location
- 3. Service
- 4. Manufacturer
- 5. Air flow, design and actual
- 6. Entering air DB temperature, design and actual
- 7. Entering air WB temperature, design and actual
- 8. Leaving air DB temperature, design and actual
- 9. Leaving air WB temperature, design and actual
- 10. Water flow, design and actual
- 11. Water pressure drop, design and actual
- 12. Entering water temperature, design and actual
- 13. Leaving water temperature, design and actual
- 14. Saturated suction temperature, design and actual
- 15. Air pressure drop, design and actual

Heating Coils:

- 1. Identification/number
- 2. Location
- Service
- 4. Manufacturer
- 5. Air flow, design and actual
- 6. Gas flow rate
- 7. Entering air temperature, design and actual
- 8. Leaving air temperature, design and actual
- 9. Air pressure drop, design and actual

G. Electric Duct Heaters:

- 1. Manufacturer
- 2. Identification/number
- Location

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- 4. Model number
- 5. Design kW
- 6. Number of stages
- 7. Phase, voltage, amperage
- 8. Test voltage (each phase)
- 9. Test amperage (each phase)
- 10. Air flow, specified and actual
- 11. Temperature rise, specified and actual

H. Air Moving Equipment:

- 1. Location
- 2. Manufacturer
- 3. Model number
- 4. Serial number
- 5. Arrangement/Class/Discharge
- 6. Air flow, specified and actual
- 7. Return air flow, specified and actual
- 8. Outside air flow, specified and actual
- 9. Total static pressure (total external), specified and actual
- 10. Inlet pressure
- 11. Discharge pressure
- 12. Sheave Make/Size/Bore
- 13. Number of Belts/Make/Size
- 14. Fan RPM

I. Return Air/Outside Air:

- 1. Identification/location
- 2. Design air flow
- 3. Actual air flow
- 4. Design return air flow
- 5. Actual return air flow
- 6. Design outside air flow
- 7. Actual outside air flow
- 8. Return air temperature9. Outside air temperature
- Outside air temperature
 Required mixed air temperature
- Actual mixed air temperature
- 12. Design outside/return air ratio
- 13. Actual outside/return air ratio

J. Exhaust Fans:

- 1. Location
- 2. Manufacturer
- 3. Model number
- 4. Serial number
- 5. Air flow, specified and actual
- 6. Total static pressure (total external), specified and actual
- 7. Inlet pressure
- 8. Discharge pressure
- 9. Sheave Make/Size/Bore
- 10. Number of Belts/Make/Size
- 11. Fan RPM
- 12. Associated with Fume Hoods, Include:
 - a. Face velocity test at max/min sash position.

K. Duct Traverses:

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- 1. System zone/branch
- 2. Duct size
- 3. Area
- 4. Design velocity
- 5. Design air flow
- 6. Test velocity
- 7. Test air flow
- 8. Duct static pressure
- 9. Air temperature
- 10. Air correction factor

L. Duct Leak Tests:

- 1. Description of ductwork under test
- 2. Duct design operating pressure
- 3. Duct design test static pressure
- 4. Duct capacity, air flow
- 5. Maximum allowable leakage duct capacity times leak factor
- 6. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Calibrated
- 7. Test static pressure
- 8. Test orifice differential pressure
- 9. Leakage

M. Flow Measuring Stations:

- 1. Identification/number
- 2. Location
- 3. Size
- 4. Manufacturer
- 5. Model number
- 6. Serial number
- 7. Design Flow rate
- 8. Design pressure drop
- 9. Actual/final pressure drop
- 10. Actual/final flow rate
- 11. Station calibrated setting

N. Terminal Unit Data:

- 1. Manufacturer
- 2. Type, constant, variable, single, dual duct
- 3. Identification/number
- 4. Location
- 5. Model number
- 6. Size
- 7. Minimum static pressure
- 8. Minimum design air flow
- 9. Maximum design air flow
- 10. Maximum actual air flow
- 11. Inlet static pressure

O. Air Distribution Tests:

- 1. Air terminal number
- 2. Room number/location
- 3. Terminal type

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- 4. Terminal size
- 5. Area factor
- 6. Design velocity
- 7. Design air flow
- 8. Test (final) velocity
- 9. Test (final) air flow
- 10. Percent of design air flow
- P. Sound Level Reports:
 - 1. Location
 - 2. Octave bands equipment off
 - 3. Octave bands equipment on
- Q. Vibration Tests:
 - 1. Location of points:
 - a. Fan bearing, drive end
 - b. Fan bearing, opposite end
 - c. Motor bearing, center (if applicable)
 - d. Motor bearing, drive end
 - e. Motor bearing, opposite end
 - f. Casing (bottom or top)
 - g. Casing (side)
 - h. Duct after flexible connection (discharge)
 - i. Duct after flexible connection (suction)
 - 2. Test readings:
 - a. Horizontal, velocity and displacement
 - b. Vertical, velocity and displacement
 - c. Axial, velocity and displacement
 - 3. Normally acceptable readings, velocity and acceleration
 - 4. Unusual conditions at time of test
 - 5. Vibration source (if non-complying)

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SECTION 23 07 13 DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct Lagging.
- C. Insulation jackets.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 09 90 00 Painting and Coating: Painting insulation jackets.
- C. Section 22 05 53 Identification for Plumbing Piping and Equipment.
- D. Section 23 05 53 Identification for HVAC Piping and Equipment.
- E. Section 23 31 00 HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- C. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- D. ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- E. ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- F. ASTM C916 Standard Specification for Adhesives for Duct Thermal Insulation.
- G. ASTM C1071 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- H. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- I. ASTM E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- J. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- K. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.
- L. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible.
- M. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experienceand approved by manufacturer.

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1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Owens Corning Corp: www.owenscorning.com/#sle.
 - 4. CertainTeed Corporation: www.certainteed.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. Minimum "R" Value: Minimum R value of (6) is required for interior installations in conditioned plenum spaces and a minimum R value of (12) is required for exterior installations and in unconditioned plenum spaces.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- F. Tie Wire: Annealed steel, 16 gage.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com/#sle.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - Minimum "R" Value: Minimum R value of (6) is required for interior installations in conditioned plenum spaces and a minimum R value of (12) is required for exterior installations and in unconditioned plenum spaces.
 - 2. Maximum service temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent.

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- C. Vapor Barrier Jacket:
 - Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M).
 - 1. Thickness: 0.016 inch sheet.
 - Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.05 DUCT LAGGING

- A. Manufacturers:
 - 1. Sound Seal: www.soundseal.com
 - 2. Kinetics Noise Control: www.kineticsnoise.com.
 - 3. Substitutions: See Section 01 60 00 Product Requirements.
- B. Lagging: 2 lb/SF loaded vinyl noise barrier with a scrim reinforced aluminum foil facing on one side with a 1" thick fiberglass decoupler. Basis of Design: Soundseal B-20 Lagging.
 - 1. Apparent Thermal Conductivity: Maximum of 25 at 75 degrees F
 - 2. Service Temperature: Up to 350 degrees F.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated ducts conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated ducts conveying air above ambient temperature:
 - 1. Provide with or without standard vapor barrier jacket.

- 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting unless noted otherwise.
- F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section. Provide tapered caps on all horizontal ducts for shedding water.
- G. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3.03 SCHEDULES

- A. INDOOR DUCT AND PLENUM APPLICATION SCHEDULE
 - 1. NOTE: Apply duct lagging where indicated on drawings.
 - 2. Service: Round, supply-air ducts, concealed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Foil and paper.
 - e. Vapor Retarder Required: Yes.
 - 3. Service: Round, return-air ducts, concealed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Foil and paper.
 - e. Vapor Retarder Required: No.
 - 4. Service: Round, outside-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Foil and paper.
 - e. Vapor Retarder Required: Yes.
 - 5. Service: Rectangular, supply-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Foil and paper.
 - e. Vapor Retarder Required: Yes.
 - 6. Service: Rectangular, return-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Foil and paper.
 - e. Vapor Retarder Required: No.
 - 7. Service: Rectangular, outside-air ducts, concealed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.

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- c. Minimum "R" value: 8
- d. Jacket: Foil and paper.
- e. Vapor Retarder Required: Yes.
- 8. Service: Round, supply-air ducts, exposed.
 - a. Material: Mineral-fiber blanket
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8
 - d. Jacket: Spiral-wound steel, paintable.
 - e. Vapor Retarder Required: Yes.
 - f. NOTE: Provide double-walled spiral ductwork in areas not concealed above ceilings and where noted.
- 9. Service: Round, return-air ducts, exposed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8.
 - d. Jacket: Spiral-wound steel, paintable.
 - e. Vapor Retarder Required: No.
 - f. NOTE: Provide double-walled spiral ductwork in areas not concealed above ceilings and where noted.
- 10. Service: Round, outside-air ducts, exposed.
 - a. Material: Mineral-fiber blanket.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8.
 - d. Jacket: Spiral-wound steel, paintable.
 - e. Vapor Retarder Required: Yes.
 - f. NOTE: Provide double-walled spiral ductwork in areas not concealed above ceilings and where noted.
- 11. Service: Rectangular, supply-air ducts, exposed.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8.
 - d. Jacket: Canvas, painted to architects specifications.
 - e. Vapor Retarder Required: Yes.
 - f. NOTE: Provide double-walled rectangular ductwork where noted on drawings
- 12. Service: Rectangular, return-air ducts, exposed.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8.
 - d. Jacket: Canvas, painted to architects specifications.
 - e. Vapor Retarder Required: No.
- 13. Service: Rectangular, outside-air ducts, exposed.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 2 inches.
 - c. Minimum "R" value: 8.
 - d. Jacket: Canvas, painted to architects specifications.
 - e. Vapor Retarder Required: Yes.

B. OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- 1. Service: Round, supply-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 4.5 inches.
 - c. Minimum "R" value: 12.
 - d. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch

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- e. Vapor Retarder Required: Yes.
- 2. Service: Round, return-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 4.5 inches.
 - c. Minimum "R" value: 12.
 - d. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - e. Vapor Retarder Required: Yes.
- 3. Service: Rectangular, supply-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 4.5 inches.
 - c. Minimum "R" value: 12.
 - d. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - e. Vapor Retarder Required: Yes.
- 4. Service: Rectangular, return-air ducts.
 - a. Material: Mineral-fiber board.
 - b. Thickness: 4.5 inches.
 - c. Minimum "R" value: 12.
 - d. Field-Applied Jacket: aluminum
 - 1) Aluminum Thickness: 0.032 inch
 - e. Vapor Retarder Required: Yes.

END OF SECTION 23 07 13

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SECTION 23 07 19 HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 19 13 General Commissioning Requirements
- B. Section 07 84 00 Firestopping.
- C. Section 09 90 00 Painting and Coating: Painting insulation jacket.
- D. Section 22 10 05 Plumbing Piping: Placement of hangers and hanger inserts.
- E. Section 23 21 13 Hydronic Piping: Placement of hangers and hanger inserts.
- F. Section 23 23 00 Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- D. ASTM C177 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- E. ASTM C195 Standard Specification for Mineral Fiber Thermal Insulating Cement.
- F. ASTM C449 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- G. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- H. ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- ASTM C534/C534M Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- J. ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation.
- K. ASTM C552 Standard Specification for Cellular Glass Thermal Insulation.
- L. ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- M. ASTM C585 Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
- N. ASTM C591 Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- O. ASTM C610 Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
- P. ASTM C795 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- Q. ASTM D1056 Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
- R. ASTM D2842 Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- S. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.

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- T. ASTM E96/E96M Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.
- U. NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials;
 National Fire Protection Association.
- V. UL 723 Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

 Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International: www.armacell.com/#sle.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534 Grade 3; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: -40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.03 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.

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- e. Connections: Brush on welding adhesive.
- 3. Covering Adhesive Mastic:
 - a. Compatible with insulation.

B. ABS Plastic:

- 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature of 180 degrees F.
 - Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 30 mil.
 - e. Connections: Brush on welding adhesive.
- C. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - Lagging Adhesive:
 - a. Compatible with insulation.
- D. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide: 0.015 inch thick aluminum.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
- E. Stainless Steel Jacket: ASTM A666, Type 302 stainless steel.
 - 1. Thickness: 0.010 inch.
 - 2. Finish: Smooth.
 - Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion ioints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H. Glass fiber insulated pipes conveying fluids above ambient temperature:

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- 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
- 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- K. Pipe Not Concealed Above Ceilings: Finish with PVC jacket.
- L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.
- M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE

- A. PIPING INSULATION SCHEDULES
 - 1. General: Abbreviations used in the following schedules include:
 - a. Field Applied Jackets: P PVC, K-Foil and Paper, A Aluminum, SS Stainless Steel.
 - b. Piping Sizes: NPS Nominal Pipe Size.
- B. INTERIOR PIPING APPLICATION SCHEDULE
 - 1. Service: Condensate drain piping.
 - a. Operating Temperature: 35 to 75 deg F.
 - b. Insulation Material: Flexible elastomeric.
 - c. Insulation Thickness: 0.5 inch.
 - d. Jacket: PVC where not concealed above ceilings.
 - e. Vapor Retarder Required: Yes.
 - f. Finish: None.
 - Service: All refrigerant piping.
 - a. Operating Temperature: 35 to 140 deg F.
 - b. Insulation Material: Flexible elastomeric.
 - c. Insulation Thickness: Apply the following insulation thicknesses:
 - 1) Pipe, 1" or less: 1.0 inch.
 - 2) Pipe, 1-1/4" and up: 1.5 inch.
 - d. Jacket: PVC where not concealed above ceilings.
 - e. Vapor Retarder Required: Yes.
 - f. Finish: None.

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- 3. Service: Heating hot-water supply and return.
 - a. Operating Temperature: 100 to 250 deg F.
 - b. Insulation Material: Mineral fiber or glass fiber.
 - c. Insulation Thickness: Apply the following insulation thicknesses:
 - 1) Pipe, 1" or less: 1.0 inch.
 - 2) Pipe, 1-1/4" to 4": 1.5 inch.
 - 3) Pipe, 5" and up: 2.0 inch.
 - d. Jacket: PVC where not concealed above ceilings.
 - e. Vapor Retarder Required: No.
 - f. Finish: None.

C. EXTERIOR PIPING INSULATION APPLICATION SCHEDULE

- 1. Service: All refrigerant piping.
 - a. Operating Temperature: 35 to 140 deg F.
 - b. Insulation Material: Flexible elastomeric.
 - c. Insulation Thickness: Apply the following insulation thicknesses:
 - 1) Pipe, 1" or less: 1.0 inch.
 - 2) Pipe, 1-1/4" to 2": 1.5 inch.
 - 3) Pipe, 2-1/2" and up: 1.5 inch.
 - d. Jacket: Aluminum.
 - e. Vapor Retarder Required: Yes.
 - f. Finish: None.

END OF SECTION 23 07 19

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SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Input/Output Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Building static pressure transmitters.
 - 4. Equipment operation (current) sensors.
 - 5. Carbon monoxide sensors.
 - 6. Carbon dioxide sensors.
- B. Miscellaneous accessories.

1.02 REFERENCE STANDARDS

- A. AMCA 500-D Laboratory Methods of Testing Dampers for Rating.
- B. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASTM B32 Standard Specification for Solder Metal.
- D. ASTM B88 Standard Specification for Seamless Copper Water Tube.
- E. ASTM D1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- F. IEC 60529 Degrees of Protection Provided by Enclosures (IP Code).
- G. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- H. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Manufacturer's Instructions: Provide for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.

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PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Sensor range shall provide a resolution of no worse than .4°F (unless noted otherwise).
 - 2. Room temperature sensor shall be an element contained within a ventilated cover, suitable for wall mounting with digital output. Sensors located in mechanical areas, plenums, garages, gymnasiums, or corridors shall be a flat plate sensor with no possible adjustment or shall be provided with aestetically-pleasing lockable protective cover. Security screws shall be used in institutional settings as deemed necessary by the design engineer. ATC contractor shall coordinate requirements with the design engineer during the submittal process. Provide insulated base. Following sensing elements are acceptable:
 - a. Sensing element Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.
 - b. Units shall be capable of +/- 2 degrees (F) adjustment by the occupant, with display showing current temperature and setpoint.
 - Single point duct temperature sensor shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
 - a. Sensing element Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.
 - 4. Averaging duct temperature sensor shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide enough sensors to give one lineal foot of sensing element for each square foot of cooling coil face area. Temperature range as required for resolution indicated in paragraph A.
 - a. Sensing element Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.
 - 5. Liquid immersion temperature sensor shall include stainless steel thermowell, sensor and connection head for wiring connections.
 - a. Sensing element for chilled water applications Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point. Temperature range shall be as required for resolution indicated in paragraph A.
 - Sensing element for non-chilled water applications Platinum RTD, +/- 0.2°F
 accuracy at calibration point. Temperature range shall be as required for resolution of
 no worse than 0.1°F.
- B. Humidity Sensors:
 - 1. Elements: Accurate within 5 percent full range with linear output.
 - 2. Room Sensors: With locking cover, span of 10 to 60 percent relative humidity.
 - 3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 100 percent relative humidity.
- C. Building Static Pressure Transmitters:
 - Manufacturers:
 a. Dwyer Instruments Inc; _____: www.dwyer-inst.com/#sle.
 b. Johnson Controls International, PLC; _____: www.johnsoncontrols.com/#sle.
 c. Setra Systems, Inc; _____: www.setra.com/#sle.
 d. Veris Industries; _____: www.veris.com/#sle.
 e. Substitutions: See Section 01 60 00 Product Requirements.

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2. Single port for direct or tubing connection into wall or ceiling static pressure tip, direct acting, double bell, scale range 0.01 to 6.0 in-wc positive or negative, and sensitivity of 0.0005 in-wc. Transmit electronic signal to receiver with matching scale range.

D. Carbon Monoxide Sensors:

- 1. Gas sensing module that holds fixed or replaceable carbon monoxide gas-sensor cartridge.
- 2. Form Factor: IEC 60529, IP20 enclosure, single-gang electrical box mounted.
- 3. Electromechanical sensor with 0 to 500 ppm measurement range.
- 4. Accuracy: Plus/minus Five percent of range with 1 ppm resolution.
- 5. Hardwired Output: Three-wire, 4 to 20 mA, loop powered.
- 6. Alarm: Auxiliary dry contact relay driven by setpoint adjustable between 25 to 180 ppm.

E. Equipment Operation Sensors:

- 1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
- 2. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.03 THERMOSTATS

- A. Line Voltage Thermostats:
 - 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 - 2. Dead band: Maximum 2 degrees F.
 - 3. Cover: Locking with set point adjustment, with thermometer.
 - 4. Rating: Motor load.
- B. Outdoor Reset Thermostat:
 - Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
 - 2. Scale range: -10 to 70 degrees F.
- C. Immersion Thermostat:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- D. Airstream Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - 2. Averaging service remote bulb element: 7.5 feet.
- E. Electric Low Limit Duct Thermostat:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.
- F. Electric High Limit Duct Thermostat:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.
- G. Fire Thermostats:
 - 1. UL labeled, factory set in accordance with NFPA 90A.
 - 2. Normally closed contacts, manual reset.
- H. Heating/Cooling Valve Top Thermostats:
 - 1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

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HVAC & Electrical Upgrades at
Various Recreation Centers

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches, CO2 sensors, and humidistats. Refer to Section 26 2726.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide thermostats in aspirating boxes in front entrances.
- G. Provide guards on thermostats in entrances.
- H. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- I. Provide isolation (two position) dampers of parallel blade construction.
- J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- L. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- M. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of .
- Install pressure independent balancing and control valves for small terminal units on the supply or return lines of coils.
 - 1. For accuracy in flow measurements try to avoid mounting taps and pumps immediately before or after the valve. A minimum distance of five times the pipe diameter and ten times the pipe diameter before the valve for taps and pump respectively is recommended before the valve. A minimum distance of two times the pipe diameter is recommended after the valve.
 - 2. The actuator for the combined manual balancing and control valves for small terminal units can be installed in any position as per manufacturer's recommendations.
 - 3. Install in accordance with manufacturer's instructions.

City of Providence HVAC & Electrical Upgrades at Various Recreation Centers

3.03 MAINTENANCE

- A. See Section 01 70 00 Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

END OF SECTION 23 09 13

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SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

.01 NOTE: CONTRACTOR IS REQUIRED TO PROVIDE ALL COMPONENTS, WIRING, LABOR, APPURTENANCES, AND COORDINATION SERVICES TO DELIVER A FULLY-FUCNTIONAL BUILDING AUTOMATION SYSTEM.

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. System Description
- B. Operator Interface
- C. Controllers
- D. Power Supplies and Line Filtering
- E. System Software
- F. Controller Software
- G. HVAC Control Programs
- H. Control equipment.
- Software.

1.02 RELATED REQUIREMENTS

- A. Section 28 46 00 Fire Detection and Alarm.
- B. Section 23 09 13 Instrumentation and Control Devices for HVAC.
- C. Section 23 09 93 Sequence of Operations for HVAC Controls.
- D. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections.
- E. Section 27 52 23.50 Educational Intercommunications and Programs Education For Sustainability Systems

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units as an expansion of the existing city-wide building automation system.
- B. The BAS contractor shall provide all interconnecting wiring, interfaces, and programming required to completely integrate any VRF or packaged HVAC systems into the building automation system and achieve full read / write capability of all system points from the BAS operator workstation as available at the system control workstation. The BAS contractor is responsible for achieving the specified sequences of operations.
- C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- D. Include computer software and all hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- E. Controls for variable refrigerant flow (VRF) system, packaged rooftop units, packaged unit ventilators, radiation, reheat coils, unit heaters, fan coils, blower coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- F. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment, power transformers and electrical feeds, and other

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- apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- G. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - Indicate description and sequence of operation of operating, user, and application software.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- F. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section 5 years documented experience approved by manufacturer.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this Section.
- B. Require attendance of parties directly affecting the work of this Section.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

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- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.09 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for two years from Date of Substantial Completion.
- B. Provide four complete inspections per year, two in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- C. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.10 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

1.11 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Honeywell International, Inc; Niagara/Tridium: www.honeywell.com/#sle.
- B. Johnson Controls, Inc; Tridium Based FX-Series: www.johnsoncontrols.com/#sle.
- C. KMC Controls; Niagara/Tridium: www.kmccontrols.com/#sle.
- D. Substitutions: Not Permitted.

2.02 CONTROLLERS

A. BUILDING LEVEL CONTROLLERS

- 1. General:
 - Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.

2. Communication:

- a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
- b. Perform routing when connected to a network of custom application and application specific controllers.
- c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

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- 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. CUSTOM APPLICATION CONTROLLERS

- 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.

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 Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

C. APPLICATION SPECIFIC CONTROLLERS

- 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
- 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

D. INPUT/OUTPUT INTERFACE

- 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
- 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
- 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
- 4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
- 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
- 6. Binary Outputs:

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- a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
- b. Outputs provided with three position (On/Off/Auto) override switches.
- c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:

- Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
- b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
- c. Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:

- Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
- b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - 1) VAV or duct terminal units.
 - 2) Duct mounted heating coils.
 - 3) Zone dampers.
 - 4) Radiation.
- c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.03 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

- 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
- Limit connected loads to 80 percent of rated capacity.
- 3. Match DC power supply to current output and voltage requirements.
- 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
- 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
- 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
- 7. Operational Ambient Conditions: 32 to 120 degrees F.
- 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration
- 9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

- 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
- 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

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2.04 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both data base and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic Temperature Control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling.

D. Global Communications:

- Broadcast point data onto network, making that information available to all other system control units.
- 2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.
- E. Input/Output Capability:
 - 1. Discrete/digital input (contact status).
 - 2. Discrete/digital output.
 - 3. Analog input.
 - 4. Analog output.
 - 5. Pulse input (5 pulses/second).
 - 6. Pulse output (0-655 seconds in duration with 0.01 second resolution).
- F. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Install control unit's with minimum 30 percent spare capacity.
- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.
- I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:

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- 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
- 2. Control output points but change only data base state or value; leave external field hardware unchanged.
- 3. Enable control actions on output points but change only data base state or value.
- J. Local display and adjustment panel: Portable control unit, containing digital display, and numerical keyboard. Display and adjust:
 - 1. Input/output point information and status.
 - 2. Controller set points.
 - 3. Controller tuning constants.
 - 4. Program execution times.
 - 5. High and low limit values.
 - 6. Limit differential.
 - 7. Set/display date and time.
 - 8. Control outputs connected to the network.
 - 9. Automatic control outputs.
 - 10. Perform control unit diagnostic testing.
 - 11. Points in "Test" mode.

2.05 LOCAL AREA NETWORK (LAN)

- Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 100 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.06 SYSTEM SOFTWARE

- A. Operating System:
 - 1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
 - 3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.

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- c. Capture or convert graphics from AutoCAD.
- 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Air Handlers.
 - 2) Terminal HVAC Units.
 - 3) Fan Coil Units.
 - 4) VRF Fan Coils.
 - 5) VRF Heat Pumps.
 - 6) Energy Recovery Ventilators with Electric Duct Heating Coils.
 - 7) Packaged Rooftop Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.
 - c. File Format Compatible with Graphics Generation Package Program.
- B. Workstation System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 - 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 - 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 - 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
 - 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.

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- 4) Network connections.
- 5) Building management panels.
- 6) Controllers.
- Device failure is annunciated to the operator.
- 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
- 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
- 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.

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- 3) Archivable to hard disk.
- b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
- c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
- d. Set to be printed on operator command or specific time(s).

14. Reports:

- a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
- b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
- c. Tenant Override:
 - Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
- d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- C. Workstation Applications Editors:
 - 1. Provide editing software for all system applications at the PC workstation.
 - 2. Downloaded application is executed at controller panel.
 - 3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - 4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.

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- 5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values cab be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.07 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.
 - 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 - 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 - 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

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E. Alarms:

- 1. Binary object is set to alarm based on the operator specified state.
- 2. Analog object to have high/low alarm limits.
- 3. All alarming is capable of being automatically and manually disabled.
- 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - 1) Start programs.
 - 2) Print.
 - 3) Logged.
 - 4) Custom messaging.
 - 5) Graphical displays.
 - 6) Dial out to workstation receivers via system protocol.

F. Demand Limiting:

- 1. Building power consumption monitored from signals generated by a pulse generator, mounted at the building power meter.
- 2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
- 3. Demand Reduction Methods:
 - a. Supply air temperature reset.
 - b. Space temperature set-point reset.
 - c. Equipment off/on prioritization.
- 4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
- 5. Operator On-Line Changes Allowed:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum equipment shutoff time.
 - e. Minimum equipment shutoff time.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed/restore priority.
- 6. Information and Reports available Hourly, Daily, and Monthly:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.
- G. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- H. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.
- I. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
- J. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- K. Energy Calculations:

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- 1. Accumulated instantaneous power or flow rates are converted to energy use data.
- 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
- 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- L. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
- M. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- N. Run-Time Totalization:
 - 1. Totalize run-times for all binary input objects.
 - 2. Provides operator with capability to assign high run-time alarm.

2.08 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability From Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. Command selected equipment to specified state.
 - 3. Initiate logs and reports.
 - 4. Change analog limits.
 - 5. Add, delete, or change points within each control unit or application routine.
 - Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
 - 7. Add new control units to system.
 - 8. Modify and set up maintenance scheduling parameters.
 - 9. Develop, modify, delete or display full range of color graphic displays.
 - 10. Automatically archive select data even when running third party software.
 - 11. Provide capability to sort and extract data from archived files and to generate custom reports.
 - 12. Support two printer operations.
 - a. Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.
 - b. Data printer: Print reports, page prints, and data base prints.
 - 13. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 - 14. Print selected control unit data base.
- B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
 - 1. Add and delete points.
 - 2. Modify any point parameter.
 - 3. Change, add, or delete English language descriptors.
 - 4. Add, modify, or delete alarm limits.
 - 5. Add, modify, or delete points in start/stop programs, trend logs, etc.
 - 6. Create custom relationship between points.
 - 7. Create or modify DDC loops and parameters.
 - 8. Create or modify override parameters.
 - 9. Add, modify, and delete any applications program.

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- 10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
 - 1. Utilizes custom symbols or system supported library of symbols.
 - 2. Sixteen (16) colors.
 - 3. Sixty (60) outputs of real time, live dynamic data per graphic.
 - 4. Dynamic graphic data.
 - 5. 1,000 separate graphic pages.
 - 6. Modify graphic screen refresh rate between 1 and 60 seconds.

E. Operator Station:

- 1. Accept data from LAN as needed without scanning entire network for updated point data.
- 2. Interrogate LAN for updated point data when requested.
- 3. Allow operator command of devices.
- 4. Allow operator to place specific control units in or out of service.
- 5. Allow parameter editing of control units.
- Store duplicate data base for every control unit and allow down loading while system is on line.
- 7. Control or modify specific programs.
- 8. Develop, store and modify dynamic color graphics.
- 9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.

F. Alarm Processing:

- Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and which alarms shall cause automatic dial-out.
- Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
- 3. Print on line changeable message, up to 100 characters in length, for each alarm point specified.
- 4. Display alarm reports on video. Display multiple alarms in order of occurrence.
- 5. Define time delay for equipment start-up or shutdown.
- 6. Allow unique routing of specific alarms.
- 7. Operator specifies if alarm requires acknowledgement.
- 8. Continue to indicate unacknowledged alarms after return to normal.
- 9. Alarm notification:
 - a. Automatic print.
 - b. Display indicating alarm condition.
 - c. Selectable audible alarm indication.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

I. Messages:

- Automatically display or print user-defined message subsequent to occurrence of selected events.
- 2. Compose, change, or delete any message.
- 3. Display or log any message at any time.
- 4. Assign any message to any event.

J. Reports:

1. Manually requested with time and date.

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- 2. Long term data archiving to hard disk.
- 3. Automatic directives to download to transportable media such as floppy diskettes for storage.
- 4. Data selection methods to include data base search and manipulation.
- Data extraction with mathematical manipulation.
- 6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
- 7. Generating reports either normally at operator direction, or automatically under work station direction.
- Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
- 9. Include capability for statistical data manipulation and extraction.
- 10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Data Collection:

- 1. Automatically collect and store in disk files.
- 2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2 year period.
- 3. Daily consumption for up to 30 meters over a 2 year period.
- Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
- 5. Provide archiving of stored data for use with system supplied custom reports.
- M. Graphic Display: Support graphic development on work station with software features:
 - 1. Page linking.
 - 2. Generate, store, and retrieve library symbols.
 - 3. Single or double height characters.
 - 4. Sixty (60) dynamic points of data per graphic page.
 - 5. Pixel level resolution.
 - 6. Animated graphics for discrete points.
 - 7. Analog bar graphs.
 - 8. Display real time value of each input or output line diagram fashion.

N. Maintenance Management:

- 1. Run time monitoring, per point.
- 2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
- 3. Equipment safety targets.
- 4. Display of maintenance material and estimated labor.
- 5. Target point reset, per point.

O. Advisories:

- 1. Summary which contains status of points in locked out condition.
- 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
- 3. Report of power failure detection, time and date.
- 4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.09 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and SI (metric) units of measurement.
- B. Demand Limiting:

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- 1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
- 2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
- 3. Forecast demand (kW): Predicted by sliding window method.
- 4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
- 5. Demand Target: Minimum of 3 per demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
- 6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
- 7. Limits: Include control band (upper and lower limits).
- 8. Output advisory if loads are not available to satisfy required shed amount, advise shed requirements and requiring operator acknowledgement.

C. Duty Cycling:

- Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
- 2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.
- 3. Set and modify following parameters for each individual load.
 - a. Minimum and maximum Off time.
 - b. On/Off time in one minute increments.
 - c. Time period from beginning of interval until load can be cycled.
 - d. Manually override the DCC program and place a load in an On or Off state.
 - e. Cooling Target Temperature and Differential.
 - f. Heating Target Temperature and Differential.
 - g. Cycle off adjustment.

D. Automatic Time Scheduling:

- 1. Self-contained programs for automatic start/stop/scheduling of building loads.
- 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
- 3. Special days schedule shall support up to 30 unique date/duration combinations.
- 4. Any number of loads assigned to any time program; each load can have individual time program.
- 5. Each load assigned at least 16 control actions per day with 1 minute resolution.
- 6. Time schedule operations may be:
 - a. Start.
 - b. Optimized Start.
 - c. Stop.
 - d. Optimized Stop.
 - e. Cycle.
 - f. Optimized Cycle.
- 7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
- 8. Create temporary schedules.
- 9. Broadcast temporary "special day" date and duration.

E. Start/Stop Time Optimization:

- 1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
- 2. Adaptive and self-tuning, adjusting to changing conditions unattended.
- 3. For each point under control, establish and modify:
 - a. Occupancy period.
 - b. Desired temperature at beginning of occupancy period.
 - c. Desired temperature at end of occupancy period.

- F. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
 - 1. Employ arithmetic, algebraic, Boolean, and special function operations.
 - 2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.
- H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
 - 1. Define time interval between each control action between 0 to 3600 seconds.
 - 2. Output may be analog value.
 - 3. Provide for "skip" logic.
 - 4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.
- I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
 - 1. Control loops: Defined using "modules" that are analogous to standard control devices.
 - 2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
 - Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Lo signal selector.
 - f. Single pole double throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 - 4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
 - 5. Display: Value or state of each of the lines which interconnect DDC modules.
- J. Fine Tuning Direct Digital Control PID or floating loops:
 - 1. Display information:
 - a. Control loop being tuned
 - b. Input (process) variable
 - c. Output (control) variable
 - d. Setpoint of loop
 - e. Proportional band
 - f. Integral (reset) Interval
 - g. Derivative (rate) Interval
 - 2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".
- K. Trend logging:
 - 1. Each control unit will store samples of control unit's data points.
 - 2. Update file continuously at discretely assignable intervals.
 - 3. Automatically initiate upload request and then store data on hard disk.
 - 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 - 5. Co-ordinate sampling with on/off state of specified point.

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6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.

2.10 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support Inch-pounds and SI (metric) units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 - Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 - 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 - 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 - 4. Use outside air temperature to determine early shut down with ventilation override.
 - 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 - 6. Operator commands:
 - a. Define term schedule
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run time control summary.
 - i. Request optimal run time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.
 - 7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 - 8. Mass temperature summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
 - 9. HVAC point summary:
 - a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and point.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:

- Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot
 deck and cold deck temperatures on dual duct and multizone systems, single zone unit
 discharge temperatures.
- 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
- 3. Operator commands:
 - a. Add/delete fan status point.
 - b. Lock/unlock program.
 - c. Request HVAC point summary.
 - d. Add/Delete discharge controller point.
 - e. Define discharge controller parameters.
 - f. Add/delete air flow rate.
 - g. Define space load and load parameters.
 - h. Request space load summary.
- 4. Control summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.
 - g. Response timer.
 - h. Reset times.
- 5. Space load summary:
 - a. HVAC system status.
 - b. Optimal run time status.
 - c. Heating/cooling loop status.
 - d. Space load point ID.
 - e. Current space load point value.
 - f. Control heat/cool limited.
 - g. Gain factor.
 - h. Calculated reset values.
 - i. Fan status point ID and status.
 - j. Control discharge temperature point ID and status.
 - k. Space load point ID and status.
 - I. Air flow rate point ID and status.

D. Enthalpy Switchover:

- 1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
- 2. Operator commands:
 - a. Add/delete fan status point.
 - b. Add/delete outside air temperature point.
 - c. Add/delete discharge controller point.
 - d. Define discharge controller parameters.
 - e. Add/delete return air temperature point.
 - f. Add/delete outside air dew point/humidity point.
 - g. Add/delete return air dew point/humidity point.
 - h. Add/delete damper switch.
 - i. Add/delete minimum outside air.
 - j. Add/delete atmospheric pressure.
 - k. Add/delete heating override switch.
 - I. Add/delete evaporative cooling switch.

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- m. Add/delete air flow rate.
- n. Define enthalpy deadband.
- o. Lock/unlock program.
- p. Request control summary.
- q. Request HVAC point summary.

3. Control summary:

- a. HVAC control system begin/end status.
- b. Enthalpy switchover optimal system status.
- c. Optimal return time system status.
- d. Current outside air enthalpy.
- e. Calculated mixed air enthalpy.
- f. Calculated cooling cool enthalpy using outside air.
- g. Calculated cooling cool enthalpy using mixed air.
- h. Calculated enthalpy difference.
- i. Enthalpy switchover deadband.
- j. Status of damper mode switch.

2.11 PROGRAMMING APPLICATION FEATURES

A. Trend Point:

- 1. Sample up to 150 points, real or computed, with each point capable of collecting 100 samples at intervals specified in minutes, hours, days, or month.
- 2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:

- 1. Allow definition of minimum of 100 messages, each having minimum length of 100 characters for each individual message.
- 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
- 3. Output assigned alarm with "message requiring acknowledgement".
- 4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:

- 1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
- 2. Provide program times for each day of week, per point, with one minute resolution.
- 3. Automatically generate alarm output for points not responding to command.
- 4. Provide for holidays, minimum of 366 consecutive holidays.
- Operator commands:
 - a. System logs and summaries.
 - b. Start of stop point.
 - c. Lock or unlock control or alarm input.
 - d. Add, delete, or modify analog limits and differentials.
 - e. Adjust point operation position.
 - f. Change point operational mode.
 - g. Open or close point.
 - h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
 - i. Begin or end point totalization.
 - j. Modify totalization values and limits.
 - k. Access or secure point.
 - I. Begin or end HVAC or load control system.
 - m. Modify load parameter.

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- n. Modify demand limiting and duty cycle targets.
- 6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

- Permit events to occur, based on changing condition of one or more associated master points.
- 2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
- 3. Operator commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install all Owner-provided equipment along with all contractor-provided equipment as required to provide a complete, fully functional building automation system.
- B. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- C. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- D. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- E. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of .
- F. Ensure that all components necessary to execute the sequences of operation are coordinated and installed by all contractors.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 2 day period.
- C. Provide basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 8 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

3.05 MAINTENANCE

A. Provide service and maintenance of energy management and control systems for two years from Date of Substantial Completion.

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B. Provide four complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

END OF SECTION 23 09 23

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SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

THE MECHANICAL CONTRACTOR SHALL PROVIDE ALL NECESSARY LABOR MATERIALS TO PROVIDE A FULLY FUNCTIONAL BUILDING AUTOMATION SYSTEM FOR THE PROJECT. THIS INCLUDES ALL CONTROL COMPONENTS, CONTROLLERS, WIRING, PROGRAMMING, AND COORDINATION BETWEEN TRADES TO ACCOMPLISH THE SEQUENCE OF OPERATIONS HEREIN. CONTRACTOR SHALL ENSURE THAT ALL COMPONENTS ARE COORDINATED BETWEEN EQUIPMENT SUPPLIERS AND CONTROLS VENDOR FOR ALL EQUIPMENT.

1.01 PART 1 GENERAL

1.02 SECTION INCLUDES

- A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.
- B. Sequence of operation for:
 - 1. Electric Radiation and Convectors
 - 2. Variable Refrigerant Volume (VRF/VRV) Systems
 - 3. Cabinet heaters / Unit Heaters
 - 4. Packaged Air Handling Units.

1.03 RELATED SECTIONS

- A. Section 23 09 23 Direct-Digital Control System for HVAC.
- B. Section 23 09 13 Instrumentation and Control Devices for HVAC.
- C. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections.

1.04 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
 - Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
 - 2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.
 - 3. Include at least the following sequences:
 - a. Start-up.
 - b. Warm-up mode.
 - c. Normal operating mode.
 - d. Unoccupied mode.
 - e. Shutdown.
 - f. Capacity control sequences and equipment staging.
 - g. Temperature and pressure control, such as setbacks, setups, resets, etc.
 - h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - i. Effects of power or equipment failure with all standby component functions.
 - j. Sequences for all alarms and emergency shut downs.
 - k. Seasonal operational differences and recommendations.
 - I. Interactions and interlocks with other systems.

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- 4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
- For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
- 6. Include schedules, if known.
- C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
 - 1. Label with settings, adjustable range of control and limits.
 - 2. Include flow diagrams for each control system, graphically depicting control logic.
 - 3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - 4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 - 5. Include all monitoring, control and virtual points specified in elsewhere.
 - 6. Include a key to all abbreviations.
- D. Points List: Submit list of all control points indicating at least the following for each point.
 - 1. Name of controlled system.
 - 2. Point abbreviation.
 - 3. Point description; such as dry bulb temperature, airflow, etc.
 - 4. Display unit.
 - 5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
 - 6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
 - 7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
 - 8. Calculated point (Yes / No); i.e. a "virtual" point generated from calculations of other point values.
- E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.06 QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL SYSTEM DESIGN AND OPERATION STANDARDS

- A. The BAS shall control the mechanical systems within the site based upon the following design parameters:
 - 1. The gymnasiums shall be heated and cooled via packaged air-handling units utilizing direct-expansion cooling and heating with hot-gas reheat, electrical resistance supplemental heating, and energy recovery sections. These units will control discharge air temperature and volume and local humidity.
 - 2. The remainder of the buildings shall be heated and cooled by a high efficiency heat pump split system with return air tempered by electric duct heating coils as required to maintain a return air temperature to the units. All units shall be controlled by the BAS. The units shall

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be controlled by a new DDC controller and DDC-based temperature sensors with local control adjustment of +/- 2 degrees F (adjustable). This shall interface with the factory controller to provide full adjustment as indicated in the sequence below but shall not take the place of the factory controls and safeties governing the refrigeration systems.

B. Each unit shall be controlled by an individual DDC Controller and all required sensors, control valves, and appurtenances required to complete the sequence of operation. Units shall include occupied/unoccupied control, night-setback, morning warm-up/cool-down, and enthalpy-based economizer functions.

3.02 ELECTRIC RADIATION AND CONVECTORS

- A. The electric radiation or convector units controlled by independent temperature sensors mounted within the space being served. The unit shall be energized and de-energized to maintain temperature within the space (70 °F, user adjustable).
- B. When the HVAC system is in cooling mode, the unit shall be de-energized.
- C. The following items shall be displayed at the Operator's Terminal:
 - 1. Temperature Setpoint.
 - 2. Actual space temperature.
 - Commanded status of unit (on/off).

3.03 SINGLE ZONE PACKAGED ROOFTOP UNITS WITH HEAT PUMP AND ELECTRIC RESISTANCE SUPPLEMENTAL HEAT AND CENTRAL ENERGY RECOVERY

- A. Each unit shall be controlled by an individual DDC Controller. The DDC Controller shall be wired to a space temperature sensor, space-level CO2 sensor, space-level CO sensor, discharge air temperature sensor, return air temperature sensor, space differential pressure sensor, damper motors, and the contacts to the factory-mounted unit control system controlling the compressor(s), hot-gas bypass, hot-gas reheat, and gas train combustion equipment.
- B. Cooling Mode:
 - During the programmed occupied mode, the supply fan shall run continuously with the outside air damper open to the minimum position (10% outdoor air unless otherwise shown on Schedule).
 - a. The fan modulates to maintain space temperature while maintaining the discharge air setpoint (normally 55.0 deg. F 60.0 deg. F). As the cooling load decreases, the fans will modulate down to minimum speed. As the space temperature continues to fall below the cooling setpoint by 1.0 deg. F (adj.) and remains at minimum speed for a period of time (default=10 minutes adj.) the fan will remain at minimum speed and enter into a discharge air reset mode. As the space temperature continues to drop toward the space occupied heating setpoint, the discharge air setpoint is reset between the "normal" discharge air cooling setpoint and the discharge air heating setpoint.
 - b. The fan will remain at minimum speed until the space temperature exceeds the cooling setpoint +1.0 deg. F for 10 minutes (adj.). At that point it will revert to its fan modulating mode with its discharge setpoint equal to its Discharge Air Cooling setpoint.
 - c. When in the occupied mode, the outdoor-air damper shall modulate to maintain the current outdoor airflow at setpoint. The BAS shall calculate and reset this outdoor airflow setpoint based on the current ventilation requirements based on field mounted CO2 sensor. The amount of outside air will be increased above the minimum setting on a rise in return air CO2 above the setpoint of 750 PPM (adjustable). On a return to setpoint the reverse occurs. Upon a rise in CO2 level above 1500 PPM, a high CO2 level will be displayed at the BAS workstation.
 - d. Setpoints are adjustable at the BAS workstation. As the outdoor air damper and supply air fan adjusts, the return exhaust fan shall automatically adjust it's speed to maintain a constant static pressure within the space (0.3" WC, adjustable).

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- 2. The DX cooling shall stage and modulate to maintain the discharge air temperature setpoint in cooling mode. If economizing is enabled the outside air damper shall also modulate to maintain the discharge air temperature setpoint.
 - a. As noted in paragraph B-1-a above, if cooling or heating is required and the fan is at minimum airflow then the DAT setpoint shall be reset up or down to accommodate space requirements.
- Economizer: The DDC Controller shall receive input from the Global Enthalpy Sensor. If
 the enthalpy of the outdoor air is lower than the defined minimum level (user adjustable)
 the mixing box economizer sequence shall be activated upon a call for cooling. The
 outside air damper shall never close past the minimum position during the occupied
 period.
- 4. When dehuminidification is required as sensed by the factory-provided humidistat (setpoint, 60% RH, adjustable), the hot-gas reheat system will be engaged and follow the factory-programmed sequence.

C. Heating Mode:

- During the programmed occupied mode, the supply fan shall run continuously with the outside air damper open to the minimum position (10% outdoor air unless otherwise shown on Schedule).
 - a. The supply fan shall modulate airflow to maintain space temperature. The supply fan shall not modulate below the minimum OA ventilation rate required in the space or 60% airflow, whichever is greater. If cooling or heating is required and the fan is at minimum airflow then the DAT setpoint shall be reset up or down to accommodate space requirements. When the space temperature decreases to 1.0 deg. F below the heating setpoint, the fan will ramp up to 100% and the heat will be enabled. When the space temperature exceeds the heating setpoint +1.0 deg. F the heat will be disabled and the fan will ramp down to its minimum speed. Reset of the discharge air setpoint will occur every 5-10 minutes (adj.)
 - b. When the space temperature rises above the occupied cooling setpoint the mode shall transition to cooling. When the space temperature falls below the occupied heating setpoint the mode shall transition to heating. When the space temperature is above the occupied cooling setpoint or below the occupied heating setpoint the mode shall remain in its last state. If the space temperature sensor fails the mode shall remain in its last state and an alarm shall be annunciated at the BAS. If the local and communicated setpoints fail the controller shall disable the supply fan and an alarm shall be annunciated at the BAS.
 - c. When in the occupied mode, the outdoor-air damper shall modulate to maintain the current outdoor airflow at setpoint. The BAS shall calculate and reset this outdoor airflow setpoint based on the current ventilation requirements based on field mounted CO2 sensor. The amount of outside air will be increased above the minimum setting on a rise in return air CO2 above the setpoint of 750 PPM (adjustable). On a return to setpoint the reverse occurs. Upon a rise in CO2 level above 1500 PPM, a high CO2 level will be displayed at the BAS workstation.
 - d. Setpoints are adjustable at the BAS workstation. As the outdoor air damper and supply air fan adjusts, the return exhaust fan shall automatically adjust it's speed to maintain a constant static pressure within the space (0.3" WC, adjustable).
- 2. The primary heating shall be the operation of the refrigerant cycle in heat-pump mode. The refrigerant system shall modulate as required to maintain the discharge setpoint. If the unit cannot maintain the discharge setpoint or if the OA temperature is below the factory setpoint for heat-pump operation, the electric resistance heating section shall be energized and modulate to maintain the discharge air temperature setpoint as defined on the unit schedule. Temperatures shall be user-adjustable. As noted in paragraph C-1-a above, If cooling or heating is required and the fan is at minimum airflow then the DAT setpoint shall be reset up or down to accommodate space requirements.
- D. Energy Recovery Wheel Operation

- 1. FOR UNITS EQUIPPED WITH AN ENERGY RECOVERY WHEEL: The AHU shall be in cooling recovery mode when the outdoor air temperature is greater than the space temperature and higher than the energy wheel enable setpoint (system economizer setpoint temperature). When the wheel is enabled, both outdoor & exhaust air bypass dampers shall be closed, outdoor air damper shall be at minimum, return air damper shall be open, and cooling shall be enabled. In cooling the recovery wheel shall be disabled when the outdoor air temperature is less than the space temperature and both outdoor & exhaust air bypass dampers shall be open.
- 2. The AHU shall be in heating recovery mode when the outdoor air temperature is less than the space temperature and less than the energy wheel enable setpoint and the supply air temperature is less than the discharge air setpoint. When heat recovery is enabled the wheel shall be enabled as the first stage of heat, the outdoor air damper shall be at minimum, the outdoor & bypass recovery bypass dampers shall be open, and the unit heat shall be disabled. On a continued call for heat the second stage is enabled, the outdoor recovery bypass damper shall close, and the exhaust recovery bypass damper shall modulate to maintain the space temperature setpoint. If additional heat is required the third stage is enabled, the return air damper shall be open, both recovery bypass dampers shall be closed, and the unit heat shall be enabled.
- 3. If the outdoor air temperature drops below the outdoor air frost protection setpoint (adj.), the outdoor air bypass damper shall modulate to maintain the exhaust-side leaving temperature at setpoint. If the outdoor air bypass damper reaches 100% open for 5 minutes (adj.), the wheel shall be turned off to prevent frosting and an alarm shall be annunciated.

E. Unoccupied Mode:

- 1. During the programmed un-occupied mode, the supply fan, compressor, gas train, and dampers for shall be cycled / modulated to maintain the un-occupied setpoints (55 degrees in Heating mode, 80 degrees in Cooling mode, both adjustable). Unless required for economizer cycle, the outside air damper shall remain closed.
- F. All setpoints and shall be adjustable at the BAS workstation.
- G. Provide a current sensor on one phase of power feeding each supply fan, exhaust fan, heat wheel, and compressor for status indication at the Operator's Terminal.
- H. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating; a low temperature alarm shall be activated at the Operator's Terminal. If the discharge temperature fails to fall to a programmed minimum temperature on a call for mechanical cooling, a high temperature alarm shall be activated at the Operator's Terminal.
- I. The following items shall be displayed at the Operator's Terminal:
 - 1. Space temperature.
 - 2. Space temperature setpoint.
 - 3. Space humidity.
 - 4. Space humidity setpoint.
 - 5. Low Space temperature alarm.
 - 6. High Space temperature alarm.
 - 7. Discharge air temperature.
 - 8. Discharge air temperature setpoint.
 - 9. Return air temperature.
 - 10. Outside air temperature, humidity and enthalpy.
 - 11. Economizer enthalpy setpoint.
 - 12. Space CO2 level.
 - 13. Space CO2 level setpoint.
 - 14. Space CO level
 - 15. Space high CO2 level alarm: "1500 PPM", adjustable.
 - 16. Space high CO level alarm: "1500 PPM", adjustable.
 - 17. Supply fan operational status and speed (percentage)

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- 18. Commanded status of supply fan.
- 19. Exhaust fan operational status and speed (percentage)
- 20. Commanded status of exhaust fan.
- 21. Heat Wheel operational status via current sensor.
- 22. Commanded status of heat wheel.
- 23. Commanded status of compressor(s) / reversing valve / hot gas reheat
- 24. Commanded status of gas-train.
- 25. Commanded position of dampers.
- 26. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

3.04 EXHAUST FANS

- A. Exhaust Fans
 - Provide controllers/relays/etc as required to integrate existing and new exhaust fans into the new BAS.
 - 2. Exhaust fans shall be scheduled for occupied and unoccupied cycles based on an operator adjustable time schedule. Fans may also be manually enabled and disabled at the operator workstation. Provide a current sensor for status indication at the operator's terminal.

3.05 UNIT HEATERS

- A. Single temperature room temperature sensors set at 68 degrees F (adjustable) maintains constant space temperature by cycling unit fan motor and energizing electric heating elements.
- B. The following points shall be visible at the operator terminal:
 - Space setpoint
 - 2. Unit status (on/off)
 - 3. Space temperature

3.06 SINGLE ZONE HIGH EFFICIENCY HEAT PUMP SPLIT SYSTEMS

- A. The variable refrigerant split system shall have a BAS DDC interface wired to the manufacturer factory central system controller to provide operation, configuration, and monitoring of the system. The manufacturer factory central controller shall operate in BACnet protocol, and be connected to manufacturer factory space temperature sensors as specified.
- B. Sequence of operation:
 - 1. Cooling Mode: Cooling mode shall be selected based on system requirements at the room level space temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously. On a rise in space temperature above the setpoint (75 degrees, adjustable), the manufacturer central controller shall energize the central compressor to provide cooling. The electronic expansion valve kit shall modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.
 - a. Economizer: The DDC Controller shall receive input from the Global Enthalpy Sensor. If the enthalpy of the outdoor air is lower than the defined minimum level (22 btu/lb, user adjustable), the outdoor air damper shall modulate open and the return air damper shall proportionally modulate closed to maintain a discharge air temperature of 52 degrees (user adjustable). The outside air damper shall never close past the minimum position during the occupied period.
 - 2. Heating Mode: Heating mode shall be selected based on system requierments at the room level space temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously. On a drop in space temperature below the setpoint (72 degrees, adjustable), the manufacturer central controller shall energize the central compressor with the requisite reversing valve to provide heating to the evaporator unit as required. The electronic expansion valve kit shall

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- modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.
- 3. Unoccupied Mode: During the programmed un-occupied mode, the supply fan, compressor, electric heat, and dampers for shall be cycled / modulated to maintain the un-occupied setpoints (55 degrees in Heating mode, 80 degrees in Cooling mode, both adjustable). Unless required for economizer cycle, the outside air damper shall remain closed.
- 4. The following items shall be accessible and displayed at the Operator's Terminal:
 - a. Space temperature setpoint at each fan-coil unit (user adjustable).
 - b. Actual space temperature of each fan-coil unit space.
 - c. Operational status of each fan-coil unit (heating, cooling, off, user adjustable).
 - d. Factory error codes from each unit.
 - e. Discharge air temperature of each fan coil/blower coil
 - f. Discharge air temperature of the associated electric duct heating coil
 - g. Outside air temperature, humidity and enthalpy
 - h. Fan operational status via current sensor
 - i. Compressor status
 - j. Commanded status of fan
 - k. Commanded position of outside air, return air and relief air dampers
- C. When any heat pump is energized and in occupied heating mode, the associated electric duct heating coil shall be energized to maintain a minimum air temperature of 70 deg. F (adj.) to the blower coil/fan coil unit. In unoccupied mode or in cooling mode, the electric duct heating coil shall remain off.
- D. For units over 2000 CFM, provide a duct smoke detector for each unit in both the supply air duct and return air duct. Provide an interlock to shut down the units upon activation of the duct smoke detector(s).
- E. Each terminal unit (fan coil/blower coil) shall be controlled by the factory-provided wall-mounted controller. The controller shall be capable of allowing space temperature adjustment of +2 / -2 degrees (user adjustable).
- F. Provide a ventilated lockable enclosure around fan coil/blower coil temperature sensors
- G. The following items shall be displayed at the operator's terminal:
 - 1. Discharge air temperature of the fan coil/blower coil
 - 2. Discharge air temperature of the associated electric duct heating coil
 - 3. Outside air temperature, humidity and enthalpy
 - 4. Fan operational status via current sensor
 - 5. Compressor status
 - 6. Commanded status of fan
 - 7. Commanded position of outside air, return air and relief air dampers

END OF SECTION 23 09 93

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SECTION 23 23 00 REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers.
- L. Flexible connections.

1.02 REFERENCE STANDARDS

- A. AHRI 495 Performance Rating of Refrigerant Liquid Receivers.
- B. AHRI 710 Performance Rating of Liquid-Line Driers.
- C. AHRI 730 (I-P) Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers.
- D. AHRI 750 Thermostatic Refrigerant Expansion Valves.
- E. AHRI 760 Performance Rating of Solenoid Valves for Use With Volatile Refrigerants.
- F. ASHRAE Std 15 Safety Standard for Refrigeration Systems.
- G. ASHRAE Std 34 Designation and Safety Classification of Refrigerants.
- H. ASME BPVC-VIII-1 Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.
- ASME BPVC-IX Boiler and Pressure Vessel Code, Section IX Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- J. ASME B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- K. ASME B16.26 Cast Copper Alloy Fittings for Flared Copper Tubes.
- L. ASME B31.5 Refrigeration Piping and Heat Transfer Components.
- M. ASME B31.9 Building Services Piping.
- N. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- O. ASTM A234/A234M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- P. ASTM B88 Standard Specification for Seamless Copper Water Tube.
- Q. ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric).
- R. ASTM B280 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- S. ASTM F708 Standard Practice for Design and Installation of Rigid Pipe Hangers.
- T. AWS A5.8M/A5.8 Specification for Filler Metals for Brazing and Braze Welding.

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- U. AWS D1.1/D1.1M Structural Welding Code Steel.
- V. MSS SP-58 Pipe Hangers and Supports Materials, Design, Manufacture, Selection, Application, and Installation.
- W. MSS SP-69 Pipe Hangers and Supports Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- X. MSS SP-89 Pipe Hangers and Supports Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
- Y. UL 429 Electrically Operated Valves.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Provide pipe hangers and supports in accordance with MSS SP-69 unless indicated otherwise.
- C. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.

D. Valves:

- 1. Use service valves on suction and discharge of compressors.
- 2. Use gage taps at compressor inlet and outlet.
- 3. Use gage taps at hot gas bypass regulators, inlet and outlet.
- 4. Use check valves on compressor discharge.
- 5. Use check valves on condenser liquid lines on multiple condenser systems.
- E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:

- 1. Use line size strainer upstream of each automatic valve.
- Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
- 3. On steel piping systems, use strainer in suction line.
- 4. Use shut-off valve on each side of strainer.
- G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
- H. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
 - 2. Use a filter-drier on suction line just ahead of compressor.
 - 3. Use sealed filter-driers in lines smaller than 1/2 inch outside diameter.
 - 4. Use sealed filter-driers in low temperature systems.
 - 5. Use sealed filter-driers in systems utilizing hermetic compressors.
 - 6. Use replaceable core filter-driers in lines of 1/2 inch outside diameter or greater.
 - 7. Use replaceable core liquid-line filter-driers in systems utilizing receivers.
 - 8. Use filter-driers for each solenoid valve.

I. Solenoid Valves:

- Use in liquid line of systems operating with single pump-out or pump-down compressor control.
- 2. Use in liquid line of single or multiple evaporator systems.
- 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

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J. Receivers:

- 1. Use on systems five tons and larger, sized to accommodate pump down charge.
- Use on systems with long piping runs.
- K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.04 SUBMITTALS

- A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- C. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Test Reports: Indicate results of leak test, acid test.
- E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- F. Submit welders certification of compliance with ASME (BPV IX) or AWS D1.1.
- G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
- H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.
- B. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.
- C. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
- C. Welders Certification: In accordance with ASME (BPV IX) or AWS D1.1.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.08 MAINTENANCE PRODUCTS

- A. See Section 01 6000 Product Requirements, for additional provisions.
- B. Provide two refrigeration oil test kits each containing everything required to conduct one test.
- C. Provide two filter-dryer cartridges of each type.

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PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

2.02 REGULATORY REQUIREMENTS

2.03 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.
- B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.
- C. Pipe Supports and Anchors:
 - 1. Conform to ASTM F 708, MSS SP-58, MSS SP-69, and MSS SP-89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 7. Vertical Support: Steel riser clamp.
 - 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 - 11. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 REFRIGERANT

A. Refrigerant: See Schedules

2.05 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Technologies: www.henrytech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
- B. Indicators: Single or Doubleport type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.06 VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation: www.hantech.com/#sle.
 - 2. Henry Technologies: www.henrytech.com/#sle.
 - 3. Danfoss Flomatic: www.flomatic.com/#sle.
- B. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat

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disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Packed Angle Valves:

 Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

D. Ball Valves:

 Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

E. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.07 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.
- B. Straight Line, Non-Cleanable Type:
 - 1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 500 psi.

2.08 CHECK VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation: www.hantech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Globe Type:
 - Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 500 psi.
- C. Straight Through Type:
 - 1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.09 PRESSURE REGULATORS

- A. Manufacturers:
 - 1. Hansen Technologies Corporation: www.hantech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.10 PRESSURE RELIEF VALVES

- A. Manufacturers:
 - 1. Hansen Technologies Corporation: www.hantech.com/#sle.
 - 2. Henry Technologies: www.henrytech.com/#sle.
 - 3. Sherwood Valve/Harsco Corporation: www.sherwoodvalve.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.

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B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 425 psi, adjusted to meet system requirements.

2.11 FILTER-DRIERS

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.

B. Performance:

- Flow Capacity Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
- 2. Flow Capacity Suction Line: As indicated in schedule, minimum, rated in accordance with AHRI 730 (I-P).
- 3. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710.
- 4. Pressure Drop: 2 psi, As indicated in schedule, maximum, when operating at full connected evaporator capacity.
- 5. Design Working Pressure: As indicated in schedule or 500 psi, minimum.
- C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns; of construction that will not pass into refrigerant lines.
- D. Construction: UL listed.
 - 1. Replaceable Core Type: Steel shell with removable cap.
 - 2. Sealed Type: Copper shell.
 - 3. Connections: As specified for applicable pipe type.

2.12 SOLENOID VALVES

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
- B. Valve: AHRI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.
- C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.
- D. Electrical Characteristics: per drawings.

2.13 EXPANSION VALVES

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
- B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum

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10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.14 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Danfoss Automatic Controls: www.danfoss.com.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
- B. Valve:
 - 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
 - 2. Capacity: per drawings.
 - 3. Electrical Characteristics: per drawings.
- C. Evaporation Control System:
 - Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
 - 2. Electrical Characteristics: per drawings.
- D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.15 RECEIVERS

- A. Manufacturers:
 - 1. Henry Technologies: www.henrytech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sherwood Valve/Harsco Corporation: www.sherwoodvalve.com/#sle.
- B. Internal Diameter 6 inch and Smaller:
 - 1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- C. Internal Diameter Over 6 inch:
 - AHRI 495, welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); 400
 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid
 level indicator.

2.16 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Circuit Hydraulics, Ltd: www.circuit-hydraulics.co.uk.
 - 2. Flexicraft Industries: www.flexicraft.com/#sle.
 - 3. Penflex: www.penflex.com/#sle.
- B. Corrugated stainless steel or bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

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

- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:

- 1. Provide inserts for placement in concrete formwork.
- 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into and grouted flush with slab.

G. Pipe Hangers and Supports:

- 1. Install in accordance with ASTM F 708 and MSS SP-89.
- 2. Support horizontal piping as scheduled.
- Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- 4. Place hangers within 12 inches of each horizontal elbow.
- 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- 7. Provide copper plated hangers and supports for copper piping.
- H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.
- K. Flood piping system with nitrogen when brazing.
- L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.
- N. Insulate piping and equipment; refer to Section and Section 22 07 16.
- O. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.
- Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- T. Fully charge completed system with refrigerant after testing.

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U. Provide electrical connection to solenoid valves. Refer to Section 26 27 17.

3.03 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.

3.04 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 - 9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- B. Hanger Spacing for Steel Piping.
 - 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 7. 4 inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION 23 23 00

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SECTION 23 31 00 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Casing and plenums.

1.02 REFERENCE STANDARDS

- A. ASTM A36/A36M Standard Specification for Carbon Structural Steel.
- B. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM A1008/A1008M Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
- E. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- F. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM B209M Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- H. ASTM C14 Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
- I. ASTM C14M Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
- J. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- K. ASTM C443M Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
- L. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
- M. NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- N. NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- O. SMACNA (LEAK) HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.
- P. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible.
- Q. SMACNA (FGD) Fibrous Glass Duct Construction Standards.
- R. UL 181 Standard for Factory-Made Air Ducts and Air Connectors.
- S. IECC 2012 International Energy Conservation Code Duct construciton standards, leakage testing

1.03 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

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1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials and duct connections.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems.
- D. <u>MANDATORY Test Reports</u>: Pressure test all ductwork. Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) HVAC Air Duct Leakage Test Manual.
 - Utilize standard equation CL=FP^0.65 where F= Measured leakage rate in CFM per 100 square feet of duct surface, and P = Static Pressure of the test. Leakage rate shall not exceed 4.0 in that equation.
- E. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.
- F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.06 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.07 FIELD CONDITIONS

- Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- 3. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 304.
- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- E. Flexible Ducts:
 - 1. Two ply vinyl film supported by helically wound spring steel wire.
 - a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 - b. Maximum Velocity: 4000 fpm.
 - c. Temperature Range: -10 degrees F to 160 degrees F.

F. Insulated Flexible Ducts:

- 1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
 - a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 - b. Maximum Velocity: 4000 fpm.

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- c. Temperature Range: -10 degrees F to 160 degrees F.
- G. Stainless Steel Ducts: ASTM A 666, Type 304.
- H. All Ducts: Galvanized steel, unless otherwise indicated.
- Low Pressure Supply (Heating Systems): 1 inch w.g. pressure class, galvanized steel.
- J. Low Pressure Supply (System with Cooling Coils): 1 inch w.g. pressure class, galvanized steel.
- K. Medium and High Pressure Supply (All VAV Primary Supply Duct between AHU and VAV Terminal Unit): 2 inch w.g. pressure class, galvanized steel.
- L. Return and Relief: 1 inch w.g. pressure class, galvanized steel.
- M. General Exhaust: 1 inch w.g. pressure class, galvanized steel.
- N. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 250 g/L, excluding water.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide turning vanes.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.
- F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Double Wall Insulated Round Ducts: Round spiral lockseam duct with paintable galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall. Provide paint in color selected by architect.
 - 1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
 - 2. Insulation:
 - a. Thickness: 2 inch, Minimum R-8.
 - b. Material: Fiberglass, with mylar coating between insulation and perforated liner.
- C. Double Wall Insulated Rectangular Ducts: Rectangular spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall. Provide paint in color selected by architect

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- 1. Manufacture in accordance with SMACNA (DCS).
- 2. Insulation:
 - a. Thickness: 2 inch, minimum R-8.
 - b. Material: Fiberglass
- D. Flexible Ducts: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film. Insulation R-value to match duct system R-value.
 - 2. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 20 degrees F to 210 degrees F.
- E. Transverse Duct Connection System: SMACNA "J" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
 - 1. Manufacturers:

2.05 CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- D. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 - 1. Provide clear wire glass observation ports, minimum 6 X 6 inch size.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide flexible duct connectors at all motorized equipment.
- B. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
- C. Install in accordance with manufacturer's instructions.
- D. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

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- J. Use double nuts and lock washers on threaded rod supports.
- K. Tape joints of PVC coated metal ductwork with PVC tape.
- L. Connect terminal units to supply ducts with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- M. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- N. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- O. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- P. Use stainless steel for ductwork exposed to view and stainless steel or carbon steel for ducts where concealed.
- Q. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- R. At exterior wall louvers, seal duct to louver frame and install blank-out panels as required.

3.02 CLEANING AND TESTING

 Conduct required duct-leakage testing for all ductwork as defined within this specification and otherwise noted in the contract documents.

3.03 SCHEDULES

- A. Ductwork Material:
 - 1. Low Pressure Supply (Heating Systems): Steel, Aluminum.
 - 2. Low Pressure Supply (System with Cooling Coils): Steel, Aluminum.
 - 3. Medium and High Pressure Supply: Steel.
 - 4. Return and Relief: Steel, Aluminum.
 - 5. General Exhaust: Steel, Aluminum.
 - 6. Outside Air Intake: Steel.
 - 7. Exposed round ductwork: Double-walled spiral.
- B. Ductwork Pressure Class:
 - 1. Supply (Heating Systems): 1 inch
 - 2. Supply (System with Cooling Coils): 2 inch.
 - 3. Return and Relief: 1 inch.
 - 4. General Exhaust: 1 inch.
 - 5. Outside Air Intake: 2 inch.

END OF SECTION 23 31 00

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SECTION 23 33 00 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers metal.
- C. Backdraft dampers.
- D. Combination fire and smoke dampers.
- E. Duct access doors.
- F. Duct test holes.
- G. Fire dampers.
- H. Flexible duct connections.
- I. Smoke dampers.
- J. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment.
- C. Section 23 31 00 HVAC Ducts and Casings.
- D. Section 26 27 17 Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. NFPA 92 Standard for Smoke Control Systems.
- C. NFPA 92A Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences.
- D. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible.
- E. UL 33 Safety Heat Responsive Links for Fire-Protection Service.
- F. UL 555 Standard for Fire Dampers.
- G. UL 555S Standard for Smoke Dampers.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.

1.05 PROJECT RECORD DOCUMENTS

A. Record actual locations of access doors and test holes.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.

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B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

1.08 EXTRA MATERIALS

- A. See Section 01 6000 Product Requirements, for additional provisions.
- B. Provide two of each size and type of fusible link.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Manufacturers:
 - 1. Krueger: www.krueger-hvac.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. Titus: www.titus-hvac.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

2.03 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - 4. Krueger: www.krueger-hvac.com.
 - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

2.04 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated, 18 gage, galvanized steel frame.
 - 1. Blades: Neoprene coated fabric material.
 - 2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 - 3. Maximum Velocity: 1000 fpm (5 m/sec) face velocity.
- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: galvanized steel or extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.05 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries Inc: www.nailor.com/#sle.
 - 3. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
 - 4. Pottorff; ____: www.pottorff.com/#sle.
 - 5. Ruskin Company: www.ruskin.com/#sle.
 - 6. Substitutions: See Section 01 60 00 Product Requirements.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel

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AIR DUCT ACCESSORIES

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- jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labelled spring return electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.06 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Nailor Industries Inc: www.nailor.com/#sle.
 - 2. Ruskin Company: www.ruskin.com/#sle.
 - 3. SEMCO Incorporated: www.semcoinc.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 - 4. Larger Sizes: Provide an additional hinge.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.07 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.08 FIRE DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries Inc: www.nailor.com/#sle.
 - 3. NCA, a brand of Metal Industries Inc; ____: www.ncamfg.com/#sle.
 - 4. Pottorff; : www.pottorff.com/#sle.
 - 5. Ruskin Company: www.ruskin.com/#sle.
 - 6. Substitutions: See Section 01 60 00 Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Ceiling Dampers: Galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125 inch ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
- D. Horizontal Dampers: Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations or closure under air flow conditions. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

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- F. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- G. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.09 FLEXIBLE DUCT CONNECTIONS

- Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 6 inches wide.
 - 2. Metal: 3 inches wide, 24 gage thick galvanized steel.
- C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

2.10 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 multiple blade type fire damper, normally closed automatically operated by 120V electric actuator.

2.11 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries Inc: www.nailor.com/#sle.
 - 3. NCA, a brand of Metal Industries Inc; _____: www.ncamfg.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
 - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- C. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.
- E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

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PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Provide access doors at any location where dampers are concealed above inaccessible ceilings.
- C. Provide flexible duct connectors at expansion joints and at all connections to motorized equipment.
- Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- E. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- F. Provide duct test holes where indicated and required for testing and balancing purposes.
- G. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- H. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
 - 1. Smoke dampers shall be integrated into the "smoke purge control system". Dampers in the return ductwork shall be overridden to the open position when the smoke purge is activated.
- I. Demonstrate re-setting of fire dampers to Owner's representative.
- J. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- K. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment; see Section 22 05 48.
- L. For fans developing static pressures of 5.0 inches and over, cover flexible connections with leaded vinyl sheet, held in place with metal straps.
- M. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- N. Use splitter dampers only where indicated.
- O. Provide balancing dampers on high velocity systems where indicated. Refer to Section 23 36 00 Air Terminal Units.
- P. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 33 00

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SECTION 23 34 23 HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inline centrifugal fans.

1.02 REFERENCE STANDARDS

- A. AMCA 99 Standards Handbook.
- B. AMCA 204 Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- D. AMCA (DIR) [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc..
- E. AMCA 300 Reverberation Room Methods of Sound Testing of Fans.
- F. AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- G. NEMA MG 1 Motors and Generators.
- H. NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- I. UL 705 Power Ventilators.

1.03 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 5 years of documented experience.
- B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 FIELD CONDITIONS

A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

1.06 EXTRA MATERIALS

- A. See Section 01 6000 Product Requirements, for additional provisions.
- B. Supply two sets of belts for each fan.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck: www.greenheck.com/#sle.
- B. Loren Cook Company: www.lorencook.com/#sle.

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- C. PennBarry: www.pennbarry.com/#sle.
- D. American Coolair/ILG: www.coolair.com
- E. Substitutions: See Section 01 60 00 Product Requirements.

2.02 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 INLINE CENTRIFUGAL FANS

- A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, motorized backdraft damper with junction box and wire whip to energize damper upon activation of fan.
- Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof or wall exhausters with aluminum lag screws to roof curb or structure.
- C. Extend ducts to roof or wall exhausters into roof curb or structure. Counterflash duct to roof or wall opening.
- D. Hung Cabinet Fans:
 - Install fans with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.
 - 2. Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Install backdraft dampers on inlet to roof and wall exhausters.
- F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION 23 34 23

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SECTION 23 37 00 AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers.
 - 1. Perforated ceiling diffusers.
- B. Rectangular ceiling diffusers.
- C. Slot ceiling diffusers.
- D. Registers/grilles.
 - 1. Ceiling-mounted, exhaust and return register/grilles.
 - 2. Ceiling-mounted, supply register/grilles.
 - 3. Wall-mounted, supply register/grilles.
 - 4. Wall-mounted, exhaust and return register/grilles.
- E. Fabric air distribution devices.
- F. Door grilles.
- G. Louvers.
- H. Goosenecks.
- Gravity ventilators.

1.02 RELATED REQUIREMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 09 90 00 Painting and Coating: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

- A. AMCA 500-L Laboratory Methods of Testing Louvers for Rating.
- B. ARI 890 Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute.
- C. ASHRAE Std 70 Method of Testing the Performance of Air Outlets and Air Inlets.
- D. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- E. ASTM B221M Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- F. SMACNA (ASMM) Architectural Sheet Metal Manual.
- G. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Samples: Submit one of each required air outlet and inlet type.
- D. Project Record Documents: Record actual locations of air outlets and inlets.
- E. Fabric Duct Dispersion System
 - 1. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.
 - 2. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for both NFPA 90-A and UL 2518.

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- 3. Provide detailed drawings confirming configuration of Textile Dispersion System (diameter, lengths, airflow, pressure, and textile permeability).
- 4. Provide detailed installation instructions for components to be installed.
- 5. Provide warranty and maintenance documentation.

1.05 WARRANTY

A. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.06 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum [five] years of documented experience.
- D. Fabric Duct Dispersion System
 - Building Codes and Standards:
 - a. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518. Also Classified by UL-C (Canada) S102.2, BS 5867 Part 2, 1980; GB8624-2006.
 - b. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
 - 2. Design & Quality Control
 - a. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Protect textile air dispersion system and SkeleCore Pull-Tight components from damage during shipping, storage, and handling.
- B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping

1.08 MOCK-UP

- A. Provide mock-up of typical interior and exterior ceiling module with supply and return air outlets.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carnes Company HVAC: www.carnes.com.
- B. Krueger: www.krueger-hvac.com/#sle.
- C. Price Industries: www.price-hvac.com/#sle.
- D. Titus: www.titus-hvac.com/#sle.
- E. Tuttle and Bailey: www.tuttleandbailey.com.
- F. Substitutions: See Section 01 60 00 Product Requirements.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Square, stamped, multi-core diffuser to discharge air in 360 degree, one way, two way, three way or four way pattern as shown on drawings and with sectorizing baffles where indicated.

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- B. Frame: Surface mount or inverted T-bar as indicated on drawings. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Aluminum with baked enamel off-white finish.
- D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 PERFORATED FACE CEILING DIFFUSERS

- A. Type: Perforated face with fully adjustable pattern and removable face.
- B. Frame: Surface mount or Inverted T-bar as indicated on drawings. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel backpan with aluminum frame and baked enamel off-white finish.
- D. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.04 CEILING SLOT DIFFUSERS

- A. Fabrication: Aluminum extrusions with factory clear lacquer finish.
- B. Color: To be selected by Architect from manufacturer's standard range.
- C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket, mitered end border.
- D. Plenum: Integral, galvanized steel, insulated.

2.05 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- B. Frame: 1 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum extrusions with factory off-white enamel or prime coat finish as indicated on drawings or selected by architect.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.06 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.
- B. Frame: 1 inch margin with countersunk screw mounting.
- C. Fabrication: Aluminum extrusions, with factory off-white enamel, baked enamel, or prime coated finish as indicated on drawings or selected by architect.
- Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.07 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, horizontal face, double deflection.
- B. Frame: 1 inch margin with countersunk screw mounting and gasket.
- C. Fabrication: Aluminum extrusions, with factory off-white enamel, baked enamel, prime coat or clear lacquer finish as indicated on drawings or selected by architect.
- D. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

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2.08 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, horizontal face.
- B. Frame: 1 inch margin with countersunk screw mounting.
- C. Fabrication: Aluminum extrusions, with factory off-white enamel, baked enamel, prime coated or clear lacquer finish as indicated on drawings or selected by architect.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- E. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

2.09 FABRIC AIR DISTRIBUTION DEVICES

- A. Manufacturers:
 - 1. FabricAir, Inc: www.fabricair.com/#sle.
 - 2. KE Fibertec.
 - 3. DuctSox Corporation: www.ductsox.com/#sle.
 - 4. Substitutions: To request a substitution for products not listed, providecomplete submittal package to engineer indicating any and all deviations between basis of design and proposed substitution. Substitution request must be completely submitted to engineer not less than 10 business days prior to bid opening for review.
- B. Basis of Design: Fabric Air: www.fabricair.com
- C. Textile
 - 1. Fabric Air Combi 70
 - a. Duct Shape: Round
 - b. Fabric: 100% Flame Retardant Polyester
 - c. Weight: 7.67 oz./yd² per ASTM D3776
 - d. Shrinkage: Max. 0.5% per EN ISO 5077
 - e. Color: As selected by Architect at time of submittal
 - f. Temperature Range: -40°F and +284°F
 - g. Base Permeability @ 0.5" WG: 2.28 CFM/SQFT per ASTM D737, Shall be verified by the Frazier Permeability Test
 - h. Fire Retardancy: Shall meet the requirements of NFPA 90-A, ICC AC167 and UL 2518
 - i. Warranty: 10 years

D. System Fabrication Requirements

- 1. The system is made with sewn in, but still removable, aluminum hoops. The rods support the shape of the fabric system by 180° (8"-48"), 120° (49"-60"), 90° (61"-68") and 60° (69"-80"). Hoops must be pre-installed from factory, no installation at site. Diameter of hoops and distance between as specified by manufacturer.
- 2. Elbows of 70° or more to have 2 hoops sewn in order to maintain shape.
- 3. Air dispersion shall be accomplished with linear arrays of laser cut orifices. Orifices shall be from 0.12" to 0.55" diameter. Due to exact throw requirements and NC requirements alternative flow models are not acceptable.
- 4. Number, spacing, and size of linear arrays of laser cut orifices shall be determined by the manufacturer.
- 5. Fabric system shall include connectors to attach to suspension system listed below.
- 6. Provide system in sections optimized for maintenance, connected by zippers. Zippers shall provide closure completely around the circumference to prevent leakage. Required number of zippers shall be specified by the manufacturer.
- 7. Each section to have a unique tag including information about manufacturers order number, position, diameter of section, length of section, maintenance instruction, code compliance and contact details for spare parts.

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E. Design Parameters

- Textile air diffusers shall be designed to 3" maximum, with 0.5" as the standard.
- Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
- 3. System overall design: diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
- Do not use textile diffusers in concealed locations. 4.
- Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

F. Hangers and Supports

- Type 8: One row H-rail/cable system located 2" above 12 o'clock of FabricAir system. Hardware to include H-rail joint, eye bolt, end cap H-rail, cable, tie down strap and H-rail as required. FabricAir system shall be attached to hardware using one single row of plastic sliders located 12 o'clock spaced 20 inches.
 - a. Hardware
 - Anodized Aluminum H-Rails With PVC coated Galvanized Steel suspension cable. Suspension cable clamps, H-rail suspension eyebolts, and all other factory supplied metal components shall be Galvanized Steel.
 - PVC Coated Galvanized Steel Tensioning and Suspension Cable Cable clamps, cable tensioners, and all other factory supplied metal components shall be Galvanized Steel.

2.10 LOUVERS

- A. Type: 4 inch or 6 inch deep as indicated on drawings with blades on 45 degree slope, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.
- B. Color: To be selected by Architect from manufacturer's standard range. Provide Kynar / Hylar 500 Finish.
- C. Fabrication: 12 gage, 0.1046 inch thick extruded aluminum, welded assembly, with factory prime coat finish.
- Fabrication: 12 gage thick extruded aluminum, welded assembly, with factory prime coat, baked enamel, anodized or fluoropolymer spray finish as indicated on drawings or selected by
- E. Mounting: Furnish with exterior angle flange, screw holes in jambs or masonry strap anchors for installation.

2.11 GOOSENECKS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards of minimum 18 gage stainless steel.
- Mount on minimum 12 inch high curb base where size exceeds 9 x 9 inch.

2.12 GRAVITY VENTILATORS

- A. Hood Relief Gravity Ventilator:
 - Manufacturers:
 - a. American Coolair Corporation; _____: www.coolair.com/#sle.
 b. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.
 c. Loren Cook Company; _____: www.lorencook.com/#sle.

 - c. Loren Cook Company; _____
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - Hood and Base:
 - a. Material: Aluminum.
 - b. Hood Construction: Precision formed, arched panels with interlocking seams.
 - c. Vertical End Panels: Fully locked into hood end panels.
 - d. Curb Cap: Pre-punched mounting holes for installation.

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- 3. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/2 inch Galvanized mesh.
 - c. Horizontally mounted across hood discharge area.
- 4. Hood Support: Galvanized steel construction and fastened so hood can be removed completely from base or hinged open.
- 5. Options/Accessories:
 - a. Roof Curbs:
 - 1) Flat Roofs:
 - (a) Welded curb with 45 degree cant and wood nailer.
 - Pitched Roofs: Welded, straight side curb with flashing flange and wood nailer.
 - 3) Material: Aluminum.
 - 4) Insulation Thickness: 1 inch.
 - b. Dampers:
 - 1) Type: Motorized.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulate opposite side of air distribution for all supply diffusers or registers (top-side or back-side).
- C. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- D. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- E. Install diffusers to ductwork with air tight connection.
- F. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- G. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.
- H. Fabric Duct Dispersion System
 - 1. Installation of Textile Air Dispersion System
 - a. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.
 - 2. Cleaning and Protection
 - a. Clean air handling unit and ductwork prior to the textile dispersion system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
 - b. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
 - c. If textile dispersion systems become soiled during installation, they should be removed and cleaned following the manufacturers cleaning instructions.

3.02 AIR OUTLET AND INLET SCHEDULE

A. See Drawings

END OF SECTION 23 37 00

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SECTION 23 73 13

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Casing construction.
- B. Fan section.
- C. Coil section.
- D. Filter and air cleaner section.
- E. Damper section.
- F. Airflow measurement.
- G. Controls.

1.02 REFERENCE STANDARDS

- A. ABMA STD 11 Load Ratings and Fatigue Life for Roller Bearings.
- B. AHRI 410 Forced-Circulation Air-Cooling and Air-Heating Coils.
- C. AMCA (DIR) (Directory of) Products Licensed Under AMCA International Certified Ratings Program.
- D. AMCA 99 Standards Handbook.
- E. AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- F. AMCA 300 Reverberation Room Methods of Sound Testing of Fans.
- G. AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- H. AMCA 500-D Laboratory Methods of Testing Dampers for Rating.
- AMCA 611 Certified Ratings Program Product Rating Manual for Airflow Measurement Stations.
- J. ARI 430
- K. ASHRAE Std 52.2 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- L. ASHRAE Std 62.1 Ventilation for Acceptable Indoor Air Quality.
- M. ASHRAE Std 90.1 I-P Energy Standard for Buildings Except Low-Rise Residential Buildings.
- N. ASHRAE Std 135 A Data Communication Protocol for Building Automation and Control Networks.
- O. ASTM B177/B177M Standard Guide for Engineering Chromium Electroplating.
- P. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.
- Q. SMACNA (DCS) HVAC Duct Construction Standards Metal and Flexible.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of units with size, location and installation of service utilities.
- B. Coordinate the work with other trades for installation of roof mounted air handling units on roof curbs.
- C. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- D. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

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1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data

Various Recreation Centers

- 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
- 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
- 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
- 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
- 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- D. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- E. Specimen Warranty: Submit sample of manufacturer's warranty.
- F. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- G. Manufacturer's Instructions: Include installation instructions.
- H. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: Two sets for each unit.
 - 3. Extra Filters: Two sets for each unit.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Construct to AMCA 99 and ARI 430 standards.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.07 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Provide minimum two year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Air Enterprises Inc.
- B. Buffalo Air Handling
- C. Engineered Aire

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- D. Environmental Air Systems
- E. Governair Corporation
- F. Haakon Industries
- G. Ingenia Technologies
- H. Temtrol
- I. Daikin Applied: www.daikinapplied.com/#sle.
- J. JCI/York: www.johnsoncontrols.com/hvac-equipment

2.02 CASING CONSTRUCTION

- A. Full Perimeter Base Rail:
 - 1. Construct of galvanized steel.
 - 2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.

B. Casing:

- Construct of one piece, insulated, double wall panels.
- 2. Provide mid-span, no through metal, internal thermal break.
- 3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
- 4. Casing Air Pressure Performance Requirements:
 - a. Able to withstand up to 6 inches w.g. positive or negative static pressure.
 - b. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 6 inches w.g. in positive pressure sections and minus 6 inches w.g. in negative pressure sections.

C. Access Doors:

- Construction, thermal and air pressure performance same as casing.
- 2. Provide surface mounted handles on hinged, swing doors.
- D. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities (minimum 300 lb load).
- E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- F. Insulation:
 - 1. Provide min. 2 inches closed cell foam insulation
 - 2. Comply with NFPA 90A.
- G. Drain Pan Construction:
 - 1. Provide cooling coil sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.
 - 2. Slope in three planes to promote positive drainage and eliminate stagnate water conditions.
 - 3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
 - 4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.

H. Finish:

- 1. Indoor Units:
 - a. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
 - b. Color: Manufacturer's standard color.

2.03 FAN SECTION

A. Type: Air foil, single width, single inlet, centrifugal plug type fan, in compliance with AMCA 99.

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- B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
- Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- E. Mounting:
 - 1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
 - 2. Factory mount motor on slide rails.
 - 3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
 - 4. Mount base on vibration isolators.
- F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted starter-disconnect, variable frequency drive, and external motor junction box.
- H. Fan Accessories:
- I. Flexible Duct Connections:
 - For separating fan, coil, and adjacent sections.
- J. Drives:
 - 1. Comply with AMCA 99.
 - 2. Bearings: Heavy duty pillow block type, roller bearings with ABMA STD 11, L-50 life at 400,000 hours.
 - 3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
 - 4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
 - 5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.04 COIL SECTION

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C. Eliminators: Three break of Type 304 stainless steel, mounted over drain pan.
- D. Air Coils:
 - 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- E. Fabrication:
 - 1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum.
 - 3. Casing: Die formed channel frame of galvanized steel.
- F. Refrigerant Coils:

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- 1. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- 2. Headers: Seamless copper tubes with silver brazed joints.
- 3. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
- 4. Configuration: Down feed with bottom suction.

2.05 FILTER AND AIR CLEANER SECTION

- A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B. Throwaway Filters:
 - 1. Media: 2 inch fiberglass with rigid supporting mesh across the leaving face, capable of operating up to a maximum of 500 fpm without loss of efficiency and holding capacity.
 - 2. Frame: Rigid.
 - 3. Minimum Efficiency Reporting Value: MERV 11 when tested in accordance with ASHRAE Std 52.2.
- C. Differential Pressure Gauge:
 - 1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
 - 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.06 DAMPER SECTION

- A. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor and return air.
- B. Damper Blades:
 - Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
 - Self-lubricating nylon sleeve bearings.
 - 3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 - Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
 - 5. Arrange in parallel or opposed-blade configuration.

2.07 AIRFLOW MEASUREMENT

- A. Airflow Measurement Station:
 - Provide factory installed, airflow measurement station tested in accordance with AMCA 611 and bearing the AMCA Ratings Seal for Airflow Measurement Performance.
 - 2. Station Location: Install in outdoor and return opening(s) to measure airflow.
 - Damper Blades:
 - a. Galvanized steel or extruded aluminum construction.
 - b. Housed in galvanized steel or extruded aluminum frame and mechanically fastened to a rotating axle rod.
 - c. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 - 4. Measurement Range: Minimum of 15 percent to 100 percent of unit nominal flow.
 - 5. Operation: Provide low voltage signal corresponding to actual airflow for controlling and documenting airflow.
 - 6. Accuracy: Plus/minus 5 percent.

2.08 CONTROLS

- Control transformer with terminal strip.
- B. VRF heat pump control interface.
- C. Combination Starter-Disconnects:
 - 1. Provide combination starter-disconnect for each fan motor.

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- 2. Factory mount in full metal enclosure and wire to fan motor.
- D. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135, BACnet MS/TP.
- E. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- D. Provide fixed sheaves required for final air balance.
- E. Make connections to coils with unions or flanges.
- F. Refrigerant Coils: Provide sight glass in liquid line within 12 inches of coil.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Final Acceptance Requirements:
 - 1. Use dial indicator gauges to demonstrate fan and motor are aligned.
 - 2. Verify compliance with specifications using vibration analysis.
 - 3. Maximum Vibration Levels:
 - a. 0.075 inch per second at 1 times run speed and at fan/blade frequency.
 - b. 0.04 inch per second at other multiples of run speed.

3.03 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform systems startup.
- B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- C. Adjust for proper operation within manufacturer's published tolerances.

3.04 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- C. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.

END OF SECTION 23 73 13

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SECTION 23 74 13

PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged roof top unit.
- B. Unit controls.
- C. Remote panel.
- D. Mounting curb and base.
- E. Maintenance service.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. AHRI 270 Sound Performance Rating of Outdoor Unitary Equipment.
- ASHRAE Std 135 A Data Communication Protocol for Building Automation and Control Networks.
- D. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.03 SUBMITTALS

- A. See Section 01 33 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

1.06 WARRANTY

A. Provide a five year warranty to include coverage for refrigeration compressors and heat exchangers.

1.07 MAINTENANCE SERVICE

 Furnish service and maintenance of packaged roof top units for one year from Date of Substantial Completion.

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- B. Provide maintenance service with a two month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- D. Submit copy of service call work order or report, and include description of work performed.

1.08 EXTRA MATERIALS

A. Provide two sets of filters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Valent Incorporated
- B. York / JCI
- C. Trane Horizon
- D. Innovent Corporation
- E. Daikin

2.02 AIR CONDITIONING UNITS

- General: Roof or ground mounted packaged units having electric heating elements as scheduled and electric refrigeration.
- B. Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, electric heating elements, , energy recovery wheel, factory-mounted controls, air filters, hot water heating coil, refrigerant cooling coil and variable-speed compressors and hot-gas reheat circuits, condenser coil and condenser fan as scheduled.
- C. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 27 17.

2.03 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, including access doors with piano hinges and locking handle. Structural members shall be minimum 18 gage, with access doors or panels of minimum 20 gage.
- B. Insulation: two inch thick minimum glass fiber or injected foam, double-walled unit construction.
- C. Supply and Exhaust as scheduled: Backward inclined or airfoil type, resiliently mounted with rubber isolated hinge mounted high efficiency direct drive motor. Isolate complete fan assembly. Provide factory-mounted variable-frequency drives for all fan motors.
- D. Air Filters: Minimum efficiency reporting value (MERV) of at least 11.
- E. Vibration Isolation Curb: Provide min. 48" tall custom side-discharge vibration isolation plenum curb.

2.04 ELECTRIC HEATING COIL

- A. Finned tube heating elements or Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, >>airflow proving device,>> load fuses.
- B. Controls: Start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.

2.05 EVAPORATOR OR INDOOR COILS

A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection for cooling coils.

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B. Provide thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.06 COMPRESSOR

- A. Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gage ports, and filter drier.
- B. Five minute timed off circuit to delay compressor start.
- C. Outdoor thermostat to energize compressor above 35 degrees F ambient.
- D. Provide step capacity control by variable-speed scroll technology and/or adjusting variable-speed compressors.
- E. Provide modulating hot-gas reheat coil for humidity control.

2.07 CONDENSER OR OUTDOOR COIL

- A. Provide copper tube aluminum or copper fin coil assembly with subcooling rows and coil guard.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C. Provide refrigerant pressure switches to cycle condenser fans.

2.08 MIXED AIR CASING

- A. Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position.
- B. Gaskets: Provide tight fitting dampers with edge gaskets.
- C. Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.
- D. Outdoor airflow monitoring station: Provided at intake of the unit.
- E. Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 70 degrees (F) ambient, or when ambient air enthalpy exceeds return air enthalpy.

2.09 OPERATING CONTROLS

- A. Provide factory controller and all necessary sensors and components for operation of refrigerant system, fan VFDs based on static-pressure feedback, energy recovery wheel, humidity control function, and economizer function. The humidity control (dehumidification sequence) shall be capable of being enabled when the unit is in both heating and cooling modes. The humidistat setpoint shall govern control of this sequence.
- B. Provide BACnet interface on unit for connection of operating controls for BAS control. Control shall allow for modulating heating via the heat pump and supplemental electric resistance heat and modulating cooling, fan, and damper control. See section 23 09 93 for required data to be relayed to the BAS for monitoring and control.
- C. Provide remote mounted fan control switch for smoke-purge for each unit (on-auto) to activate only the exhaust fan at each unit, keep the outdoor air damper closed, and de-engerize the energy wheel.
- D. See Specification Section 230993 Sequence Of Operations, for additional required operating capabilities of the units.
- E. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135, BACnet MS/TP.

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2.10 ENERGY RECOVERY

- A. The energy recovery module shall be provided as shown on the drawing and shall have a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seats and bearings.
- B. The energy recovery cassette shall be rated in accordance with ARI Standard 1060 and shall bear the ARI certification symbol.
- C. The energy recovery cassette shall contain a total energy heat wheel constructed of a light weight polymer material with permanently bonded desiccant coating. The energy recovery wheel media shall be capable of removal from the cassette and be cleanable using hot water or light detergent without degrading the latent efficiency.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.or illustrated by the manufacturer.
- B. Verify that proper power supply is available.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 90A.
- C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.
- D. Locate remote panels where identified in field coordination meeting.
- E. Tie unit into BAS as specified.
- F. Pipe condensate to nearest roof drain.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

- A. Provide service and maintenance of packaged roof top units for one year year from Date of Substantial Completion.
- B. Provide routine maintenance service with a three month interval as maximum time period between calls.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- D. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 23 74 13

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SECTION 23 81 01 TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electric heaters.

1.02 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.,
- D. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- E. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- F. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturers warranty for all motors.
- C. Provide two year parts and labor warranty for enitre unit, from substitute and completion.

PART 2 PRODUCTS

2.01 ELECTRIC RADIANT CEILING PANELS

- A. Manufacturers:
 - 1. QMark.
 - 2. Marley.
 - 3. Trane.
 - 4. Berko.
 - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Assembly: UL listed and labelled assembly with terminal box and cover, and built-in controls. See sequence of operations for additional ATC requirements.
- C. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material or exposed helical coil of pickel chrome resistance wire refractory ceramic support bushings.
- D. Cabinet: 0.0478 inch steel with easily removed front panel with integral air outlet and inlet grilles.

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E. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

2.02 ELECTRIC UNIT HEATERS

- A. Manufacturers:
 - QMark.
 - 2. Marley.
 - 3. Trane.
 - 4. Berko.
 - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Assembly: UL listed and labelled assembly with terminal box and cover, and built-in controls. See sequence of operations for additional ATC requirements.
- C. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material or exposed helical coil of pickel chrome resistance wire refractory ceramic support bushings.
- D. Cabinet: 0.0478 inch steel with easily removed front panel with integral air outlet and inlet grilles.
- E. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.
- G. Motor: Permanently lubricated, sleeve bearings for horizontal models, ball bearings for vertical models.
- H. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Provide thermal overload.

I.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.
- D. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- E. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 26 27 17.

3.02 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 23 81 01

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SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/condensing unit(s).

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. ITS (DIR) Directory of Listed Products.
- C. NFPA 70 National Electrical Code.
- D. UL 1995 Heating and Cooling Equipment.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
- B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.05 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Daikin; ____: www.daikinac.com/#sle.
- B. Mitsubishi Electric Trane HVAC US, LLC; _____: www.metahvac.com/#sle.
- C. Samsung: www.samsunghvac.com
- D. Basis of Design: The system design indicated in Contract Documents is based on equipment and system designed by LG Electronics U.S.A., Inc.

2.02 HVAC SYSTEM DESIGN

- A. System Operation: Heating or cooling, selected at system level.
 - Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
 - 2. Conditioned spaces are indicated on drawings.
 - 3. Required equipment unit capacities are indicated on drawings.
 - 4. Refrigerant piping sizes are not indicated on drawings.
 - 5. Connect equipment to condensate piping provided by others; condensate piping is indicated on drawings.
- B. Cooling Mode Interior Performance:
 - 1. Daytime Setpoint: 72 degrees F, plus or minus 1.5 degrees F.
 - 2. Night Setback: 72 degrees F.
 - 3. Interior Relative Humidity: 40 percent, maximum.
- C. Heating Mode Interior Performance:
- D. Outside Air Design Conditions:
- E. Energy Design Wind Speed: 25 mph.

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- F. Operating Temperature Ranges:
 - 1. Cooling Mode Operating Range: 23 degrees F to 110 degrees F dry bulb.
- G. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:
 - 1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 540 feet, actual; 620 feet, equivalent.
 - 2. Total Combined Liquid Line Length: 3280 feet, minimum.
 - 3. Minimum Piping Length Between Indoor Units: 49 feet.
- H. Control Wiring Lengths:
 - 1. Between Outdoor/Condenser Unit and Indoor/Evaporator Unit: 6,665 feet, minimum.
 - 2. Between Outdoor/Condenser Unit and Central Controller: 3,330 feet, minimum.
 - 3. Between Indoor/Evaporator Unit and Remote Controller: 1,665 feet.
- . Controls: Provide the following control interfaces:

2.03 EQUIPMENT

- A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
 - 1. Refrigerant: R-410A.
 - 2. Performance Certification: AHRI Certified; www.ahrinet.org.
 - 3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
 - 4. Provide units capable of serving the zones indicated.
 - 5. Thermal Performance: Provide heating and cooling capacity as indicated, based on the following nominal operating conditions:
 - 6. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.
- B. Electrical Characteristics:
 - 1. Power Condensing Units: 460 Volts, 3-phase, 60 Hz.
 - 2. Control: 18 volts DC.
- C. Refrigerant Piping:
 - Insulate each refrigerant line individually between the condensing and indoor units.

2.04 OUTDOOR/CONDENSING UNITS

- A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.
 - 1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
 - 2. Refrigerant: Factory charged.
 - 3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 - 4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 - 5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
 - 6. Sound Pressure Level: As specified, measured at 3 feet from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
 - Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.

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- 8. Provide refrigerant auto-charging feature and refrigerant charge check function.
- 9. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, 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.
- 10. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
- 11. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
- 12. Controls: Provide contacts for electrical demand shedding.
- B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
 - 1. Designed to allow side-by-side installation with minimum spacing.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
 - 1. Provide minimum of 2 fans for each condensing unit.
 - 2. External Static Pressure: Factory set at 0.12 in WG, minimum.
 - 3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG, minimum; provide for mounting of field-installed ducts.
 - 4. Fan Airflow: As indicated for specific equipment.
 - 5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.
- D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
 - Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
 - 2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
 - 3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - 4. Provide oil separators and intelligent oil management system.
 - 5. Provide spring mounted vibration isolators.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.02 SYSTEM STARTUP

- A. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- B. Adjust equipment for proper operation within manufacturer's published tolerances.

END OF SECTION 23 81 29

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VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

ARPA RECREATION CENTER HVAC IMPROVEMENTS RFP
ATTACHMENT A: Bid Documents

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SECTION 26 05 01 MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 RELATED REQUIREMENTS

A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
 - 3. Make notifications at least 24 hours in advance.
 - 4. Make temporary connections to maintain service in areas adjacent to work area.
- F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner at least 24 hours before partially or completely disabling system.
 - 2. Notify telephone utility company at least 24 hours before partially or completely disabling system.

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3. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

3.04 CLEANING AND REPAIR

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

END OF SECTION 26 05 01

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Service entrance cable.
- D. Armored cable.
- E. Metal-clad cable.
- F. Wiring connectors.
- G. Electrical tape.
- H. Heat shrink tubing.
- I. Oxide inhibiting compound.
- J. Wire pulling lubricant.
- K. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 Firestopping.
- B. Section 26 05 01 Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 26 Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- E. Section 28 46 00 Fire Detection and Alarm: Fire alarm system conductors and cables.
- F. Section 31 23 16 Excavation.
- G. Section 31 23 16.13 Trenching: Excavating, bedding, and backfilling.
- H. Section 31 23 23 Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM B3 Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
- D. ASTM B787/B787M Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM D3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- F. ASTM D4388 Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
- G. NECA 1 Standard for Good Workmanship in Electrical Construction.
- H. NECA 120 Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable.
- I. NECA 121 Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF).

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- J. NEMA WC 70 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- K. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- L. NFPA 70 National Electrical Code.
- M. UL 4 Armored Cable.
- N. UL 44 Thermoset-Insulated Wires and Cables.
- O. UL 83 Thermoplastic-Insulated Wires and Cables.
- P. UL 486A-486B Wire Connectors.
- Q. UL 486C Splicing Wire Connectors.
- R. UL 486D Sealed Wire Connector Systems.
- S. UL 493 Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
- T. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
- U. UL 854 Service-Entrance Cables.
- V. UL 1569 Metal-Clad Cables.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
- D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

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D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
 - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 2. In addition to other applicable restrictions, may not be used:
 - a. Unless approved by Owner.
 - b. Where not approved for use by the authority having jurisdiction.
 - c. Where exposed to view.
 - d. Where exposed to damage.
 - e. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- H. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- I. Conductor Material:
 - Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
 - 2. Tinned Copper Conductors: Comply with ASTM B33.

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- J. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Isolated Ground, All Systems: Green with yellow stripe.
 - e. Travelers for 3-Way and 4-Way Switching: Pink.
 - f. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Southwire Company: www.southwire.com/#sle.
 - c. Houston Wire & Cable co.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

A. Manufacturers:

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- 1. Cerro Wire LLC: www.cerrowire.com/#sle.
- 2. Southwire Company: www.southwire.com/#sle.
- 3. Houston Wire & Cable co..
- 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.
- C. Provide equipment grounding conductor unless otherwise indicated.
- D. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- E. Insulation Voltage Rating: 600 V.

2.05 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Copper Service Entrance Cable:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. Service Wire Co: www.servicewire.com/#sle.
 - d. Southwire Company: www.southwire.com/#sle.
 - e. Substitutions: See Section 01 60 00 Product Requirements.
- B. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2, and with UL 44, Type RHH/RHW-2.
- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 600 V.

2.06 ARMORED CABLE

- A. Manufacturers:
 - AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Southwire Company: www.southwire.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN.
- F. Grounding: Combination of interlocking armor and integral bonding wire.
 - 1. Provide additional full-size integral insulated equipment grounding conductor for redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities.
- G. Armor: Steel, interlocked tape.

2.07 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Southwire Company: www.southwire.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.

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- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
- G. Grounding: Full-size integral equipment grounding conductor.
 - 1. Provide additional isolated/insulated grounding conductor where indicated or required.
- H. Armor: Steel, interlocked tape.
- I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.08 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Sizes 10 and under: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Sizes 8 and larger: Use mechanical connectors.
- D. Wiring Connectors for Terminations:
 - Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.

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- I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 - 1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. Ilsco: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.

2.09 WIRING ACCESSORIES

- A. Electrical Tape:
 - Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
 - c. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 - a. Product: 3 M.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
 - Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 - a. Product: 3 M.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
 - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 - 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 - 6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 - 7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Burndy: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 - 1. Manufacturers:
 - a. Burndy: www.burndy.com.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. Ilsco: www.ilsco.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.

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- b. American Polywater Corporation: www.polywater.com/#sle.
- c. Ideal Industries, Inc: www.idealindustries.com/#sle.
- d. Substitutions: See Section 01 60 00 Product Requirements.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location shown.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.
- E. Install armored cable (Type AC) in accordance with NECA 120.
- F. Install metal-clad cable (Type MC) in accordance with NECA 120.
- G. Installation in Raceway:
 - Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- H. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- I. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- J. Terminate cables using suitable fittings.
 - 1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.

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- b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- K. Install conductors with a minimum of 12 inches of slack at each outlet.
- L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- O. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- Q. Insulate ends of spare conductors using vinyl insulating electrical tape.
- R. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- S. Identify conductors and cables in accordance with Section 26 05 53.
- T. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

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3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 26 05 19

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground access wells.
- G. Grounding and bonding components.
- H. Provide all components necessary to complete the grounding system(s) consisting of:
 - 1. Existing metal underground water pipe.
 - 2. Metal frame of the building.
 - Existing metal underground gas piping system.
 - 4. Metal underground gas piping system.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 56 00 Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction.
- C. NEMA GR 1 Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- D. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- E. NETA STD ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association.
- F. NFPA 70 National Electrical Code.
- G. UL 467 Grounding and Bonding Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance: 25 ohms.

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Various Recreation Centers

1.06 SUBMITTALS

- See Section 01 30 00 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Shop Drawings:
- D. Product Data: Provide for grounding electrodes and connections.
- E. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Project Record Documents: Record actual locations of grounding electrode system components and connections.
- H. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

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F. Grounding Electrode System:

- 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
- 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
- 3. Metal Building or Structure Frame:
 - a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
- 4. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground access well for each electrode.
- 5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

G. Service-Supplied System Grounding:

- 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
- For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Bonding and Equipment Grounding:

- Provide bonding for equipment grounding conductors, equipment ground busses, metallic
 equipment enclosures, metallic raceways and boxes, device grounding terminals, and
 other normally non-current-carrying conductive materials enclosing electrical
 conductors/equipment or likely to become energized as indicated and in accordance with
 NFPA 70.
- 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
- 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
- 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

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- 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
- 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
- 8. Provide bonding for interior metal air ducts.
- 9. Provide bonding for metal building frame where not used as a grounding electrode.
- I. Isolated Ground System:
 - 1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
 - 2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
 - 3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - a. Exceptions:
 - 1) Use mechanical connectors for connections to electrodes at ground access wells.
 - Unless otherwise indicated, use exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 - 4. Manufacturers Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Burndy: www.burndy.com.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 5. Manufacturers Exothermic Welded Connections:
 - a. Burndy: www.burndy.com.
 - b. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.
 - c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.

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D. Ground Bars:

- 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
- 2. Size: As indicated.
- 3. Holes for Connections: As indicated or as required for connections to be made.
- Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.
 - d. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 01 60 00 Product Requirements.

E. Ground Rod Electrodes:

- 1. Comply with NEMA GR 1.
- 2. Material: Copper-bonded (copper-clad) steel.
- 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
- Manufacturers:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. Galvan Industries, Inc: www.galvanelectrical.com/#sle.
 - d. Harger Lightning & Grounding: www.harger.com/#sle.
 - e. Substitutions: See Section 01 60 00 Product Requirements.

2.03 MANUFACTURERS

- A. Cooper Power Systems: www.cooperpower.com.
- B. Framatome Connectors International: www.fciconnect.com.
- C. Lightning Master Corporation: www.lightningmaster.com.
- D. Substitutions: See Section 01 60 00 Product Requirements.

2.04 CONNECTORS AND ACCESSORIES

- A. Mechanical Connectors: Bronze.
 - 1. Substitutions: See Section 01 60 00 Product Requirements.
- B. Wire: Stranded copper.
- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

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- 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.
- F. Provide bonding to meet requirements described in Quality Assurance.
- G. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Each of branch circuits and feeder circuits shall have dedicated equipment grounding conductor, sharing this conductor with other grounding conductors is not permitted.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 26 05 26

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 05 50 00 Metal Fabrications: Materials and requirements for fabricated metal supports.
- C. Section 26 05 34 Conduit: Additional support and attachment requirements for conduits.
- D. Section 26 05 37 Boxes: Additional support and attachment requirements for boxes.
- E. Section 26 51 00 Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 26 56 00 Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 Metal Framing Standards Publication.
- E. NECA 1 Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 National Electrical Code.
- G. UL 5B Strut-Type Channel Raceways and Fittings.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
- 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
- 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencina

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

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- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Installer's Qualifications: Include evidence of compliance with specified requirements.
- E. Product Data: Provide manufacturer's catalog data for fastening systems.
- F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.

- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. nVent; Caddy: www.nvent.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 3. Conduit Clamps: Bolted type unless otherwise indicated.
 - 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Substitutions: See Section 01 60 00 Product Requirements.
 - 5. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
 - e. Substitutions: See Section 01 60 00 Product Requirements.
- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - c. Erico International Corporation: www.erico.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
 - f. Substitutions: See Section 01 60 00 Product Requirements.
- E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Elgen Manufacturing Company, Inc; ____: www.elgenmfg.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Comply with MFMA-4.
 - 3. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 - Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 5. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 - 7. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

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- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.

G. Anchors and Fasteners:

- Manufacturers Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- 2. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
- 3. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
- 4. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- 5. Hollow Masonry: Use toggle bolts.
- 6. Hollow Stud Walls: Use toggle bolts.
- 7. Steel: Use beam clamps, machine bolts, or welded threaded studs.
- 8. Sheet Metal: Use sheet metal screws.
- 9. Powder-actuated fasteners are not permitted.
- 10. Hammer-driven anchors and fasteners are not permitted.
- 11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

2.02 MANUFACTURERS

- A. Thomas & Betts Corporation: www.tnb.com.
- B. Threaded Rod Company: www.threadedrod.com.
- C. Substitutions: See Section 01 60 00 Product Requirements.

2.03 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized.
- C. Anchors and Fasteners:
 - 1. Do not use powder-actuated anchors.
 - 2. Obtain permission from Architect before using powder-actuated anchors.
 - 3. Concrete Structural Elements: Use precast inserts.
 - 4. Steel Structural Elements: Use beam clamps.
 - 5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
 - 6. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use hollow wall fasteners.
 - 7. Solid Masonry Walls: Use expansion anchors.
 - 8. Sheet Metal: Use sheet metal screws.
 - 9. Wood Elements: Use wood screws.
- D. Formed Steel Channel:
 - 1. Product: manufactured by [B-Line.

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2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to study to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: Also comply with Section 26 05 34.
- I. Box Support and Attachment: Also comply with Section 26 05 37.
- J. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
- K. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.
- Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- M. Secure fasteners according to manufacturer's recommended torque settings.
- N. Remove temporary supports.
- O. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 05 29

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SECTION 26 05 34 CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Flexible metal conduit (FMC).
- C. Liquidtight flexible metal conduit (LFMC).
- D. Electrical metallic tubing (EMT).
- E. Rigid polyvinyl chloride (PVC) conduit.
- F. Conduit fittings.
- G. Accessories.
- H. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 84 00 Firestopping.
- C. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
- D. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 Hangers and Supports for Electrical Systems.
- F. Section 26 05 37 Boxes.
- G. Section 26 0553 Identification for Electrical Systems.
- H. Section 26 05 37 Boxes.
- Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- J. Section 31 23 16.13 Trenching: Excavating, bedding, and backfilling.
- K. Section 33 71 19 Electrical Underground Ducts and Manholes.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
- C. ANSI C80.5 American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
- D. NECA 1 Standard for Good Workmanship in Electrical Construction.
- E. NECA 101 Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- F. NECA 111 Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- G. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- H. NFPA 70 National Electrical Code.
- I. UL 1 Flexible Metal Conduit.
- J. UL 6 Electrical Rigid Metal Conduit-Steel.
- K. UL 360 Liquid-Tight Flexible Metal Conduit.
- L. UL 514B Conduit, Tubing, and Cable Fittings.

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- M. UL 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- N. UL 797 Electrical Metallic Tubing-Steel.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
- 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Shop Drawings:
 - Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
 - 2. Include proposed locations of roof penetrations and proposed methods for sealing.
- D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.
- E. Product Data: Provide for metallic conduit and flexible metal conduit.
- F. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING

- Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

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PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 - 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
- D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit.
- E. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- F. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.
- H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit.
- I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
 - 1. Locations subject to physical damage include, but are not limited to:
 - Where exposed below 8 feet, except within electrical and communication rooms or closets.
- J. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- K. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.
- L. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
 - 1. Maximum Length: 6 feet.
- M. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
 - c. HVAC equipment.
- N. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.

2.02 CONDUIT REQUIREMENTS

- Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

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- E. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
 - 3. Control Circuits: 1/2 inch (16 mm) trade size.
 - 4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
 - 5. Underground, Interior: 3/4 inch (21 mm) trade size.
 - 6. Underground, Exterior: 1 inch (27 mm) trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube Company: www.wheatland.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Non-Hazardous Locations: Use insulated fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedtube.com.
 - 2. Beck Manufacturing, Inc: www.beckmfg.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.05 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.

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- b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
- c. Thomas & Betts Corporation: www.tnb.com/#sle.
- d. Substitutions: See Section 01 60 00 Product Requirements.
- 2. Description: Fittings with insulated bushing complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
- 3. Material: Use steel or malleable iron.
- D. Description: Interlocked steel construction.
- E. Fittings: NEMA FB 1.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com.
 - 2. Electri-Flex Company: www.electriflex.com.
 - 3. International Metal Hose: www.metalhose.com.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Description: Fittings with insulated bushing complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - b. O-Z/Gedney, a brand of Emerson Industrial Automation: www.emersonindustrial.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Description: Fittings with insulated bushings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
 - 5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
 - 6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

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2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 - 3. JM Eagle: www.jmeagle.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

- Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
- E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- E. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - When conduit destination is indicated and routing is not shown, determine exact routing required.
 - 3. Conceal all conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - Within joists in areas with no ceiling.
 - 5. Arrange conduit to maintain adequate headroom, clearances, and access.

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- 6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
- 7. Arrange conduit to provide no more than 150 feet between pull points.
- 8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
- 9. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
- 10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
- 11. Group parallel conduits in the same area together on a common rack.

F. Conduit Support:

- Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
- 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
- 4. Use conduit strap to support single surface-mounted conduit.
 - Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
- 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
- 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
- 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
- 8. Use of spring steel conduit clips for support of conduits is not permitted.
- 9. Use of wire for support of conduits is not permitted.
 - a. For securing conduits to studs in hollow stud walls.
 - b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).

G. Connections and Terminations:

- 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
- 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
- 3. Use suitable adapters where required to transition from one type of conduit to another.
- 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
- 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
- 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
- 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:

- 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
- 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
- 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
- 4. Conceal bends for conduit risers emerging above ground.

- 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
- Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
- 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
- 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- I. Underground Installation:
 - 1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
 - 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
 - Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length.
- J. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.
- L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where conduits are subject to earth movement by settlement or frost.

M. Conduit Sealing:

- 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
- 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- N. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- O. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- P. Provide grounding and bonding in accordance with Section 26 05 26.
- Q. Identify conduits in accordance with Section 26 05 53.

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3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

3.06 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Section roofing section.

END OF SECTION 26 05 34

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SECTION 26 05 37 BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

- Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.
- D. Pull and junction boxes.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 Firestopping.
- B. Section 08 31 00 Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- D. Section 26 05 29 Hangers and Supports for Electrical Systems.
- E. Section 26 05 34 Conduit:
 - Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- F. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 27 26 Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- H. Section 26 2716 Electrical Cabinets and Enclosures.
- I. Section 26 2726 Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.

1.03 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 Standard for Installing and Maintaining Wiring Devices.
- NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NEMA OS 1 Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- E. NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- F. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. NFPA 70 National Electrical Code.
- H. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations.
- I. UL 50E Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 508A Industrial Control Panels.
- K. UL 514A Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

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- 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
- 4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
- 5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
- 6. Coordinate the work with other trades to preserve insulation integrity.
- 7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
- 8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Keys for Lockable Enclosures: Two of each different key.
- F. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 QUALITY ASSURANCE

- Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 - Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

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- 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 - 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 - 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 - 3. Use suitable concrete type boxes where flush-mounted in concrete.
 - 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 - 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 - 6. Use shallow boxes where required by the type of wall construction.
 - 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 - Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 - 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 - 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 - 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 - 12. Wall Plates: Comply with Section 26 27 26.
 - 13. Manufacturers:
 - a. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - b. O-Z/Gednev. a brand of Emerson Electric Co: www.emerson.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 - Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 - 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 - 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 - 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.

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2.02 MANUFACTURERS

- A. Appleton Electric: www.appletonelec.com.
- B. Steel City
- C. Substitutions: Reco, Inc. See Section 01 60 00 Product Requirements.

2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
 - Concrete Ceiling Boxes: Concrete type.
- B. Nonmetallic Outlet Boxes: NEMA OS 2.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.04 FLOOR BOXES

- A. Floor Boxes: NEMA OS 1, fully adjustable, 4 inches deep.
- B. Material: Cast metal.
- C. Shape: Rectangular.
- D. Service Fittings: As specified in Section 26 2726.

2.05 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 2716.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron; Cast Aluminum.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 - 1. Material: Galvanized cast iron; Cast Aluminum.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
 - 3. Cover Legend: "ELECTRIC".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.

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- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.

H. Box Locations:

- 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
- 2. Locate boxes as required for devices installed under other sections or by others.
- 3. Locate boxes so that wall plates do not span different building finishes.

4.

- 5. Locate boxes so that wall plates do not cross masonry joints.
- 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
- 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
- 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
- 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
- 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 34.

I. Box Supports:

- Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
- Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

- 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
- 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
- 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- O. Close unused box openings.

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- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 26 05 26.
- R. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- S. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- T. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
- Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- V. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
 - 1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- W. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- X. Maintain headroom and present neat mechanical appearance.
- Y. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- Z. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- AA. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- AB. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- AC. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- AD. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- AE. Use flush mounting outlet box in finished areas.
- AF. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- AG. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- AH. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- Al. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- AJ. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- AK. Use adjustable steel channel fasteners for hung ceiling outlet box.
- AL. Do not fasten boxes to ceiling support wires.
- AM. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AN. Use gang box where more than one device is mounted together. Do not use sectional box.
- AO. Use gang box with plaster ring for single device outlets.
- AP. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- AQ. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- AR. Set floor boxes level.
- AS. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.03 ADJUSTING

A. Adjust floor boxes flush with finish flooring material.

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- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.04 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.05 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 26 05 37

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SECTION 26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Warning signs and labels.
- G. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 13 Exterior Painting.
- B. Section 09 90 00 Painting and Coating.
- C. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 26 27 26 Wiring Devices Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- E. Section 27 10 00 Structured Cabling: Identification for communications cabling and devices.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 National Electrical Code.
- D. UL 969 Marking and Labeling Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittals procedures.
- Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- D. Product Data: Provide catalog data for nameplates, labels, and markers.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

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1.07 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

1.08 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements for additional requirements.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchgear:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Switchboards:
 - Identify ampere rating.
 - 2) Identify voltage and phase.
 - Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - c. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - Identify load(s) served. Include location when not within sight of equipment.
 - e. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - Identify load(s) served. Include location when not within sight of equipment.
 - 2. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
 - Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.

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- 4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
- 5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
- 6. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
- 7. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
- 8. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
- 9. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- 11. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 - 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
- C. Identification for Raceways:
 - 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
 - 2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - 2) Field-Painting: Comply with Section 09 91 23 and 09 91 13.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
 - 3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
 - 4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.

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- 5. Use underground warning tape to identify underground raceways.
- D. Identification for Boxes:
 - 1. Use voltage markers to identify highest voltage present.
 - 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 09 91 23 and 09 91 13 per the same color code used for raceways.
- E. Identification for Devices:
 - 1. Identification for Communications Devices: Comply with Section 27 10 00.
 - 2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 - 3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
 - 4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.

2.02 MANUFACTURERS

- A. Brady Corporation: www.bradycorp.com.
- B. Seton Identification Products: www.seton.com/aec.
- C. HellermannTyton: www.hellermanntyton.com.
- D. Substitutions: See Section 01 60 00 Product Requirements.

2.03 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2 Materials
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 - 3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - 4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
 - Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
 - 6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 - Manufacturers:
 - a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

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- C. Format for Equipment Identification:
 - 1. Minimum Size: 1 inch by 2.5 inches.
 - 2. Legend:
 - a. System designation where applicable:
 - Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - Color:
 - a. Normal Power System: White text on black background.
- D. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- E. Locations:
 - 1. Each electrical distribution and control equipment enclosure.
 - Communication cabinets.
 - 3. Disconnect switches, and starters.
- F. Letter Size:
 - 1. Use 1/8 inch letters for identifying individual equipment and loads.
 - 2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.04 WIRE AND CABLE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. HellermannTyton: www.hellermanntyton.com/#sle.
 - 3. Panduit Corp: www.panduit.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.
- H. Description: split sleeve type wire markers.
- Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes each load connection.
- J. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 - Control Circuits: Control wire number indicated on shop drawings.

2.05 VOLTAGE MARKERS

- A. Manufacturers: Panduit Corp
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Panduit Corp.

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- 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.
- G. Location: Furnish markers for each conduit longer than 6 feet.
- H. Spacing: 20 feet on center.
- I. Color:
 - 1. 480 Volt System: Brown.
 - 2. 208 Volt System: Yellow.
 - 3. Fire Alarm System: Red.
- J. Legend:
 - 1. 480 Volt System: brown.
 - 2. 208 Volt System: yellow.
 - Fire Alarm System: red.

2.06 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Corporation: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
- B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.07 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.brimar.com/#sle.
 - 2. Clarion Safety Systems, LLC: www.clarionsafety.com/#sle.
 - 3. Seton Identification Products: www.seton.com/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- C. Warning Signs:
 - 1. Materials:

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- a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
- b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
- 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
- 3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

- 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
- 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
- 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.
- B. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 26 05 53

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SECTION 26 09 19 ENCLOSED CONTACTORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General purpose contactors.
- B. Lighting contactors.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 Hangers and Supports for Electrical Systems.
- B. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 28 13 Fuses.

1.03 REFERENCE STANDARDS

- NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- B. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot Devices.
- C. NEMA ICS 6 Industrial Control and Systems: Enclosures.
- D. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- E. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- F. NFPA 70 National Electrical Code.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide dimensions, size, voltage ratings and current ratings.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Allen-Bradley/Rockwell Automation: www.ab.com/#sle.
- B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Substitutions: See Section 01 60 00 Product Requirements.

2.02 GENERAL PURPOSE CONTACTORS

- A. Description: NEMA ICS 2, AC general purpose magnetic contactor.
- B. Coil operating voltage: 120 volts, 60 Hertz.

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- C. Poles: As required to match circuit configuration and control function.
- D. Enclosure: NEMA ICS 6, Type 1.
- E. Accessories:
 - Selector Switch: ON/OFF/AUTOMATIC.
 - Indicating Light: RED.
 - 3. Auxiliary Contacts: One, normally open.

2.03 LIGHTING CONTACTORS

- A. Description: NEMA ICS 2, magnetic lighting contactor.
- B. Configuration: Mechanically held, 3 wire control.
- C. Coil operating voltage: 120 volts, 60 Hertz.
- D. Poles: As required to match circuit configuration and control function.
- E. Contact Rating: Match branch circuit overcurrent protection, considering derating for continuous loads.
- F. Enclosure: NEMA ICS 6, Type 1.
- G. Accessories:
 - Selector Switch: ON/OFF/AUTOMATIC.
 - 2. Indicating Light: RED.
 - 3. Auxiliary Contacts: One, normally open.

2.04 ACCESSORIES

- A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.
- B. Cover Mounted Pilot Devices: NEMA ICS 5, oiltight type.
- C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
- D. Pushbuttons: Lockable type.
- E. Indicating Lights: , LED type.
- F. Selector Switches: Rotary type.
- G. Relays: NEMA ICS 2, .
- H. Control Power Transformers: 120 volt secondary, 50 VA minimum, in each enclosed contactor. Provide fused primary and secondary, and bond unfused leg of secondary to enclosure.

2.05 DISCONNECTS

- A. Combination Contactors: Combine contactor with disconnect in common enclosure.
- B. Disconnects: Thermal magnetic circuit breaker with integral thermal and instantaneous magnetic trip in each pole; UL listed.
- C. Disconnects: Fusible switch assembly; NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed contactors plumb. Provide supports in accordance with Section 26 05 29.
- C. Height: 5 ft to operating handle.
- D. Provide fuses for fusible switches; refer to Section 26 28 13 for product requirements.
- E. Provide engraved plastic nameplates; refer to Section 26 0553 for product requirements and location.

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3.02 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform applicable inspections and tests listed in NETA STD ATS, Section 7.16.1.

END OF SECTION 26 09 19

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SECTION 26 24 13 SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Switchboards.
- B. Overcurrent protective devices for switchboards.
- C. Switchboard accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Concrete for supporting foundations and pads.
- B. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 Hangers and Supports for Electrical Systems.
- D. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 73 Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 26 27 01 Electrical Service Entrance.
- G. Section 26 28 13 Fuses.
- H. Section 26 43 00 Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. ANSI C12.1 American National Standard Code for Electricity Metering.
- C. ANSI C39.1 American National Standard Requirements for Electrical Analog Indicating Instruments; 1981 (R1992).
- D. IEC 60051-1 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories Part 1: Definitions and General Requirements Common To All Parts;
- E. IEC 60051-2 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories Part 2: Special Requirements for Ammeters and Voltmeters.
- F. IEEE C12.1 American National Standard Code for Electricity Metering; Institute of Electrical and Electronic Engineers; 1988.
- G. IEEE C57.13 IEEE Standard Requirements for Instrument Transformers.
- H. NECA 1 Standard for Good Workmanship in Electrical Construction.
- I. NECA 400 Standard for Installing and Maintaining Switchboards.
- J. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- K. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- L. NEMA PB 2 Deadfront Distribution Switchboards.
- M. NEMA PB 2.1 General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less.
- N. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- O. NFPA 70 National Electrical Code.
- P. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- Q. UL 869A Reference Standard for Service Equipment.

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- R. UL 891 Switchboards.
- S. UL 1053 Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

- 1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
- 2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
- 3. Obtain Utility Company approval of switchboard prior to fabrication.
- 4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
 - 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 4. Include documentation of listed series ratings.
 - 5. Include documentation demonstrating selective coordination.
- D. Service Entrance Switchboards: Include documentation of Utility Company approval of switchboard.
- E. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- F. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
- G. Test Reports: Indicate results of factory production tests.
- H. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

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- I. Project Record Documents: Record actual locations of switchboards.
- J. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Enclosure Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
- B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- E. Deliver in 48 inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
- F. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- G. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switchboards Basis of Design: Schneider Electric co. QED power style switchboard.
- B. Switchboards Other Acceptable Manufacturers:
 - 1. Eaton Corporation: www.eaton.com.
 - 2. General Electric Company: www.geindustrial.com/#sle.
- C. Substitutions: See Section 01 60 00 Product Requirements.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
- F. Schneider Electric; Square D Products: www.schneider-electric.us.
- G. Substitutions: See Section 01 60 00 Product Requirements.

- H. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 SWITCHBOARDS

- A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
- D. Front-Connected Switchboards:
 - Main Device(s): Individually-mounted.
 - 2. Feeder Devices: Panel/group-mounted.
 - 3. Arrangement: Front accessible only (not rear accessible), rear aligned.
 - 4. Gutter Access: Bolted covers.
 - 5. Basis of Design: Schneider Electric QED power style switchboard.
- E. Service Entrance Switchboards:
 - Listed and labeled as suitable for use as service equipment according to UL 869A.
 - 2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
 - 3. Comply with Utility Company requirements for electrical service.

F. Service Conditions:

- 1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet.
 - b. Ambient Temperature:
 - 1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
- 2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
 - a. Altitude: 1000 feet.
 - b. Ambient Temperature: Between 23 degrees F and 104 degrees F.

G. Short Circuit Current Rating:

- 1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- 2. Minimum Rating: 65,000 rms symmetrical amperes.
- 3. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
- 4. Label equipment utilizing series ratings as required by NFPA 70.
- H. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- I. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- J. Bussing: Sized in accordance with UL 891 temperature rise requirements.

- 1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
- 2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
- 3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- 4. Phase and Neutral Bus Material: Copper.
- 5. Ground Bus Material: Copper.
- K. Conductor Terminations: Suitable for use with the conductors to be installed.
 - Line Conductor Terminations:
 - Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Main and Neutral Lug Type: Mechanical.
 - 2. Load Conductor Terminations:
 - a. Lug Material: Copper, suitable for terminating copper conductors only.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
 - 2) Provide compression lugs where indicated.

L. Enclosures:

- 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
 - b. Outdoor Locations: Type 3R.
- 2. Finish: Manufacturer's standard unless otherwise indicated.
- 3. Outdoor Enclosures:
 - a. Enclosure Type: Non-walk-in type unless otherwise indicated.
 - b. Color: Manufacturer's standard.
 - c. Access Doors: Lockable, with all locks keyed alike.

M. Future Provisions:

- 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- 2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
- 3. Arrange and equip through bus and ground bus to accommodate future installation of additional switchboard sections.
- N. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.
- O. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where overcurrent protective devices equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - Use zero sequence or residual ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- P. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.
- Q. Owner Metering:

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- 1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
- 2. Basis of Design: PM 8000.
- Measured Parameters:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase and neutral.
 - c. Frequency (Hz).
 - d. Real power (kW): For each phase, 3-phase total.
 - e. Reactive power (kVAR): For each phase, 3-phase total.
 - f. Apparent power (kVA): For each phase, 3-phase total.
 - g. Power factor.
 - h. Current demand.
 - i. Power demand: Real, reactive, and apparent.
- 4. Meter Accuracy: Plus/minus 1.0 percent.
- Features:
 - a. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
 - b. Remote monitoring capability via PC.
- R. Instrument Transformers:
 - 1. Comply with IEEE C57.13.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.
- S. Description: NEMA PB 2 switchboard with electrical ratings and configurations as indicated and specified.
- T. Ratings:
 - 1. Voltage: 120/208; 277/480 volts.
 - 2. Configuration: Three phase, four wire, grounded.
 - 3. Main Bus: 2000 amps.277/480 v.
 - 4. Integrated Equipment Rating: 100000 rms amperes symmetrical.
- U. Main Section Devices: Individually mounted and compartmented.
- V. Distribution Section Devices: Group mounted- double row sections.
- W. Bus Material: Copper with tin plating, standard size.
- X. Bus Connections: Bolted, accessible from front for maintenance.
- Y. Fully insulate load side bus bars
- Z. Ground Bus: Extend length of switchboard.
- AA. Insulated Ground Bus: Extend length of switchboard.
- AB. Molded Case Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole.
 - 1. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
 - 2. Include shunt trip where indicated.
 - Circuit Breakers 1- 400amp and up shall be provided with field repalceable trip unit.
 - All Feeder breakers in 208/120v swithboard shall be series rated for min. of 65 kAIC with 1-pole circuit breakers in all panelboards. All feeder breakers in 480y/277v ,3ph4w switchboard shall be series rated for min. of 65 KAIC.
- AC. Solid-State Molded Case Circuit Breakers: With electronic sensing, timing and tripping circuits for adjustable current settings; UL listed.
 - 1. Ground fault trip, ground fault sensing integral with circuit breaker.
 - 2. Instantaneous trip.
 - 3. Adjustable short time/ long time trip.

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- 4. Stationary mounting.
- 5. Include shunt trip where indicated.
- AD. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials and sizes indicated.
- AE. Ground Fault Sensor: Zero sequence type.
- AF. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches. Max time delay shall be one second for ground fault currents equal to or greater ethan 3000 amps.
- AG. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.
- AH. Enclosure: Type NEMA 1-Indoors.
 - 1. Align sections at front and rear.
 - 2. Switchboard Height: 91.5 inches, excluding floor sills, lifting members and pull boxes.
 - 3. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
 - 4. Structure: Free standing, self supporting, totally front accessible.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Circuit Breakers:
 - Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 2. Molded Case Circuit Breakers:
 - Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 2) Provide electronic trip circuit breakers where indicated.
 - b. Minimum Interrupting Capacity:
 - 1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 21000 rms symmetrical amperes at 480 VAC.
 - c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.

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- e. Provide the following features and accessories where indicated or where required to complete installation:
 - Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

2.04 SURGE PROTECTIVE DEVICES

A. See Section for factory-installed, internally mounted surge protective devices. List and label switchboards containing surge protective devices as a complete assembly including surge protective device.

2.05 POWER METERS

- A. Manufacturers:
 - 1. SQ D PM 8000 or approved equal.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- B. Watt-Hour Meters and Wattmeters: ANSI C12.1, three phase induction type with two stators, each with current and potential coil, rated 5 amperes and 120 volts at 60 Hertz.
 - 1. Meter suitable for connection to 3- and 4-wire circuits.
 - 2. Potential indicating lamps.
 - 3. Adjustments for light and full load, phase balance, and power factor.
 - 4. Digital register.
 - 5. Integral demand indicator.
 - 6. Ratchets to prevent reverse rotation.
 - 7. Removable meter with draw-out test plug.
 - 8. Semi-flush mounted case with matching cover.
 - 9. BACnet gateway to provide connection to building automation system.
- C. Provide meters with appropriate multiplier tags.

2.06 METERING TRANSFORMERS

- A. Manufacturers:
 - 1. Square D or equal.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- B. Current Transformers: IEEE C57.13, 5 ampere secondary, wound; bushing; bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Potential Transformers: IEEE C57.13, 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

2.07 SOURCE QUALITY CONTROL

- A. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
 - 1. Dielectric tests.
 - 2. Mechanical operation tests.
 - 3. Grounding of instrument transformer cases test.
 - 4. Electrical operation and control wiring tests, including polarity and sequence tests.
 - 5. Ground-fault sensing equipment test.
- B. Shop inspect and test switchboard according to NEMA PB 2.
- C. Make completed switchboard available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

PART 3 EXECUTION

3.01 EXAMINATION

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A. Verify that field measurements are as shown on the drawings.

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- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide concrete housekeeping pad under the provisions of Section .
- B. Verify that field measurements are as instructed by manufacturer.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.
- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
- D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- E. Provide required support and attachment components in accordance with Section 26 05 29.
- F. Install switchboards plumb and level.
- G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install all field-installed devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 05 73.
- L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- M. Provide filler plates to cover unused spaces in switchboards.
- N. Identify switchboards in accordance with Section 26 05 53.
- O. Install switchboard in locations shown on drawings, according to NEMA PB 2.1.
- P. Install in a neat and workmanlike manner, as specified in NECA 400.
- Q. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- R. Identify switchboards in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
- D. Perform field inspection and testing in accordance with Section .
- E. Inspect and test in accordance with NETA STD ATS, except Section 4.
- F. Perform inspections and tests listed in NETA STD ATS, Section 7.1.
- G. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 225 amperes. Tests listed as optional are not required.

- H. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
 - 1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.
- I. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
- J. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10.
- K. Test shunt trips to verify proper operation.
- L. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.05 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchboard covers and doors.
- C. Adjust all operating mechanisms for free mechanical movement.
- D. Tighten bolted bus connections in accordance with manufacturer's instructions.
- E. Adjust circuit breaker trip and time delay settings to values indicated.
- F. Adjust circuit breaker trip and time delay settings to values as instructed by Architect.

3.06 CLEANING

- A. See Section 01 74 19 Construction Waste Management and Disposal, for additional requirements.
- Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
- C. Touch up scratched or marred surfaces to match original finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 Demonstration and Training, for additional requirements.

3.08 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 26 24 13

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SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- C. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- D. Section 26 05 29 Hangers and Supports for Electrical Systems.
- E. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 05 73 Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- G. Section 26 22 00 Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
- H. Section 26 28 13 Fuses: Fuses for fusible switches and spare fuse cabinets.
- Section 26 43 00 Surge Protective Devices.

1.03 REFERENCE STANDARDS

- A. FS W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction.
- C. NECA 407 Standard for Installing and Maintaining Panelboards.
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- F. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- G. NEMA PB 1 Panelboards.
- H. NEMA PB 1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 Volts or Less.
- I. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- J. NFPA 70 National Electrical Code.
- K. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations.
- L. UL 50E Enclosures for Electrical Equipment, Environmental Considerations.
- M. UL 67 Panelboards.
- N. UL 98 Enclosed and Dead-Front Switches.
- O. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- P. UL 869A Reference Standard for Service Equipment.
- Q. UL 943 Ground-Fault Circuit-Interrupters.
- R. UL 1053 Ground-Fault Sensing and Relaying Equipment.

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1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
- 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include wiring diagrams showing all factory and field connections.
 - 2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

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- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

1.09 MAINTENANCE MATERIALS

- A. See Section 01 6000 Product Requirements, for additional provisions.
- B. Furnish two of each panelboard key.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com/#sle.
- B. General Electric Company: www.geindustrial.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Substitutions: See Section 01 60 00 Product Requirements.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.

- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
 - 5. Metal frame for type written directory
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.
 - 1. Ampere Rating: Not less than ampere rating of panelboard bus.
 - 2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
 - 3. Coil Voltage: As required for connection to control system indicated.
- L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- N. Load centers are not acceptable.

2.03 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. SQ D.
 - 2. General Electric.
 - 3. Eaton Cutler Hammer.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - 1. Phase and Neutral Bus Material: Copper.
 - 2. Ground Bus Material: Copper.
- E. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
 - 3. Provide electronic trip circuit breakers where indicated.
- F. Enclosures
 - Provide surface-mounted enclosures unless otherwise indicated or shown on the electrical drawings.

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- Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continuous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
- 3. Provide metal circuit directory holder mounted on inside of door.
- G. Manufacturers:
 - 1. SQ.D or Equal.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- H. Description: NEMA PB 1, circuit breaker type.
- I. Service Conditions:
 - 1. Altitude: 1000 feet.
 - 2. Temperature: 55 degrees F.
- J. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.
- K. Minimum integrated short circuit rating: As indicated.
 - 1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
 - 2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).
- L. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.
- M. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.
- N. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- O. Enclosure: NEMA PB 1, Type 1, 5 34" deep, 20" wide, cabinet box. With continued hinge and lock.
- P. Cabinet Front: Surface type, fastened with , hinged door with flush lock, finished in manufacturer's standard gray enamel.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. SQD.
 - 2. General Electric.
 - 3. Eaton Cutler Hammer.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
 - 2. Main and Neutral Lug Type: Mechanical.
- D. Bussing:
 - Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
- E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- F. Enclosures:
 - Provide surface-mounted or flush-mounted enclosures as indicated.
 - Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

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- 3. Provide metal circuit directory holder mounted on inside of door.
- G. Manufacturers:
 - 1. SQ.D or Equal.
 - 2. Substitutions: See Section 01 60 00 Product Requirements.
- H. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- I. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.
- J. Minimum Integrated Short Circuit Rating: As indicated.
 - 1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
 - 2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).
- K. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
 - 1. Type SWD for lighting circuits.
 - 2. Type HACR for air conditioning equipment circuits.
 - 3. Class A ground fault interrupter circuit breakers where scheduled.
 - 4. Do not use tandem circuit breakers, or miniature circuit breakers.
- L. Enclosure: NEMA PB 1, Type 1.
- M. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.
- N. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.05 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 21000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper, suitable for terminating copper conductors only.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - b. Provide interchangeable trip units where indicated.
 - Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

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- 2) Long time delay.
- 3) Short time pickup and delay.
- 4) Instantaneous pickup.
- 5) Ground fault pickup and delay where ground fault protection is indicated.
- 6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- 7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
- 8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
- 9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
- 10. Do not use tandem circuit breakers.
- 11. Do not use handle ties in lieu of multi-pole circuit breakers.

2.06 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- K. Install all field-installed branch devices, components, and accessories.

- L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.
- M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- N. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.
- O. Install panelboards plumb. Install recessed panelboards flush with wall finishes, where installed surface mounted secure or anchor panelboard to brick or cinder block wall.
- P. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- Q. Provide filler plates to cover unused spaces in panelboards.
- R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- S. Identify panelboards in accordance with Section 26 05 53.
- T. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
- U. Provide identification nameplate for each panelboard in accordance with Section 26 0553.
- V. Provide arc flash warning labels in accordance with NFPA 70.
- W. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
 - 1. Minimum spare conduits: 5 empty 1 inch.
- X. Ground and bond panelboard enclosure according to Section 26 0526.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Perform field inspection and testing in accordance with Section 01 4000.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
- H. Correct deficiencies and replace damaged or defective panelboards or associated components.
- Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

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C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 24 16

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SECTION 26 27 01 ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Service racks.
- B. Metering transformer cabinets.
- C. Meter bases.

1.02 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- B. NFPA 70 National Electrical Code; National Fire Protection Association.

1.03 SYSTEM DESCRIPTION

A. System Characteristics: 480Y/277 volts, three phase, four-wire, 60 Hertz.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

1.05 SUBMITTALS

- A. See Section 01 3000 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.
- C. Submit utility company-prepared drawings.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with utility company written requirements and NFPA 70.
 - 1. Maintain one copy of each document on site.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING

A. Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. GE Industrial: www.geindustrial.com.
- B. Milbank Manufacturing: www.milbankmfg.com.
- C. Square D: www.squared.com.
- D. Substitutions: See Section 01 60 00 Product Requirements.

2.02 COMPONENTS

- A. Metering Transformer Cabinets: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.
 - 1. Size: As required by utility.
- B. Meter Base: Furnished by utility company.
- C. Utility Transformer Pad: sized as indicated on drawings or size as required by utility company.
- D. Other Components: As required by utility company.

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PART 3 EXECUTION

3.01 PREPARATION

- A. Arrange with utility company to obtain permanent electric service to the Project.
- B. Verify that field measurements are as indicated on utility company drawings.

3.02 INSTALLATION

- A. Install service rack, transformer pad, metering transformer cabinets, and meter base as required by utility company.
- B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

END OF SECTION 26 27 01

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SECTION 26 27 17 EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 34 Conduit.
- C. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- D. Section 26 05 37 Boxes.
- E. Section 26 27 26 Wiring Devices.

1.03 REFERENCE STANDARDS

- A. NEMA WD 1 General Color Requirements for Wiring Devices.
- B. NEMA WD 6 Wiring Devices Dimensional Specifications.
- C. NFPA 70 National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

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PART 2 PRODUCTS

2.01 MATERIALS

- Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 4. Product:
 - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. Disconnect Switches: As specified in Section and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 34.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 37.

2.02 EQUIPMENT CONNECTIONS

- A. As required by equipment manufacturer:
 - 1. Electrical Connection: Flexible conduit.
 - 2. Electrical Connection: Cord and plug (NEMA 6-20R).
 - 3. Provide field-installed disconnect switch.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION 26 27 17

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SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Receptacles.
- B. Wall plates.

1.02 RELATED REQUIREMENTS

- A. Section 09 69 00 Access Flooring.
- B. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- C. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- D. Section 26 05 33.23 Surface Raceways: Surface raceway systems, including multioutlet assemblies.
- E. Section 26 05 37 Boxes.
- F. Section 26 05 37 Boxes.
- G. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- H. Section 26 09 23 Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
- I. Section 26 27 17 Equipment Wiring: Cords and plugs for equipment.
- J. Section 26 29 13 Enclosed Controllers: Manual motor starters and horsepower rated motor-starting switches without overload protection.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 Connector, Electrical, Power, General Specification for.
- B. FS W-S-896 Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. NECA 1 Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 General Color Requirements for Wiring Devices.
- F. NEMA WD 6 Wiring Devices Dimensional Specifications.
- G. NFPA 70 National Electrical Code.
- H. UL 20 General-Use Snap Switches.
- I. UL 498 Attachment Plugs and Receptacles.
- J. UL 514D Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 Ground-Fault Circuit-Interrupters.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
- 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
- Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
- 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.

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- Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
- 6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Operation and Maintenance Data:
 - 1. GFCI Receptacles: Include information on status indicators.
- E. Project Record Documents: Record actual installed locations of wiring devices.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Extra Wall Plates: One of each style, size, and finish.
 - 3. Extra Flush Floor Service Fittings: Two of each type.

1.06 QUALITY ASSURANCE

- Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

1.08 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell Incorporated; : www.hubbell-wiring.com.
- B. Leviton Manufacturing Company, Inc; : www.leviton.com.
- C. Lutron Electronics Company, Inc: www.lutron.com.
- D. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
- E. Cooper Wiring Devices: www.cooperwiringdevices.com.
- F. Leviton Manufacturing, Inc: www.leviton.com.
- G. Substitutions: See Section 01 60 00 Product Requirements.
- H. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

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2.02 APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
- D. Provide GFI protection for all receptacles installed within 6 feet of sinks.
- E. Provide GFCI protection for receptacles serving electric drinking fountains.
- F. Unless noted otherwise, do not use combination switch/receptacle devices.
- G. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.03 ALL WIRING DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.04 WALL SWITCHES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
 - 1. Body and Handle: Black plastic with toggle handle.
 - 2. Ratings:
 - a. Voltage: 120 277 volts, AC.
 - b. Current: 20 amperes.
 - 3. Ratings: Match branch circuit and load characteristics.
- E. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.05 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:

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- Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, tamper resistant; single or duplex as indicated on the drawings.
 - a. Products:
 - 1) Hubbell Wiring Devices.
 - 2) Leviton.
 - 3) Pass & Saymore.
 - 4) Substitutions: See Section 01 60 00 Product Requirements.

D. GFI Receptacles:

- 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
- 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, tamper resistant.
- E. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
 - 1. Device Body: Black plastic.
 - 2. Configuration: NEMA WD 6, type as specified and indicated.
- F. Convenience Receptacles: Type 5 20.
- G. Single Convenience Receptacles.
- H. Duplex Convenience Receptacles.
- I. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.06 TELEPHONE JACKS

- A. Product: AMP manufacturing
- B. Substitutions: See Section 01 60 00 Product Requirements.

2.07 WALL PLATES

- A. Manufacturers:
 - 1. Hubbell Incorporated; : www.hubbell-wiring.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; : www.leviton.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. All Wall Plates: Comply with UL 514D.
 - Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard; .
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.
- F. Decorative Cover Plates: stainless steel.
- G. Jumbo Cover Plates: stainless steel.
- H. Weatherproof Cover Plates: Gasketed cast metal with hinged cover.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

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- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that openings in access floor are in proper locations.
- H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
 - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- J. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- K. Install securely, in a neat and workmanlike manner, as specified in NECA 1.
- L. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or

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- improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Install receptacles with grounding pole on top.
- Q. Connect wiring device grounding terminal to outlet box with bonding jumper.
- R. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- S. Connect wiring devices by wrapping conductor around screw terminal.
- T. Use jumbo size plates for outlets installed in masonry walls.
- U. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.04 INTERFACE WITH OTHER PRODUCTS

- Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights.
- B. Install convenience receptacle 18 inches above finished floor.
- C. Install convenience receptacle 6 inches above backsplash of counter.
- D. Install telephone jack 18 inches above finished floor.
- E. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.
- F. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.

3.05 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, adjusting, and balancing in accordance with Section 01 40 00.
- B. Inspect each wiring device for damage and defects.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.
- G. Verify that each telephone jack is properly connected and circuit is operational.

3.06 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.07 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 27 26

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SECTION 26 28 13 FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 05 73 Power System Studies: Additional criteria for the selection of protective devices specified in this section.
- C. Section 26 24 13 Switchboards: Fusible switches.
- D. Section 26 24 16 Panelboards: Fusible switches.
- E. Section 26 28 18 Enclosed Switches: Fusible switches.
- F. Section 26 29 13 Enclosed Controllers: Fusible switches.

1.03 REFERENCE STANDARDS

- A. NEMA FU 1 Low Voltage Cartridge Fuses.
- B. NFPA 70 National Electrical Code.
- C. UL 248-1 Low-Voltage Fuses Part 1: General Requirements.
- D. UL 248-4 Low-Voltage Fuses Part 4: Class CC Fuses.
- E. UL 248-12 Low-Voltage Fuses Part 12: Class R Fuses.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Enclosed Switches: See Section 26 28 18.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 Product Requirements, for additional provisions.
 - 2. Extra Fuses: One set(s) of three for each type and size installed.
 - 3. Fuse Pullers: One set(s) compatible with each type and size installed.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

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- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 MAINTENANCE MATERIALS

- A. See Section 01 6000 Product Requirements, for additional provisions.
- B. Furnish two fuse pullers.
- C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com/#sle.
- B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.
- C. Littelfuse, Inc: www.littelfuse.com/#sle.
- D. Substitutions: See Section 01 60 00 Product Requirements.

2.02 APPLICATIONS

- A. Service Entrance:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- B. General Purpose Branch Circuits: Class RK1, time-delay.
- C. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
 - 1. Class RK1, Time-Delay Fuses:
 - a. Products:
 - 1) Bussman.
 - 2) Little fuse.
 - 3) Shawmut.
- H. Class CC Fuses: Comply with UL 248-4.
- I. Power Load Feeder Switches: Class RK1 (time delay).
- J. Motor Load Feeder Switches: Class RK1 (time delay).
- K. Other Feeder Switches: Class RK1 (time delay).
- General Purpose Branch Circuits: Class RK1 (time delay).

2.04 CLASS RK1 (TIME DELAY) FUSES

- A. Manufacturers:
 - 1. Bussman Corp.

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- 2. Substitutions: See Section 01 60 00 Product Requirements.
- B. Construction: Current limiting, dual-element fuse, 10 seconds minimum at 500% rated amps, with copper fuse element.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26 28 13

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SECTION 26 28 17 ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
- 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 2. Include documentation of listed series ratings.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Maintain one copy of each document on site.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

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E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

 Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

1.08 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com/#sle.
- B. General Electric Company: www.geindustrial.com/#sle.
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Substitutions: See Section 01 60 00 Product Requirements.
- E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

- Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers unless otherwise indicated.
- H. Provide electronic trip circuit breakers where indicated.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted enclosures unless otherwise indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 14000 min. rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 21000 min. rms symmetrical amperes at 480 VAC.
 - Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 - 1. Provide mechanical lugs unless otherwise indicated.
 - 2. Lug Material: Copper, suitable for terminating copper conductors only.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2. Provide interchangeable trip units for circuit breaker frame sizes 225 amperes and larger.
- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 - e. Ground fault pickup and delay where ground fault protection is indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:

- 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
- H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.
- I. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
- J. Molded Case Circuit Breakers: UL listed for the following service conditions:
 - 1. Temperature: 95 degrees F.
 - 2. Altitude: 1000 feet.

2.04 TRIP UNITS

- A. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time continuous current, short time pickup current setting for automatic operation. Range of Adjustment: amperes.
- B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 250 amperes and larger with changeable trip units.
- C. Current Limiting Circuit Breaker: Provide circuit breaker as indicated with automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.
- D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with zero sequence type ground fault sensor; instantaneous trip.

2.05 CURRENT LIMITERS

- A. Current Limiters: Designed for application with molded case circuit breaker.
- B. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.
- C. Provide interlocks to trip circuit breaker and to prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

2.06 ACCESSORIES

- A. Enclosures:
 - Fabricate enclosures from steel.
 - 2. Finish: Manufacturer's standard enamel finish, gray color.
- B. Provide accessories as scheduled.
- C. Handle Lock: Include provisions for padlocking.
- D. Provide mechanical trip device.
- E. Provide grounding lug in each enclosure.
- F. Provide products suitable for use as service entrance equipment where so applied.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

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3.02 INSTALLATION

- Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.
- Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- I. Height: 5 feet to operating handle.
- J. Provide identification nameplates for each enclosed circuit breaker in accordance with Section 26 0553.
- K. Provide arc flash warning labels in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with manufacturer's instructions and NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 400 amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.
- G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.
- H. Perform field inspection and testing in accordance with Section 01 4000.
- I. Inspect and test each circuit breaker.
- J. Inspect each circuit breaker visually.
- K. Perform several mechanical ON-OFF operations on each circuit breaker.
- L. Verify circuit continuity on each pole in closed position.
- M. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
- N. Include description of testing and results in test report.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

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ENCLOSED CIRCUIT BREAKERS

City of Providence HVAC & Electrical Upgrades at Various Recreation Centers

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 17

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SECTION 26 28 18 ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Enclosed safety switches.
- B. Fusible switches.
- C. Nonfusible switches.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 05 73 Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
- E. Section 26 28 13 Fuses.
- F. Section 26 29 13 Enclosed Controllers: Manual motor controllers.
- G. Section 26 36 00 Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.03 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA FU 1 Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.
- D. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- E. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- F. NFPA 70 National Electrical Code.
- G. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations.
- H. UL 50E Enclosures for Electrical Equipment, Environmental Considerations.
- I. UL 98 Enclosed and Dead-Front Switches.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Project Record Documents: Record actual locations of enclosed switches.

1.06 QUALITY ASSURANCE

- Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton Corporation; Cutler-Hammer Products; Model: www.eaton.com/#sle.
- B. General Electric Company; Model: www.geindustrial.com/#sle.
- C. Schneider Electric; Square D Products; Model: www.schneider-electric.us/#sle.
- D. Substitutions: See Section 01 60 00 Product Requirements.
- E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.
- E. Voltage Rating: Suitable for circuit voltage.
- F. Short Circuit Current Rating:
 - 1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 05 73.
 - 2. Minimum Ratings:

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- a. Switches Protected by Class H Fuses: 10,000 rms symmetrical amperes.
- b. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
 - Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
 - 1. Products:
 - a. Schneider Electric.
 - b. General Electric Co.
 - c. Cutler Hammer.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Comply with NEMA KS 1.
 - 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Copper, suitable for terminating copper conductors only.
 - 4. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.03 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
 - 3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
 - Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle lockable in OFF position.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed safety switches.

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D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
- J. Provide arc flash warning labels in accordance with NFPA 70.
- K. Install fuses in fusible disconnect switches.
- Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

- Clean dirt and debris from switch enclosures and components according to manufacturer's instructions
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 28 18

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SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable frequency controllers.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 REFERENCE STANDARDS

- A. IEC 60529 Degrees of Protection Provided by Enclosures (IP Code).
- B. NECA 1 Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA ICS 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- E. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot Devices.
- F. NEMA ICS 6 Industrial Control and Systems: Enclosures.
- G. NEMA ICS 7 Industrial Control and Systems: Adjustable-Speed Drives.
- H. NEMA ICS 7.1 Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.
- I. NEMA ICS 7.2 Application Guide for AC Adjustable Speed Drive Systems.
- J. NEMA ICS 61800-2 Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.
- K. NEMA MG 1 Motors and Generators.
- L. NEMA ICS 7 Industrial Control and Systems: Adjustable-Speed Drives.
- M. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- N. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- O. NFPA 70 National Electrical Code.
- P. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
- Q. UL 508A Industrial Control Panels.
- R. UL 61800-5-1 Standard for Adjustable Speed Electrical Power Drive Systems Part 5-1: Safety Requirements Electrical, Thermal, and Energy (Ed. 2).

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - Coordinate work to avoid placement of ductwork, piping, equipment, and other obstructions within dedicated equipment spaces and working clearances required by NFPA 70
 - 2. Coordinate work to provide motor controllers suitable for use with motors.
 - Coordinate work to provide controllers and associated wiring suitable for interface with control devices.
 - 4. Coordinate arrangement of electrical equipment with dimensions and clearance requirements.
 - 5. Verify with manufacturer that conductor terminations are suitable for use with conductors.
 - 6. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

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1.04 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
 - 1. Include wiring diagrams showing factory and field connections.
 - 2. Indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series-rated systems.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Manufacturer's Field Reports: Indicate start-up inspection findings.
- G. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- H. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain copy of each referenced document that prescribes execution requirements at project site.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.
- E. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- F. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- G. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.08 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

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B. Provide minimum 24 months manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Variable-Frequency Motor Controllers:
- B. ABB: www.ABB.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Danfoss: www.danfoss.us.
- E. Substitutions: See Section 01 60 00 Product Requirements.
- F. Source Limitations: Provide variable-frequency motor controllers and associated components produced by single manufacturer and obtained from single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Variable-Frequency Motor Controller:
 - 1. Basis of Design: SQD.
 - 2. Configuration: Packaged controller, nonbypass.
 - 3. Rectifier/Converter: Diode-based, 6-pulse type.
 - 4. Control Method: Vector; open-loop, without feedback.
 - 5. Filtering: Provide input/line reactor and output/load reactor.
 - 6. Features:
 - a. Braking chopper/resistor.
 - b. PID control.
 - c. Firefighter's override.
 - d. Safety interlock.
 - e. Damper/valve control.
 - f. PTC motor thermistor input.
- D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- F. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- G. Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.

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- 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
- 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- H. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 - 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- I. Control System:
 - 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 - Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 - Control Functions:
 - Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.
 - f. Adjustable motor slip compensation.
 - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 - 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
 - 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
 - 7. Outputs:
 - a. Analog Output(s): Three.
 - b. Relay Output(s): Two.

- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
 - a. Serial Communications: RS-485; support for Modbus RTU protocol.
 - b. Remote Monitoring Capabilities:
 - Motor run/stop status.
 - 2) Hand-off-auto status.
 - 3) Fault information.
 - 4) Discrete input/output status.
 - 5) Analog input/output values.
 - c. Remote Control Capabilities:
 - 1) Motor run/stop command.
 - 2) Hand-off-auto selection.
 - 3) Speed adjustment.
 - 4) Fault reset.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
- J. Power Conditioning/Filtering:
 - Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
 - 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
 - 4. Pilot Devices Required:
 - Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:
 - Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
 - 2) Motor Control Selector Switch: HAND/OFF/AUTO.
 - 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- L. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.

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- 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- M. Short Circuit Current Rating:
 - 1. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- N. Conductor Terminations: Suitable for use with conductors to be installed.
- O. Enclosures:
 - Comply with NEMA ICS 6.
 - 2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
 - 4. Cooling: Forced air or natural convection as determined by manufacturer.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Comply with NEMA ICS 2.
 - 3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 4. Trip-free operation.
 - 5. Visible trip indication.
 - 6. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 - 7. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
 - Solid State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

B. Circuit Breakers:

- 1. Motor Circuit Protectors:
 - a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of listed combination motor controller with overload protection; ratings, configurations, and features as indicated or as required.
 - b. Provide field-adjustable magnetic instantaneous trip setting.
- 2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.
 - b. Interrupting Capacity:

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- Provide circuit breakers with interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
- 2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.
- c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
- d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.

2.04 ACCESSORIES

- A. Auxiliary Contacts:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each bypass motor starter, minimum.

B. Pilot Devices:

- Comply with NEMA ICS 5; heavy-duty type.
- 2. Pushbuttons: Unless otherwise indicated, provide momentary, nonilluminated type with flush button operator; normally open or normally closed as indicated or as required.
- 3. Selector Switches: Unless otherwise indicated, provide maintained, nonilluminated type with knob operator; number of switch positions as indicated or as required.
- 4. Indicating Lights: Push-to-test type unless otherwise indicated.
- 5. Provide LED lamp source for indicating lights and illuminated devices.
- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:
 - 1. Size to accommodate burden of contactor coil(s) and connected auxiliary devices, plus 25 VA spare capacity.
 - 2. Include primary and secondary fuses.

2.05 DESCRIPTION

- A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
 - 1. Employ pulse-width-modulated inverter system.
 - 2. Design for ability to operate controller with motor disconnected from output.
 - 3. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
- B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.
- C. Finish: Manufacturer's standard enamel.

2.06 OPERATING REQUIREMENTS

- A. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- B. Operating Ambient: 0 degrees C to 40 degrees C.
- C. Minimum Efficiency at Full Load: 85 percent.
- D. Time to Stop: 5 seconds.
- E. Volts Per Hertz Adjustment: Plus or minus 0 percent.
- F. Current Limit Adjustment: 60 to 110 percent of rated.
- G. Acceleration Rate Adjustment: 0.5 to 30 seconds.
- H. Deceleration Rate Adjustment: 1 to 30 seconds.
- I. Input Signal: 4 to 20 mA DC.

2.07 COMPONENTS

- A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
- B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
- C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
- D. Include undervoltage release.
- E. Control Power Source: Integral control transformer.
- F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
- G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
- H. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
- I. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
- J. Emergency Stop: Use dynamic brakes for emergency stop function.
- K. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.
- L. Wiring Terminations: Match conductor materials and sizes indicated.
- M. Line Reactor: Furnish line reactor (s) for harmonics mitigation.

2.08 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements for additional requirements.
- B. Factory test controllers in accordance with NEMA ICS 61800-2.
- C. Shop inspect and perform standard productions tests for each controller.
- D. Make completed controller available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least 7 days before inspection is allowed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that ratings of controllers are consistent with indicated requirements.
- B. Verify that surface is suitable for controller installation.

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- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.
- E. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- Do not exceed manufacturer's recommended maximum cable length between controller and motor
- E. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- F. Provide required support and attachment in accordance with Section 26 05 29.
- G. Install controllers plumb and level.
- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install field-installed devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.
- L. Tighten accessible connections and mechanical fasteners after placing controller.
- M. Provide fuses in fusible switches; refer to Section 26 28 13 for product requirements.
- Select and install overload heater elements in motor controllers to match installed motor characteristics.
- O. Identify variable frequency controllers in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Provide the service of the manufacturer's field representative to prepare and start controllers.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.17.
- E. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.
- F. Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.05 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- Repair scratched or marred exterior surfaces to match original factory finish.

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3.06 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
- C. Demonstrate operation of controllers in automatic and manual modes.

3.07 PROTECTION

A. Protect installed controllers from subsequent construction operations.

3.08 MAINTENANCE

- A. See Section 01 70 00 Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of controllers for one year from Date of Substantial Completion.

END OF SECTION 26 29 23

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SECTION 26 43 00 SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding.
- B. Section Wiring Devices: Receptacles with integral surge protection.
- C. Section 26 24 13 Switchboards.
- D. Section 26 24 16 Panelboards.
- E. Section 27 10 00 Structured Cabling for Voice and Data: Protectors for communications service entrance.

1.03 ABBREVIATIONS AND ACRONYMS

- A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
- B. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NETA ATS Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
- D. NFPA 70 National Electrical Code.
- E. UL 1449 Standard for Surge Protective Devices.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
 - 1. SPDs with EMI/RFI filter: Include noise attenuation performance.
- C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
- D. Certificates: Manufacturer's documentation of listing for compliance with the following standards:
 - 1. UL 1449.
 - 2. UL 1283 (for Type 2 SPDs).
- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

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- F. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.
- G. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual connections and locations of surge protective devices.

1.07 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Schneider Electric; Square D Brand Surgelogic Products as indicated under product article(s) below; www.surgelogic.com.
- B. Surge Protective Devices (SPD) as manufactured by Siemens Industry, Inc. are a permitted substitution with the inclusion of a Surge Counter and an External Operable Disconnect.
- C. Surge Protective Devices (SPD) as manufactured by Advanced Protection Technologies, Inc. are a permitted substitution with inclusion of an externally operable switch / breaker.
- D. Factory-installed, Internally Mounted Surge Protective Devices:
 - 1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.
- E. Substitutions: See Section 01 60 00 Product Requirements.
- F. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
- G. Source Limitations: Furnish surge protective devices produced by a single manufacturer and obtained from a single supplier.

2.02 ALL SURGE PROTECTIVE DEVICES

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service, listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated; system voltage as indicated on the drawings.

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- B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- C. Protected Modes:
 - 1. Wye Systems: L-N, L-G, N-G, L-L.
- D. UL 1449 Voltage Protection Ratings (VPRs):
 - 1. Equivalent to basis of design.
 - 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2.000 V for L-L mode.
- E. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.
- F. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 1. Indoor clean, dry locations: Type 1.
 - 2. Outdoor locations: Type 3R.
- G. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.
 - 1. Switchboards: See Section 26 24 13.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

- A. Unless otherwise indicated, provide field-installed, externally mounted or factory-installed, internally mounted SPDs.
- B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.
- C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.
- D. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
- E. Repetitive Surge Current Capacity: Not less than 5,000 impulses.
- F. UL 1449 Nominal Discharge Current (I-n): 20 kA.
- G. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
- H. Diagnostics:
 - Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
 - 2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
- Basis of Design: Schneider Electric; Square D Brand Surgelogic Products; www.surgelogic.com.
 - 1. Field-installed, Externally Mounted Surge Protective Devices:
 - a. EMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.
 - 2. Factory-installed, Internally Mounted Surge Protective Devices:
 - a. IMA Series: Replaceable modules; 200 kA SCCR; individually fused MOVs, thermal fusing; dry contacts; EMI/RFI filtering; surge counter; duty cycle tested for 20,000 impulses; 10 year warranty.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

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- B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
- C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
- D. Verify system grounding and bonding is in accordance with Section 26 05 26, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install SPD in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
- E. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably be rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
- F. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 05 26 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS Section 7.19.1.
- Procure services of a qualified manufacturer's representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.

3.04 CLEANING

Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 43 00

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SECTION 31 22 00 GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of topsoil.
- B. Rough grading the site for site structures.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16 Excavation.
- B. Section 31 23 16.13 Trenching: Trenching and backfilling for utilities.
- C. Section 31 23 23 Fill: Filling and compaction.
- D. Section 32 92 19 Seeding: Finish ground cover.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: See Section 31 23 23 - Fill.

PART 3 EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Stake and flag locations of known utilities.
- C. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.
- D. Protect site features to remain, including but not limited to existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

3.02 ROUGH GRADING

- A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
- B. Do not remove topsoil when wet.
- C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
- Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
- E. When excavating through roots, perform work by hand and cut roots with sharp axe.
- F. See Section 31 23 23 Fill, for filling procedures.
- G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
- H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- I. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.03 SOIL REMOVAL

- A. Stockpile topsoil to be re-used on site; remove remainder from site.
- B. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.04 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

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3.05 FIELD QUALITY CONTROL

A. See Section 31 23 23 - Fill, for compaction density testing.

3.06 CLEANING

- A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.
- B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 31 22 00

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SECTION 31 23 16 EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavating for footings, slabs-on-grade, paving, and site structures.
- B. Trenching for utilities outside the building to utility main connections.
- C. Temporary excavation support and protection systems.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Grading.
- B. Section 31 23 16.13 Trenching: Excavating for utility trenches outside the building to utility main connections.
- C. Section 31 23 23 Fill: Fill materials, backfilling, and compacting.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Bedding and Fill to Correct Over-Excavation:
 - 1. See Section 31 23 23- Fill, for bedding and corrective fill materials at general excavations.
 - 2. See Section 31 23 16.13 Trenching, for bedding and corrective fill materials at utility trenches.
- B. Underground Warning Tapes:

PART 3 EXECUTION

3.01 EXAMINATION

A. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain and protect from damage.
- C. Protect existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- D. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

3.03 TEMPORARY EXCAVATION SUPPORT AND PROTECTION

A. Excavation Safety: Comply with OSHA92s Excavation Standard, 29 CFR 1926, Subpart P.

3.04 EXCAVATING

- A. Excavate to accommodate new structures and construction operations.
- B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- C. Do not interfere with 45 degree bearing splay of foundations.
- D. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

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3.05 SUBGRADE PREPARATION

- A. See Section 31 23 23 Fill, for subgrade preparation at general excavations.
- 3. See Section 31 23 16.13 Trenching, for subgrade preparation at utility trenches.

3.06 FILLING AND BACKFILLING

- A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.
- B. Install underground warning tape at buried utilities.
- See Section 31 23 23 Fill, for fill, backfill, and compaction requirements at general excavations.
- D. See Section 31 23 16.13 Trenching, for fill, backfill, and compaction requirements at utility trenches.
- E. See Section 31 22 00 Grading, for rough and final grading and topsoil replacement requirements.

3.07 REPAIR

 Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 31 23 23 - Fill.

3.08 FIELD QUALITY CONTROL

A. Provide for visual inspection of load-bearing excavated surfaces by Authority having jurisdiction before placement of foundations.

3.09 CLEANING

- A. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00 Grading.
- Remove excavated material that is unsuitable for re-use from site.
- C. Remove excess excavated material from site.

3.10 PROTECTION

- A. Divert surface flow from rains or water discharges from the excavation.
- Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.
- C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.
- D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION 31 23 16

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TRENCHING

SECTION 31 23 16.13 TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Site grading.
- B. Section 31 23 16 Excavation: Utility excavating.
- C. Section 31 23 23 Fill: Backfilling at utilities.

1.03 REFERENCE STANDARDS

A. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.04 SUBMITTALS

A. Materials Sources: Submit name of imported materials source.

1.05 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol CL.
- B. Structural Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 3. Conforming to ASTM D2487 Group Symbol CL.
- Granular Fill: Coarse aggregate, conforming to State of Delaware Highway Department standard.
- D. Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter.
- E. Topsoil: See Section 31 22 00.

2.02 ACCESSORIES

- A. Geotextile Fabric: Non-biodegradable, woven fabric for sub-surface drainage. Class 2 (AASHTO M288-06 (2011))
- B. Detectable Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.02 TRENCHING

- A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- C. Do not interfere with 45 degree bearing splay of foundations.

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- D. Cut trenches wide enough to allow inspection of installed utilities.
- E. Hand trim excavations. Remove loose matter.
- F. Remove excavated material that is unsuitable for re-use from site.
- G. Remove excess excavated material from site.
- H. Provide temporary means and methods, as required, to remove all water from trenching until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.
- I. Determine the prevailing groundwater level prior to trenching. If the proposed trench extends less than 1 foot into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by the Architect.

3.03 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.04 BACKFILLING

- A. Backfill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - Other areas: Use general fill, flush to required elevation, compacted to minimum 97
 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated:
- H. Reshape and re-compact fills subjected to vehicular traffic.

3.05 BEDDING AND FILL AT SPECIFIC LOCATIONS

- A. Utility Piping:
 - 1. Bedding: Use general fill.
 - Cover with general fill.
 - 3. Fill up to subgrade with general fill. Fill with topsoil at top 6 inches...
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.06 DETECTABLE PIPE MARKERS

A. Install detectable underground plastic pipe marker tape above HDPE, PVC and concrete pipe at a depth of 14" to 24" below surface.

3.07 TOLERANCES

- A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.08 CLEANING

- A. Leave unused materials in a neat, compact stockpile.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

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C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 31 23 16.13

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SECTION 31 23 23

FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backfilling and compacting for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Removal and handling of soil to be re-used.
- B. Section 31 23 16 Excavation: Removal and handling of soil to be re-used.
- Section 31 23 16.13 Trenching: Excavating for utility trenches outside the building to utility main connections.

1.03 DEFINITIONS

A. Finish Grade Elevations: Match existing.

1.04 REFERENCE STANDARDS

- A. AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
- C. ASTM D1556/D1556M Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- D. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
- E. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- F. ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- G. ASTM D3017 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.05 SUBMITTALS

- A. Product Data for Manufactured Fill.
- B. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. General Fill: Subsoil excavated on-site.
 - 1. Graded.
 - 2. Free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
- B. Granular Fill: Coarse aggregate, conforming to State of Rhode Island Highway Department standard.
- C. Sand: Conforming to State of Rhode Island Highway Department standard.
- D. Topsoil: See Section 31 22 00 Grading.

2.02 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

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B. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 22 00 Grading for additional requirements.
- C. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Scarify subgrade surface to a depth of 6 inches to identify soft spots.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Employ a placement method that does not disturb or damage other work.
- C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- F. Correct areas that are over-excavated.
 - 1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- G. Compaction Density Unless Otherwise Specified or Indicated:
- H. Reshape and re-compact fills subjected to vehicular traffic.
- I. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

- A. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches:
 - 1. Cover with general fill.
 - 2. Fill up to subgrade elevation.
 - 3. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.05 FIELD QUALITY CONTROL

- A. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D2922, or ASTM D3017.
- B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
- C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

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B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 31 23 23

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SECTION 32 11 23 AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Preparation of site for base course.
- B. Section 31 23 23 Fill: Compacted fill under base course.
- C. Section 32 13 13 Concrete Paving: Finish concrete surface course.

1.03 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses.

1.04 SUBMITTALS

A. Materials Sources: Submit name of imported materials source.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate where directed by Owner.
- C. Aggregate Storage, General:
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Coarse Aggregate: Pit run washed stone; free of shale, clay, friable material and debris.
 - 1. Graded in accordance with ASTM C136, within the following limits:
 - a. 3/4 inch sieve: 95 to 100 percent passing.

2.02 SOURCE QUALITY CONTROL

A. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

- A. Under Portland Cement Concrete Paving:
 - 1. Place coarse aggregate to a total compacted thickness of 4 inches.
 - 2. Compact to 95 percent of maximum dry density.
- B. Level and contour surfaces to elevations and gradients indicated.
- C. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

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- D. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for general requirements for field inspection and testing.
- B. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION 32 11 23

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SECTION 32 12 16 ASPHALT PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Double course bituminous concrete paving for patching
- B. Surface sealer.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Preparation of site for paving and base.
- B. Section 31 23 23 Fill: Compacted subgrade for paving.
- C. Section 32 11 23 Aggregate Base Courses: Aggregate base course.
- D. Section 32 13 13 Concrete Paving: Concrete substrate.

1.03 REFERENCE STANDARDS

- A. AASHTO M 147 Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses.
- B. Al MS-2 Asphalt Mix Design Methods.
- C. Al MS-19 Basic Asphalt Emulsion Manual.
- D. ASTM D946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.

1.04 FIELD CONDITIONS

- A. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.
- B. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with applicable code for paving work on public property.

2.02 MATERIALS

- A. Asphalt Cement: ASTM D946.
- B. Aggregate for Binder Course: In accordance with State of Rhode Island Highways standards.
- C. Aggregate for Wearing Course: In accordance with State of Rhode Island Highways standards.
- D. Fine Aggregate: In accordance with State of Phode Island Highways standards.
- E. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- F. Primer: In accordance with State of Rhode Island Highways standards.
- G. Tack Coat: Homogeneous, medium curing, liquid asphalt.
- H. Seal Coat: Al MS-19, sand type.

2.03 ASPHALT PAVING MIXES AND MIX DESIGN

A. Asphalt Wearing Course: 5 to 7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

PART 3 EXECUTION

3.01 EXAMINATION

Verify that compacted subgrade is dry and ready to support paving and imposed loads.

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B. Verify gradients and elevations of base are correct.

3.02 PREPARATION OF GROUND SURFACE

- A. Joints with existing pavement to remain will be saw cut with a suitable motor driven wet diamond blade, to a depth sufficient to allow removal of the milled material without damaging adjacent pavement to remain.
- B. Mill butt joint to a depth of two (2) inches. Waste material becomes property of the contractor and shall be removed from the site and disposed of in a legal manner.

3.03 UTILITY TRENCH RESTORATION

- A. Utility trench to be backfilled per the requirements of Section 31 20 00
- B. The subgrade of the excavated area will be compacted with a roller (or a plate compactor for areas too small for a roller to access).
- C. Graded Aggregate Base Course Type B (GABC) will be placed and compacted in two (2) lifts of maximum four (4) inch thickness.
- D. The exposed vertical sides of existing asphalt area shall have tack coat applied, and two (2) lifts of Type C bituminous concrete shall be placed and compacted in lifts of no more than (two) 2 inches.
- E. Hot melt joint sealer shall be poured along the joint between the trench repair and existing asphalt.

3.04 PAVEMENT GRADE ADJUSTMENT

- Contractor shall broom all loose material from the existing asphalt surface prior to applying tack coat.
- B. Tack coat shall be applied to the asphalt surface in accordance with the rates specified in Table 401-B of the Standard Specifications.
- C. Bituminous concrete Type B shall be placed and compacted in variable depth lifts not to exceed 4 inches in un-compacted thickness to achieve an elevation 2 inches below finished grade.
- D. Bituminous Concrete Type C shall be placed over the area to achieve final grade.

3.05 DRIVEWAY CONSTRUCTION

- A. Excavate area of driveway to subgrade elevation.
- B. Provide a fully loaded tri-axle dump truck and proofroll the subgrade in the presence of the Owner's Representative. Any areas exhibiting deflection or pumping under load will be undercut as directed by the Owner's Representative, and backfilled with Graded Aggregate Base Course Type B, compacted in layers no greater than 4 inches thick.
- C. Place 8 inches of Graded Aggregate Base Course Type B, compacted in layers no greater than 4 inches thick.
- D. Place 2 ½ inches of Bituminous Concrete Type B, roll and allow to cool, then place and roll 2 inches type Bituminous Concrete Type C.

3.06 PAVEMENT MARKING

- A. Contractor is responsible for documenting the existing pavement markings in the area of Pavement Grade Adjustment, so that they can be reproduced on the new asphalt.
- B. White paint shall be used for typical and parking space delineation, blue paint for accessible parking space/loading area delineation, and yellow paint for Fire Lane markings.
- C. Two coats of pavement marking paint shall be applied by machine, in 4" wide stripes.
- D. Contractor is responsible to keep traffic off the fresh paint until it is dry.

3.07 PREPARATION - PRIMER

A. Apply primer in accordance with manufacturer's instructions.

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- B. Apply primer on aggregate base or subbase at uniform rate of 1/3 gal/sq yd.
- Use clean sand to blot excess primer.

3.08 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 1/3 gal/sq yd.

3.09 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place asphalt wearing course within two hours of placing and compacting binder course.
- C. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- D. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.10 SEAL COAT

A. Apply seal coat to asphalt surface course and asphalt curbs in accordance with AI MS-19.

3.11 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Variation from True Elevation: Within 1/2 inch.

3.12 PROTECTION

A. Immediately after placement, protect pavement from mechanical injury for 2 days or until surface temperature is less than 140 degrees F.

END OF SECTION 32 12 16

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SECTION 32 13 13 CONCRETE PAVING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete sidewalks patching.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 Concrete Forming and Accessories.
- B. Section 03 20 00 Concrete Reinforcing.
- C. Section 07 90 05 Joint Sealers: Sealant for joints.
- D. Section 31 22 00 Grading: Preparation of site for paving.

1.03 REFERENCE STANDARDS

- ACI 211.1 Selecting Proportions for Normal-Density and High Density-Concrete Guide.
- B. ASTM A185/A185M Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- C. ASTM A615/A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- D. ASTM C39/C39M Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- E. ASTM C94/C94M Standard Specification for Ready-Mixed Concrete.
- F. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- G. ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types).
- H. ASTM D1752 Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.04 SUBMITTALS

A. Product Data: Provide data on joint filler, admixtures, and curing compound.

PART 2 PRODUCTS

2.01 PAVING ASSEMBLIES

A. Concrete Sidewalks: 4,000 psi 28 day concrete, 4 inches thick.

2.02 FORM MATERIALS

- A. Wood form material, profiled to suit conditions.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - Thickness: 1/2 inch.

2.03 REINFORCEMENT

A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 20 00.

2.04 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03 30 00.
- C. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch length.

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2.05 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 1, Class A.
- B. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.02 SUBBASE

 See Section 32 11 23 - Aggregate Base Courses, for construction of base course for work of this Section.

3.03 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

3.04 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.05 REINFORCEMENT

- A. Place reinforcement at top of slabs-on-grade.
- B. Interrupt reinforcement at contraction joints.
- C. Place dowels to achieve pavement and curb alignment as detailed.

3.06 PLACING CONCRETE

- A. Do not place concrete when base surface is wet.
- B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.07 JOINTS

- A. Align sidewalk joints.
- B. Place 1/2 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components.
 - Form joints with joint filler extending from bottom of pavement to within 1/2 inch of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide scored joints:
 - 1. At 3 feet intervals.
 - 2. Between new sidewalk and existing sidewalk.

3.08 FINISHING

A. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

3.09 JOINT SEALING

A. See Section 07 90 05 for joint sealer requirements.

StudioJAED Architects & Engineers CONCRETE PAVING

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3.10 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

- A. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
- B. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- Do not permit pedestrian traffic over pavement until 75 percent design strength of concrete has been achieved.

END OF SECTION 32 13 13

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SECTION 32 31 13 CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Chain link fencing for exterior and interior application.
- B. Posts, rails, and frames.
- C. Wire fabric vinyl coated
- D. Vinyl slats
- E. Concrete.
- F. Accessories.

1.02 REFERENCE STANDARDS

- ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A392 Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
- C. ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- D. ASTM F567 Standard Practice for Installation of Chain-Link Fence.
- E. ASTM F1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
- F. ASTM F1083 Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- G. CLFMI CLF-FIG0111 Field Inspection Guide.
- H. CLFMI CLF-PM0610 Product Manual.
- I. CLFMI CLF-SFR0111 Security Fencing Recommendations.

1.03 SUBMITTALS

- A. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

1.04 WARRANTY

Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc: www.masterhalco.com/#sle.
 - 2. Merchants Metals: www.merchantsmetals.com/#sle.
 - 3. Substitutions: See Section 01 60 00 Product Requirements.

2.02 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.
- C. Fabric with Pre-Inserted Slats: 2 inch diamond mesh interwoven wire vinyl coated, 6 gage, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
 - 1. Privacy Slats: High-density polyethylene (HDPE), woven into fabric.

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CHAIN LINK FENCES AND GATES

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a. Visual Barrier: 95 percent.

2.03 MATERIALS

- A. Posts, Rails, and Frames:
 - ASTM A1011/A1011M, Designation SS; hot-rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; zinc coating complying with ASTM F1043 and ASTM F1083.
 - 2. Line Posts: Type I round.
 - 3. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round.
 - Comply with CLFMI CLF-PM0610.

B. Wire Fabric:

- 1. ASTM A392 zinc coated steel chain link fabric vinyl coated.
- 2. Comply with CLFMI CLF-PM0610.

C. Concrete:

1. Ready-mixed, complying with ASTM C94/C94M; normal Portland cement; 2,500 psi strength at 28 days, 3 inch slump; aggregate.

2.04 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.
- C. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- D. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Fabric: 2 inch diamond mesh interwoven wire vinyl coated, 6 gage, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
- F. Tie Wire: Aluminum alloy steel wire.

2.05 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.06 FINISHES

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.
- B. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.02 INSTALLATION - EXTERIOR APPLICATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate, terminal, and gate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: ASTM F567.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- H. Install a 7 gage, 0.1770 inch coil spring wire in place of top rail.

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- I. Do not stretch fabric until concrete foundation has cured 28 days.
- J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- K. Position bottom of fabric 2 inches above finished grade.
- L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- N. Install bottom tension wire stretched taut between terminal posts.
- O. Install support arms sloped outward and attach barbed wire; tension and secure.
- P. Peen all bolts upon installation.
- Q. Perform three random field inspections confirming proper installation.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Do not infringe on adjacent property lines.

3.04 FIELD QUALITY CONTROL

- A. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- B. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.05 CLEANING

- A. Leave immediate work area neat at end of each work day.
- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.
- F. See Section 01 74 19 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 32 31 13

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SECTION 32 92 19 SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Seeding.

1.02 RELATED REQUIREMENTS

- A. Section 31 22 00 Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
- B. Section 31 23 23 Fill: Topsoil material.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

PART 2 PRODUCTS

2.01 SEED MIXTURE

- A. Seed Mixture:
 - 1. Kentucky Blue Grass: 50 percent.
 - 2. Creeping Red Fescue Grass: 10 percent.
 - 3. Norlea Perennial Rye: 40 percent.

2.02 ACCESSORIES

- Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- B. Erosion Fabric: Jute matting, open weave.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare subgrade in accordance with Section 31 22 00 Grading.
- B. Place topsoil in accordance with Section 31 22 00 Grading.

3.02 SEEDING

- A. Apply seed at a rate of 2 to 3 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
- E. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- F. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

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3.03 PROTECTION

- A. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.
- B. Secure outside edges and overlaps at 36 inch intervals with stakes.
- C. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

3.04 MAINTENANCE

- A. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- B. Water to prevent grass and soil from drying out.
- C. Roll surface to remove minor depressions or irregularities.
- D. Immediately reseed areas that show bare spots.

END OF SECTION 32 92 19

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SECTION 33 71 19

ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Conduit and duct:
 - 1. Rigid polyvinyl chloride (PVC) conduit.
 - 2. High density polyethylene (HDPE) conduit.
- B. Accessories:
 - 1. Underground warning tape.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete.
- B. Section 31 23 16 Excavation.
- C. Section 31 23 16.13 Trenching: Excavating, bedding, and backfilling.
- D. Section 31 23 23 Fill: Bedding and backfilling.

1.03 PRICE AND PAYMENT PROCEDURES

- A. See Section 01 22 00 Unit Prices, for additional unit price requirements.
- B. Ductbank:
 - 1. Basis of Measurement: By the lineal foot (meter), for each configuration.
 - 2. Basis of Payment: Includes purchase, delivery, and installation of duct, fittings, supports, and accessories, and for trenching, concrete encasement, and backfill.

1.04 REFERENCE STANDARDS

- A. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Conduit.
- B. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- C. NEMA TC 7 Solid-Wall Coilable and Straight Electrical Polyethylene Conduit.
- D. NFPA 70 National Electrical Code.
- E. UL 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- F. UL 651A Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.

1.05 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for metallic conduit, nonmetallic conduit, and manhole accessories.
- C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of manholes.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

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C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.01 CONDUIT AND DUCT

- A. Rigid Polyvinyl Chloride (PVC) Conduit: NFPA 70, Type PVC; comply with NEMA TC 2 and list and label as complying with UL 651; Schedule 40 unless otherwise indicated; rated for use with conductors rated 90 degrees C.
 - 1. Manufacturers:
 - a. Cantex Inc: www.cantexinc.com.
 - b. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
 - c. JM Eagle: www.jmeagle.com.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Fittings: Comply with NEMA TC 3 and list and label as complying with UL 651.
 - a. Manufacturer: Same as manufacturer of conduit to be connected.
- B. High Density Polyethylene (HDPE) Conduit: NFPA 70, Type HDPE; comply with NEMA TC 7 and list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.
 - Manufacturers:
 - a. Blue Diamond Industries, LLC: www.bdiky.com.
 - b. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com.
 - c. Dura-Line: www.duraline.com.
 - d. Substitutions: See Section 01 60 00 Product Requirements.

2.02 ACCESSORIES

- A. Underground Warning Tape: Polyethylene tape suitable for direct burial.
 - 1. Manufacturers:
 - a. Brady Corporation: www.bradyid.com.
 - b. Brimar Industries, Inc: www.brimar.com.
 - c. Seton Identification Products: www.seton.com.
 - d. Substitutions: See Section 01 60 00 Product Requirements.
 - 2. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
 - 3. Legend: Type of service, continuously repeated over full length of tape.
 - Color:
 - a. Tape for Buried Power Lines: Black text on red background.
 - Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.03 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- Verify that field measurements are as indicated.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.

3.02 DUCT BANK INSTALLATION

- A. Install duct to locate top of ductbank at depths as indicated on drawings.
- B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.

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- C. Cut duct square using saw or pipe cutter; de-burr cut ends.
- D. Insert duct to shoulder of fittings; fasten securely.
- E. Join nonmetallic duct using adhesive as recommended by manufacturer.
- F. Install no more than equivalent of three 90-degree bends between pull points.
- G. Provide suitable fittings to accommodate expansion and deflection where required.
- H. Terminate duct at manhole entries using end bell.
- I. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- J. Use suitable separators and chairs installed not greater than 4 feet on centers.
- K. Band ducts together before backfilling.
- L. Securely anchor duct to prevent movement during concrete placement.
- M. Place concrete under provisions of Section 03 30 00. Use mineral pigment to color concrete red.
- N. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.
- O. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.
- P. Provide suitable pull string in each empty duct except sleeves and nipples.
- Q. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- R. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.

END OF SECTION 33 71 19



CITTOFIKOVIDEN

Brett P. Smiley, Mayor

MEMORANDUM

To: Department of Public Property; Parks Department

From: Law Department

Re: Compliance with apprenticeship and "First Source" ordinances

Date: April 21, 2023

The City of Providence has hired "Building Futures," an outside consulting group, to assist with monitoring the City's compliance with ordinances relating to construction projects. Specifically, Building Futures is monitoring the City's compliance with two (2) ordinances that require the City to maximize utilization of apprentices and Providence residents in City construction projects.

1) Providence Code of Ordinances Sec. 21-28.1, governing construction contracts of \$100,000 or more, requires that no less than 15% of the total labor hours performed by contractors and subcontractors on any given project are to be completed by apprentices registered in state-registered apprenticeship programs. This requirement pertains to all labor hours for a given project, not just those for new hires.

The Law Department recommends the inclusion of the following notice (or one substantially similar) in all RFP's for construction projects valued at \$100,000 or more:

APPRENTICE REQUIREMENTS.

Attention of prospective bidders is called to the fact that this project is to be bid upon and executed under the City of Providence Code of Ordinances Chapter 21 Art. II Section 21-28.1 c(1) and (2) related to utilizing apprentices in the contract. This ordinance outlines requirements for utilizing not less than 15% of total hours worked by apprentices. The City may lower this percentage only if it determines in writing that compliance is not feasible or that it would be unduly cost prohibitive to the project. The attention of prospective bidders is also called to the fact that reporting the efforts undertaken and progress towards achieving the requirements in this ordinance is a condition for payment. Compliance reporting shall be submitted with any contract payment requisition, in a format to be specified by the City. This demonstration of compliance through such reports shall be a condition of the requisition for payment to be processed. Upon the contract being awarded to the successful bidder, a mandatory meeting will be scheduled to review the project

requirements relative to apprenticeship requirements and the process and protocols by which these goals will be achieved. At this meeting, specific forms and procedures for the documentation and achievement of these requirements by the successful bidder will be provided, discussed and agreed upon for the execution of the contract.

2) Providence "First Source" Ordinance Sec. 21-91 – Sec. 21-96 requires that when hiring new workers for a construction project, employers seek to hire Providence residents when available. If the awarded contractor, regardless of tier, is a signatory to a Collective Bargaining Agreement that governs the contractor's hiring and referral process, the contractor must contact both Building Futures and the local hiring halls to request apprentices or journey workers who are residents of Providence. In the case of apprentices, this is a way to meet the requirements of both ordinances with one hire.

The Law Department recommends the inclusion of the following notice (or one substantially similar) in all RFP's for City construction projects:

"FIRST SOURCE" REQUIREMENTS.

Attention of prospective bidders is called to the fact that this project is to be bid upon and executed under the City of Providence Code of Ordinances Chapter 21 Art. III 1/2 First Source Agreements Sec. 21-91 through 21-96. This ordinance outlines requirements for hiring Providence residents to work on this project. The City may waive this requirement only upon a determination in writing that qualified residents of Providence are not available for the project, pursuant to Sec. 21-94(e). The attention of prospective bidders is called to the fact that reporting the efforts undertaken and progress towards achieving the requirements in this ordinance is a condition for payment. Compliance reporting shall be submitted with any contract payment requisition, in a format to be specified by the City. This demonstration of compliance through such reports shall be a condition of the requisition for payment to be processed. Upon the contract being awarded to the successful bidder, a mandatory meeting will be scheduled to review the project requirements relative to the First Source Agreements and the process and protocols by which these goals will be achieved. At this meeting, specific forms and procedures for the documentation and achievement of these requirements by the successful bidder will be provided, discussed and agreed upon for the execution of the contract.

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If your department or any of your contractors has difficulty securing registered apprentices or Providence residents to participate in construction projects, you are encouraged to contact Building Futures, who may be able to assist:

William Bryan, AUP Manager, Renowned Advising renownedadvising@gmail.com or