



CAMERON COUNTY PURCHASING

1100 East Monroe St,
Brownsville, Texas 78520
(956) 544-0871 Fax: (956) 550-7219

ADDENDUM # 1

PAGE 1 of 314

DATE OUT: 2/21/23

BID TITLE: SANTA ROSA PARK IMPROVEMENTS CONSTRUCTION PHASE II

BID # 230104

DEADLINE: FEBRUARY 22, 2023

(IN ORDER TO AVOID DISQUALIFICATION – ALL ADDENDUMS MUST BE SIGNED AND RETURNED BY DEADLINE AND INCLUDED IN THE SEALED BID PACKAGE SUBMITTED)

1.- CHANGE # 1

BID OPENING DUE DATE WILL BE CHANGE TO THE FOLLOWING:

FROM

DATE DUE: ~~FEBRUARY 28, 2023-~~ DUE NO LATER THAN ~~3:00 P.M.~~

TO

DATE DUE: ~~MARCH 14, 2023-~~ DUE NO LATER THAN ~~3:00 P.M.~~

Note:

This addendum is issued for the purpose of modifying the plans and specifications for the Cameron County Santa Rosa Park Improvements – Phase II.

This addendum shall become part of the contract and all CONTRACTORS shall be bound by its content. All aspects of the specifications and drawings not covered herein shall remain the same.

The General Conditions and the Special Conditions of the specifications shall govern all parts of the work and apply in full force to this addendum.

PAGE # 5 OF THIS ADDENDUM # 1 CONTAINS THE REVISED BID FORM WHICH WILL REPLACE ORIGINAL BID FORM IN BID PACKAGE. MAKE SURE TO USE REVISED BID FORM WHEN SUBMITTING BID PACKAGE.

Company Name _____ Phone # _____
Vendor Signature _____ Date _____

Must include and return with Bid package

February 21, 2023

CAMERON COUNTY
CAMERON COUNTY SANTA ROSA PARK IMPROVEMENTS PHASE II
PROJECT # 2023-C230104

GMS ARCHITECTS
BROWNSVILLE, TEXAS 78526
(956) 546-0110

ADDENDUM NO. 1

A. PURPOSE AND INTENT

This addendum is issued for the purpose of modifying the plans and specifications for the Cameron County Santa Rosa Park Improvements – Phase II.

This addendum shall become part of the contract and all CONTRACTORS shall be bound by its content. All aspects of the specifications and drawings not covered herein shall remain the same.

The General Conditions and the Special Conditions of the specifications shall govern all parts of the work and apply in full force to this addendum.

B. SCOPE

I. CLARIFICATION:

- The bid date will be March 14, 2023, at 3:00 pm.

II. SPECIFICATIONS:

- New Specification Cover Sheet
- New Bid Form
- Add Appendix C - Wage Rates for Cameron County – 6 Pages to Construction Documents.
- Division 1; Section 01010 General Requirements
 - Delete Section 01010 and replace with Section 01010 – Addendum #1 (3 Pages).
 - Add Section 01110 TDI Windstorm Certification Delegated Responsibility to Construction Documents. (2 Pages)
- Division 2
 - Add Section 02200 Earthwork to Construction Documents. (8 Pages)
 - Add Section 02466 Drilled Piers to Construction Documents. (7 Pages)
- Division 3 – Add Sections 03100 Concrete Forms (4 Pages), 03200 Concrete Reinforcement (3 Pages) and 03300 CIP Concrete (10 Pages) to Construction Documents.
- Division 4 - Add Section 04220 Concrete Masonry Units to Construction Documents. (6 Pages)
- Division 5 – Add Section 05120 Structural Steel Framing to Construction Documents. (9 Pages)
- Division 10 - Add Section 10800 Toilet Accessories (2 Pages) to Construction Documents.

II. PLANS:

- Add Sheet L2.01 – Irrigation Plan to Construction Documents
- Add Sheet L2.02 - Irrigation Legend, Notes and Details to Construction Documents.
- Sheet D1.01
 - Delete sheet and replace with D1.01 – Addendum #1.
- Sheet A1.01
 - Delete sheet and replace with A1.01 – Addendum #1.
- Sheet A2.01
 - Delete sheet and replace with A2.01 – Addendum #1.
- Add Sheet S1.1 General Structural Notes to Construction Documents.
- Add Sheet S1.2 General Structural Notes to Construction Documents.
- Add Sheet S2.1 Foundation Plan and Sections to Construction Documents.
- Add Sheet S3.1 Framing Plan and Sections to Construction Documents.

III. ETHOS ENGINEERING ADDENDUM #1 – 239 PAGES

CAMERON COUNTY PARKS

Santa Rosa Park Improvements

Phase II

Project No. C230104

ARCHITECTS

Gomez Mendez Saenz, Inc.

Mejia & Rose, Inc.

Green Rubiano & Associates

Ethos Engineering

Set No.



GMS ARCHITECTS



Roan G. Gomez, AIA

BID # 230104 SANTA ROSA PARK IMPROVEMENTS CONSTRUCTION PHASE II

BID PROPOSAL FORM
(GENERAL CONTRACT)

Project: Cameron County Santa Rosa Park Improvements Construction Phase II
Place: Cameron County Purchasing Department, 1100 E. Monroe Street 3rd Floor,
Attention: Mr. Ignacio Amezcua, Purchasing Agent
Due Date: **March 14, 2023**
Time: Before 3:00 p.m.

1. Pursuant to and in compliance with the Invitation to Bid and the proposed Contract Documents, prepared by Architect Gomez Mendez Saenz, Inc. relating to the above referenced project, the undersigned, having become thoroughly familiar with the terms and conditions of the proposed Contract Documents and with local conditions affecting the performance and costs of the work at the place where the work is to be completed, and having fully inspected the site in all particulars, hereby proposes and agrees to fully perform the work within the time stated and in strict accordance with the proposed Contract Documents, and addenda, thereto, including furnishing of any and all labor and materials for all roofing, for the following sum of money:

A: BID:
All labor, materials, services and equipment, necessary for completion of the work shown on the drawings and described in the specifications.

DOLLARS (\$) _____)

Same in Words: _____

B. ALTERNATES:

All labor, materials, services and equipment, necessary for completion of the work shown on the drawings and described in the specifications.

1. Walkway Solar Lighting, as noted on MEP Drawings: DOLLARS (\$) _____)

Same in Words: _____

2. Mechanical Unit replacement and repairs, as noted on MEP Drawings. DOLLARS (\$) _____)

Same in Words: _____

3. Baseball Field Light Replacement, as noted on MEP Drawings. DOLLARS (\$) _____)

Same in Words: _____

2. If awarded this Contract the undersigned will execute a satisfactory Construction Contract, Performance Bond, Labor and Material Payment Bond and proof of insurance coverage, with the Owner for the entire work as per the Contract Documents within 5 days after notice of award. It is agreed that this proposal is subjected to the Owner's acceptance for a period of Thirty (30) days from the above date.
3. Contractor shall be substantially completed within _____ calendar days.

BID # 230104 SANTA ROSA PARK IMPROVEMENTS CONSTRUCTION PHASE II

4. Enclosed is a Certified Check or Bidders Bond in the amount of \$ _____ compliance with the specification requirements. (5% of the highest amount bid).

The above check or Bidders Bond is to become the property of the Owner in the event the Construction Contract (when offered by the Owner) and the bonds and proof of insurance coverage are not executed within the time set forth above.

5. The undersigned agrees to the following:

- A. To furnish all materials as shown and specified in the plans and specifications.
- B. To start work 5 days after notice of award of contract.
- C. To work _____ working days per week.

6. The full amount of all allowances as specified in the General Requirements, Division 1, of the specifications, in the Base Proposal price shown.

7. Receipt is acknowledged of the following addendas:

No.	Dated	No.	Dated
No.	Dated	No.	Dated

8. Bidder agrees that the Owner has the right to accept or reject any or all bids and to waive all informalities.

Respectfully submitted,

By: _____ Date _____
Signature

Title: _____

Business Address: _____

(Seal - if Bidder is a corporation)

"General Decision Number: TX20230236 01/06/2023

Superseded General Decision Number: TX20220236

State: Texas

Construction Type: Building

County: Cameron County in Texas.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

<p>If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:</p>	<p>. Executive Order 14026 generally applies to the contract.</p> <p>. The contractor must pay all covered workers at least \$16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.</p>
<p>If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:</p>	<p>. Executive Order 13658 generally applies to the contract.</p> <p>. The contractor must pay all covered workers at least \$12.15 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.</p>

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number Publication Date
0 01/06/2023

BOIL0074-003 01/01/2021

	Rates	Fringes
BOILERMAKER.....	\$ 29.47	24.10

ENGI0178-005 06/01/2020

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
(1) Tower Crane.....	\$ 32.85	13.10
(2) Cranes with Pile Driving or Caisson Attachment and Hydraulic Crane 60 tons and above.....	\$ 28.75	10.60
(3) Hydraulic cranes 59 Tons and under.....	\$ 32.35	13.10

IRON0084-011 06/01/2022

	Rates	Fringes
IRONWORKER, ORNAMENTAL.....	\$ 26.76	7.88

PLUM0823-002 10/01/2018

	Rates	Fringes
PIPEFITTER (HVAC Pipe Installation Only).....	\$ 27.87	10.04

SUTX2014-011 07/21/2014

	Rates	Fringes
BRICKLAYER.....	\$ 16.17 **	0.00
CARPENTER, Excludes Drywall Hanging, and Metal Stud Installation.....	\$ 16.00 **	0.00
CEMENT MASON/CONCRETE FINISHER...	\$ 12.46 **	0.00
DRYWALL FINISHER/TAPER.....	\$ 10.75 **	2.68
DRYWALL HANGER AND METAL STUD INSTALLER.....	\$ 19.42	0.37
ELECTRICIAN (Low Voltage Wiring Only).....	\$ 13.50 **	0.68
ELECTRICIAN, Excludes Low Voltage Wiring.....	\$ 14.00 **	0.54
INSULATOR - MECHANICAL (Duct, Pipe & Mechanical System Insulation).....	\$ 14.04 **	4.79
IRONWORKER, REINFORCING.....	\$ 12.01 **	0.00
IRONWORKER, STRUCTURAL.....	\$ 15.04 **	4.34
LABORER: Common or General.....	\$ 8.87 **	0.00

LABORER: Mason Tender - Brick...	\$ 10.00 **	0.00
LABORER: Mason Tender - Cement/Concrete.....	\$ 10.89 **	0.96
LABORER: Pipelayer.....	\$ 11.00 **	3.47
LABORER: Roof Tearoff.....	\$ 10.06 **	0.00
OPERATOR: Backhoe/Excavator/Trackhoe.....	\$ 13.15 **	0.00
OPERATOR: Bobcat/Skid Steer/Skid Loader.....	\$ 13.93 **	0.00
OPERATOR: Bulldozer.....	\$ 18.29	1.31
OPERATOR: Drill.....	\$ 16.22	0.34
OPERATOR: Forklift.....	\$ 14.83 **	0.00
OPERATOR: Grader/Blade.....	\$ 13.07 **	0.00
OPERATOR: Loader.....	\$ 12.87 **	0.70
OPERATOR: Mechanic.....	\$ 17.00	0.00
OPERATOR: Paver (Asphalt, Aggregate, and Concrete).....	\$ 16.03 **	0.00
OPERATOR: Roller.....	\$ 12.70 **	0.00
PAINTER (Brush, Roller and Spray), Excludes Drywall Finishing/Taping.....	\$ 11.27 **	0.00
PIPEFITTER, Excludes HVAC Pipe Installation.....	\$ 14.67 **	2.50
PLUMBER, Excludes HVAC Pipe Installation.....	\$ 13.59 **	0.00
ROOFER.....	\$ 11.42 **	0.00
SHEET METAL WORKER (HVAC Duct Installation Only).....	\$ 18.40	2.12
SHEET METAL WORKER, Excludes HVAC Duct Installation.....	\$ 21.13	6.53
TILE FINISHER.....	\$ 11.22 **	0.00
TILE SETTER.....	\$ 12.15 **	0.00
TRUCK DRIVER: Dump Truck.....	\$ 12.39 **	1.18
TRUCK DRIVER: Flatbed Truck.....	\$ 19.65	8.57
TRUCK DRIVER: Semi-Trailer Truck.....	\$ 12.50 **	0.00
TRUCK DRIVER: Water Truck.....	\$ 12.00 **	4.11

WELDERS - Receive rate prescribed for craft performing

operation to which welding is incidental.

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 ** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$16.20) or 13658 (\$12.15). Please see the Note at the top of the wage determination for more information.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

 The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations

Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01010 - SUMMARY OF WORK:

- 1.1 Location: The project site for Cameron County Parks – Santa Rosa Park Phase-II Improvements is located at Santa Rosa Blvd. (FM506), Santa Rosa, TX.
- 1.2 Approval of Working Surfaces: Any contractor performing work over the work of other contractors shall notify the Architect of any unsatisfactory condition. Beginning of work by any contractor shall constitute the acceptance of the previous work.
- 1.3 Checking Dimensions at Site: Before ordering any materials or doing any work, verify all measurements of the building and be responsible for the correctness of them. No extras will be allowed for variations from drawings in existing conditions or for work performed under this contract. Any discrepancies found shall be submitted to the Architect for instruction before proceeding. The Section shall be enforced diligently.
- 1.4 Cutting & Patching: No excessive cutting will be permitted, nor shall any structural members be cut without the approval of the Architect. Each contractor shall leave all chases and openings straight, true and of the proper size in his work as may be necessary for the proper installation of his and/or other contractor's work. After such work has been installed, he shall carefully fit around, close up, repair, patch and point up same as directed, to the entire satisfaction of the Architect.
- 1.5 Cooperation: The General Contractor, all other contractors and all sub-contractors shall coordinate their work with all adjacent work and shall cooperate with all other trades as to facilitate the general progress of the work. Each trade shall afford all other trades every reasonable opportunity for installation of their work and storage of their materials.
- 1.6 Project Logbook: The project superintendent shall maintain a daily project logbook, indicating which sub-contractors were on the job, time of arrival, and the number of workers. Statements as to the daily progress shall be logged. This logbook shall be made available to the Architect and shall be kept at the job site office.
- 1.7 Inspection and Tests: Architect and his representative shall at all times have access to the work whether it is in preparation or progress. Provide proper and safe facilities for such access and inspection. Make all inspections and test in connection with this entire contract as required by the Architect. All material testing shall be paid for by the Testing Allowance and be done by an independent testing laboratory meeting the approval of the architect.
- 1.8 Security: Provide security fencing in all work areas. See Temporary Facilities.
- 1.9 Mockup Panel: Provide a mock-up for evaluation of product and application workmanship.
 1. Install in area and of size designated by Architect.
 - a. Construct mockup to illustrate backup wall, exterior sheathing, air barrier, cavity wall, connectors, weep holes, cavity vents, and through wall flashing.
 - b. Construct mockup panel 72 inches by 72 inches to illustrate coursing, anchorage, mortar joints and color, window opening and flashing system.

2. Do not proceed with work until finish color, texture, pattern, joint sizes, and installation workmanship are approved by Architect.
3. Correct mock-up area as required to produce acceptable work.

2. ALLOWANCES:

See Paragraph 4.8 of the General Conditions.

2.1 Testing Allowance: A recognized, independent material testing laboratory will be selected and paid directly by the Owner.

2.2 Betterment Allowance: Include the sum set forth below as a Betterment Allowance which will, if needed, be expended on Betterment to the Project, as directed in writing by approved change orders.

Betterment Allowance: \$20,000.00

2.3 Structural Allowance: Include the sum set forth below as a Betterment Allowance which will, if needed, be expended on Betterment to the Project, as directed in writing by approved change orders.

Reinforcing Steel Allowance: \$ 4,000.00

Fabricated Steel Allowance: \$ 6,000.00

2.4 Signage Allowance: Include the sum set forth below as a Betterment Allowance which will, if needed, be expended on Betterment to the Project, as directed in writing by approved change orders.

Signage Allowance: \$ 5,000.00

2.5 Splash Pad Allowance: Include the sum set forth below as a Betterment Allowance which will, if needed, be expended on Betterment to the Project, as directed in writing by approved change orders.

Splash Pad Allowance: \$ 30,000.00

SECTION 0110 - BID SCHEDULE

1. BID SCHEDULE: All proposals and alternate bid items shall be subject to the General and Special Conditions and all other related sections of the specifications and requirements of the drawings. The Owner shall have the right to accept or reject any or all alternates.

1.1 BASE BID: The Contractor shall state on the General Contract Bid Proposal under the Base Bid, the amount for all work, complete in all respects in accordance with plans and specifications, to construct Santa Rosa Park Improvements. The scope of work is defined in the plans and specifications.

1.2 ALTERNATES: The Contractor shall state on this Bid Form, under each Alternate the amount to add to this bid to perform all work, complete in all respects, in accordance with the plans and specifications to construct work required by the Alternates.

Alternate #1 – Install Solar Powered Walkway Pole Lights, as shown on Electrical Drawings.

Alternate #2 – Mechanical Unit Replacement and Repairs, as noted on MEP Drawings.

Alternate #3 – Baseball Fields Lighting Replacement, as noted on the MEP Drawings.

SECTION 0120 - AS BUILT DRAWINGS:

As the work proceeds, keep careful records of piping, electrical circuits, duct work and other concealed work whose installed location varies from that shown on plans. Refer to Section 01705 Project Closeout for additional requirements.

SECTION 0130 - REPORTS:

The Contractor will provide a written report to the Architect after each inspection conducted by the City Inspectors concerning their findings.

SECTION 0140 - QUANTITIES & WARRANTIES:

All guarantees and warranties expressed or implied shall be provided to the Architect in written form prior to final payment.

SECTION 0150 - PICTURES:

In addition to the required monthly progress photos, the Contractor will provide the following:

1. Aerial job photos.
2. Sequence photographs showing the flashing in place prior to application of roof. This is MANDATORY. Close-ups of all flashing are required.

The Contractor is required to submit progress photos with each month's application for payment.

SECTION 0160 - CERTIFICATION OF CONSTRUCTION:

The building contractor or construction manager shall certify in writing that the facility has been constructed in accordance to the construction documents and its specifications.

SECTION 0170 - CERTIFICATION OF NON-USE OF ASBESTOS PRODUCTS

The General Contractor shall provide the Architect with written certification letters from all sub-contractors and suppliers that no asbestos products shall be use on this project.

SECTION 0180 - SCOPE AND SEQUENCE OF CONSTRUCTION

1.1 General:

No time extensions shall be considered.

The successful bidder shall under no circumstances leave this project unsecured or unprotected at any time during construction. The General Contractor is to refer to Section 01505 Temporary Facilities for all requirements required by this project.

The General Contractor to provide all necessary precautions and safeguards during construction for protection of personnel utilizing the site and any visitor who might visit the project site. The General Contractor shall provide in a neat format project monthly reports with photos showing progress of construction for their review.

SECTION 01110 - TEXAS DEPARTMENT OF INSURANCE WINDSTORM CERTIFICATION OF NEW STRUCTURES - DELEGATED RESPONSIBILITY TO THE GENERAL CONTRACTOR

PART 1 GENERAL

1.1 SUMMARY

- A. The general contractor (Contractor) shall be responsible for the windstorm certification of all new structures through the Texas Department of Insurance (TDI). The general contractor shall contract with a TDI Appointed Qualified Inspector (Inspector) to issue an Application for Windstorm Inspection Certificate of Compliance (WPI-1) form for each building, review exterior architectural and mechanical envelope assembly submittals, conduct periodic inspections of the installation of the exterior envelope assemblies, issue reports of finding of field inspections, conduct follow up inspections as deemed necessary by the Inspector and shall issue Inspection Verification (WPI-2) forms for each building. The Contractor shall include copies of each form and a final copy of the Windstorm Certificate of Compliance (WPI-8) form for each building with the substantial completion close-out documents.

1.2 CONTRACTOR'S DELEGATED RESPONSIBILITY – TDI WINDSTORM CERTIFICATION PROGRAM

- A. The Contractor is solely responsible for all activities, scheduling, safe access, and communication to achieve a windstorm certificate (WPI-8) from the TDI for each building. The contractor shall provide all construction services as needed to satisfy the requirements of the construction drawings and specifications, the referenced building code (International Building Code, 2018) and the TDI windstorm inspection program. The contractor shall contract with an Appointed Qualified Inspector (Inspector) as defined by the TDI windstorm program to provide field inspection services throughout construction. All construction administration costs, submittal preparation costs, submittal review by the Inspector costs, inspection costs, inspection coordination, including all general conditions, overhead and profit shall be included in the contractor's bid.
- B. The Contractor's Inspector shall submit an Application for Windstorm Inspection Certification of Compliance (WPI-1) form to the TDI for each individual building. The WPI-1 shall be issued within 30 days of Notice to Proceed, and shall be made available to the Owner, Architect and Authority Having Jurisdiction for construction permit applications as requested.
- C. The contractor shall make available all exterior envelope assembly submittals to their Inspector for windstorm construction compliance review and comment. Exterior envelope assembly submittals may include but are not limited to the following general items:
 - 1. Roofing assemblies
 - 2. Edge of roof details and parapet coping detail assemblies
 - 3. Soffit assemblies
 - 4. Roof mounted equipment curbs and attachment assemblies
 - 5. Wall mounted mechanical louvers and attachment assemblies
 - 6. Exterior wall cladding and finish assemblies
 - 7. Exterior doors and hardware assemblies
 - 8. Exterior overhead doors and hardware assemblies
 - 9. Exterior windows and storefront assemblies
- D. The Contractor and Inspector shall review submittals for compliance with the tested performance requirements noted in the IBC, 2018 for all door, window, storefront, wall cladding, roofing system, soffit and mechanical louver and roof mounted equipment assemblies. The contractor shall provide within the submittal substantiating product evaluation reports or tested assembly reports that confirm the tested performance requirements of the IBC are satisfied by the submitted assemblies.
- E. The Contractor shall coordinate appropriate inspections with the Inspector required to verify compliance of windstorm construction requirements as detailed by the TDI windstorm inspection program. The contractor and Inspector shall be responsible for the timing of the

inspection and safe access to the site to accommodate the needs of the Inspector throughout the entire construction.

- F. The Contractor and Inspector shall rely on the signed and sealed contract drawings as indication that the inspected buildings were designed in compliance with the International Building Code, 2018 edition. Any delegated design responsibilities of individual assemblies or components shall be the responsibility of the contractor as indicated on the contract drawings and specifications.
- G. The Contractor and Inspector shall provide site inspection reports to the Owner and Architect indicating compliance with installation details of exterior envelope assemblies or written remedial measures required by the Contractor to get inspected works in the field into compliance with submitted assembly installation details.
- H. The Contractor and Inspector shall provide a list of expected site inspections to the Owner and Architect within 30 days of the Notice to Proceed date. The inspection list shall identify the work in the field to be inspected and indicate the sequence of work at which time the Inspector will need to be present to observe the installed work prior to it being concealed by subsequent trade activities and material installation.
- I. The Contractor and Inspector shall conduct all windstorm inspections and activities required for certification of the buildings through the TDI Windstorm Certification program independent of all Architectural and Engineering Design Team field observations. The Contractor and/or the Inspector shall not rely on contract administration services from the Design Team as substitution for any delegated windstorm inspection service required by the TDI windstorm certification program and/or delegated within the contract documents to the Contractor.
- J. The contractor shall include a copy of the WPI-1, WPI-2 and WPI-8 forms for each individual building with all other substantial completion close-out documents. The contractor shall not rely on the WPI-2 from the Inspector as a means to satisfy this delegated responsibility. The windstorm inspection services delegated responsibility shall be considered incomplete until the Contractor delivers a copy a of the WPI-8 Certificate of Compliance for each individual building under contract.
- K. Should the project, Inspector or individual building be selected by the TDI for quality control auditing of the Inspector's work, the Contractor and Inspector shall be responsible for all time, documentation and field inspections requested by the TDI windstorm program to satisfy the audit requirements.

END OF SECTION 011100

SECTION 02200 EARTHWORK

PART 1 GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of earthwork is indicated on drawings.

Preparation of subgrade for building slabs, walks, and pavements is included as part of this work.

Backfilling of trenches within building lines is included as part of this work.

Definition: "Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

QUALITY ASSURANCE:

Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

Testing and Inspection Service:

Employ, at Contractor's expense, testing laboratory to perform soil testing and inspection service for quality control testing during earthwork operations.

SUBMITTALS:

Test Reports Excavating: Submit following reports directly to Architect/Engineer from the testing services, with copy to Contractor:

Field density test reports.

One optimum moisture maximum density curve for each type of soil encountered.

Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.

JOB CONDITIONS:

Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor.

Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

Operate warning lights as recommended by authorities having jurisdiction.

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

Perform excavation within drip line of large trees to remain by hand, and protect the root system from damage or dry out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.

PART 2 PRODUCTS

SOIL MATERIALS:

General:

Backfill and Fill Materials: Provide satisfactory soil materials for backfill and fill, free of clay, rock or gravel larger than 3" in any dimension, debris, waste, frozen materials, vegetable matter, and other deleterious matter. Use excavated or borrow material that has been sampled, tested and approved as satisfactory material. Backfill excavations as promptly as the work permits, but not backfill until completion of all inspections, testing, approvals, and recording locations of underground utilities.

Select Fill: Fill under all floor slabs (and extending 5'-0" beyond the building area), walks, and paved areas to consist of low plasticity index materials (12 or less) as approved by the Architect which is to be placed in 8" layers and compacted by use of sheep foot rollers, pneumatic tired roller, tamp rollers or other compaction equipment capable of obtaining the required density thru out the entire layer. This material shall be predominately sandy in nature, ideally with enough binder to facilitate trenching operations, and with more than 50% retained on a #200 sieve. On site materials are generally acceptable for use, but should be laboratory tested for compliance.

Sand Cushion: Material immediately below sidewalks and at other locations indicated on the drawings shall consist of a clean sand, free of silts, fines, or other organic impurities capable of supporting the migration of water, as approved by the Architect. This material shall be loosely compacted as in typical screeding and placement operations.

Dirt Fill: Fill dirt approved by the Architect shall be furnished, hauled, and spread on the site by this Contractor at all locations where other materials are not specified, and in accordance with drawings. High PI soils are not to be used for dirt fill.

All other materials, not specifically described but required for proper completion of the work of this Section, shall be as selected by the Contractor subject to the approval of the Architect.

PART 3 EXECUTION

GENERAL:

Ground Surface Preparation: remove vegetation, debris unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

When the existing ground surface is a density less than that specified under "Compaction" for the particular area classification, break up the optimum moisture content, and compact to the required depth and percentage of maximum density.

EXCAVATION:

Excavation to grades shown on drawings, if grades not shown excavate as required to accommodate installation.

Excavation consists of the removal and disposal of all materials encountered to obtain the required subgrade elevations, including earth, rock, etc., necessary for footings, columns, beams, slabs, etc.

Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations without the specific direction of the Architect.

Backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by the Architect.

Excavation for Pavements: Cut the ground under pavements to comply with the cross sections, elevations, and grade as shown on the drawings.

Excavation for Ditches: Cut ditches to the cross sections and grades as shown on the drawings. Deposit excavated materials a sufficient distance from the edges of ditches to prevent cave ins or material falling or sliding into ditch. Keep ditches free of an accumulation of leaves, sticks and other debris until final acceptance of work.

Removal of Unsatisfactory Soil Materials: Excavate unsatisfactory soil materials encountered that extend below the required elevations, to the additional depth directed by the Architect. Such additional excavation, provided it is not due to the fault or neglect of the Contractor, will be measured as directed by the Architect and paid for by the Owner as a change in the work. Where the removal of unsatisfactory soil materials, is due to the fault or negligence of the Contractor in his performance of earthwork and site grading operations, excavate the resulting unsatisfactory soil material and replace with compacted satisfactory soil material as required.

Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be at Contractor's expense.

Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Architect.

Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect.

Additional Excavation: When excavation has reached required subgrade elevations, notify Architect who will make an inspection of conditions.

If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Architect.

Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

Maintain sides and slopes of excavations in safe condition until completion of backfilling.

Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run off areas. Do not use trench excavations as temporary drainage ditches.

Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

Dispose of excess soil material and waste materials as herein specified.

Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

Do not backfill trenches until tests and inspections have been made and backfilling authorized by Architect. Use care in backfilling to avoid damage or displacement of pipe systems.

Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35° F. (1°C).

COMPACTION:

General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well defined moisture density relationship (cohesive soils) determined in accordance with ASTM D 1557; and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well defined moisture density relationship (cohesion-less soils).

Structures, Building Slabs: Compact subgrade and each layer of backfill or fill material at 95% relative density.

Lawn or Unpaved Areas: Compact top 6" of subgrade and each layer of backfill or fill material at 85% maximum density for cohesive materials and 90% relative density for cohesion-less soils.

Walkways: Compact top 6" of subgrade and each layer of backfill or fill material at 90% relative density.

Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.

Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

BACKFILL AND FILL:

General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.

In excavations, uses satisfactory excavated or borrow material.

Under grassed areas, use satisfactory excavated or borrow material.

Under walks and pavements, use subbase material or satisfactory excavated or borrow material, or combination of both.

Under building slabs, use drainage fill material.

Backfill excavations as promptly as work permits, but not until completion of the following:

Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
Inspection, testing, approval, and recording locations of underground utilities.

Removal of concrete formwork.

Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.

Removal of trash and debris.

Permanent or temporary horizontal bracing is in place on horizontally supported walls.

Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture condition to optimum moisture content, and compact to required depth and percentage of maximum density.

Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth for material compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand operated tampers.

Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

GRADING:

ROUGH GRADING

After excavation is made to lines shown on the Drawings, and under proposed embankments and structures, as adjusted for topsoil and landscaping depths, remove soft or undesirable material as specified in this Section. Break down sides or holes or depressions to flatten the slopes.

Locate and correct any irregularities in the subsoil, filling each depression with the appropriate subsoil resulting in a level surface. Place any fill necessary in layers moistened and compacted as specified in this Section.

Shape all areas designated for grading, including cut and fill areas, to receive a minimum of 4-inches of topsoil. Topsoil depth at areas receiving landscaping, shrubs or trees shall be coordinated through Landscaping Sections and Drawings

Scarify subsoil to a depth of 4 inches where topsoil is scheduled and in areas where subsoil has been compacted due to equipment activity. Shape all areas designated for grading, including cut and fill areas, to receive a minimum of four inches of topsoil.

Verify that subsoil has been appropriately contoured and shaped.

Tolerance on top surface of subgrade is plus/minus 1/10 foot.

FINISH GRADING

Place topsoil in areas where seeding, sodding and planting is indicated on Drawings or otherwise scheduled.

Place topsoil while soil is dry and during dry weather. Perform topsoil spreading so that planting can proceed with little additional tillage or soil preparation. Fine grade topsoil, eliminating rough or low rough areas. Manually place topsoil around trees, plants, and building to prevent any damage. Lightly compact topsoil.

Verify that finish grades and contours as indicated on Drawings have been maintained after placement of topsoil and any landscape soil.

Tolerance of finish grade is plus/minus 1/2".

FIELD QUALITY CONTROL

Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D2922-81 (nuclear density method), ASTM D 2167 (rubber balloon method), as applicable.

Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Architect.

Building Slab Subgrade: Make at least one field density test of subgrade for every 2000 sq. ft. of building slab, but in no case less than 3 tests. In each compacted fill layer,

make one field density test for every 2000 sq. ft. of overlaying building slab but in no case less than 3 tests.

If in opinion of Architect, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

MAINTENANCE:

Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

Repair and re establish grades in settled, eroded, and rutted areas too specified tolerances.

Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re shape, and compact to required density prior to further construction.

Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

DISPOSAL OF EXCESS AND WASTE MATERIALS:

Removal to Designated Areas on Owner's Property: Transport acceptable excess excavated material to designated soil storage areas on Owner's property. Stockpile soil or spread as directed by Architect.

Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.

END OF SECTION 02200

SECTION 02466 – DRILLED PIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Dry-installed straight shaft drilled piers, to be installed with use of temporary steel casings and/or the slurry displacement method, as required.
- B. Related Sections include the following:
 - 1. Division 3 – Section 03300 "Cast-In-Place Concrete" for general structural and building applications of concrete.

1.3 BASIS OF BIDS

- A. Base bids on indicated number of drilled piers; design length from top elevation to bottom of shaft, and diameter of shaft.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings Provide Electronic PDF's: For concrete reinforcement detailing fabricating, bending, and placing.
- C. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Laboratory Test Reports: For evaluation of concrete materials and mix design.
- D. Welding certificates.
- E. Qualification Data: For Drilled Pier Subcontractor and testing agency.
- F. Record drawings at Project closeout according to Division 1 Section "Closeout Procedures."

1.5 QUALITY ASSURANCE

- A. Drilled-Pier Standard: Comply with provisions in ACI 336.1, "Reference Specifications for the Construction of Drilled Piers," unless modified in this Section.

- B. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
 - 1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.
- C. Welding Standards: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- D. Trial Drilled Pier: Construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as drilled piers located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.
 - 1. Excavate shaft, install reinforcement, fill with concrete, and terminate trial drilled pier 30 inches below subgrade and leave in place.
 - 2. Install and remove temporary casings, as required.
 - 3. If Architect or Geotechnical Engineer determine that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.
- E. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
 - 1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
- B. Site Information: A geotechnical report has been prepared for this Project and is included elsewhere in the Project Manual for information only.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain. Cut bars true to length with ends square and free of burrs.

2.2 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II.
 - 1. Fly Ash Admixture: ASTM C 618, Class C.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, 1-inch maximum aggregate size.

- C. Water: Potable, complying with ASTM C 94/C 94M requirements.
- D. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 3. High-Range, Water-Reducing Admixture: ASTM C 494, Type G.
 - 4. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Sand-Cement Grout: Portland cement, ASTM C 150, Type II; clean, natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi (6.9 MPa), of consistency required for application.

2.3 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A 283/A 283M, Grade C; or ASTM A 36/A 36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

2.4 CONCRETE MIX

- A. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases.
 - 1. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis.
- B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4,000 psi
 - 2. Minimum Slump: Capable of maintaining the following slump until completion of placement:
 - a. 7 inches (+/- 1 inch).
 - 3. Do not air entrain concrete for drilled piers.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
- D. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval of proposed changes to concrete-mix proportions.

2.5 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. Do not add water to concrete mix after mixing.
 - 2. Maintain concrete temperature to not exceed 90 deg F (32 deg C).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

- A. **Unclassified Excavation:** Excavation is unclassified and includes excavation to bearing elevations regardless of character of materials or obstructions encountered.
 - 1. **Obstructions:** Unclassified excavation includes removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.
 - 2. **Obstructions:** Removal of unanticipated boulders, concrete, masonry, or other unforeseen obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets of size, power, torque, and downthrust necessary for the Work, will be paid according to Contract provisions for changes in the Work.
- B. **Classified Excavation:** Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations, as follows:
 - 1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets of size, power, torque, and downthrust necessary for the Work.
 - 2. Special excavation includes excavation that requires special equipment or procedures above or below indicated depth of drilled piers where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.
 - a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
 - b. Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock.
 - 3. **Obstructions:** Removal of unanticipated boulders, concrete, masonry, or other unforeseen obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets of size, power, torque, and downthrust necessary for the Work, will be paid according to Contract provisions for changes in the Work.
- C. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
- D. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
 - 1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 - 2. Remove water from excavated shafts before concreting.
 - 3. Excavate rock sockets of dimensions indicated.
 - 4. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.
- E. Notify and allow Owner's testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
 - 1. Do not excavate shafts deeper than elevations indicated, unless approved by Architect.
 - 2. Additional authorized excavation will be paid according to Contract provisions for changes in the Work.
- F. Excavate shafts for closely spaced drilled piers and those occurring in fragile or sand strata, only after adjacent drilled piers are filled with concrete and allowed to set.

- G. Temporary Casings: Provide watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
 - 1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
- H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
 - 1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.
- I. Inspection: Each drilled pier must be inspected and tested by Owner's testing and inspecting agency before placing concrete.
 - 1. Provide and maintain facilities with equipment required for testing and inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.
 - 2. Notify Architect and testing agency at least 24 hours before excavations are ready for tests and inspections.

3.3 STEEL REINFORCEMENT

- A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
- D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement.
- E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
- F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.
 - 1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 - 1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps.
 - 2. Vibrate top 60 inches of concrete.

- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.
 - 1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.
- D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
- E. Protect concrete work, according to ACI 301, from hot and cold temperatures that could cause physical damage or reduced strength.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
- F. When hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 90 deg F (32 deg C).
 - 1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers.
- B. A drilled-pier report will be prepared by Owner's testing and inspecting agency for each drilled pier as follows:
 - 1. Actual top and bottom elevations.
 - 2. Top of rock elevation.
 - 3. Description of soil materials.
 - 4. Description, location, and dimensions of obstructions.
 - 5. Final top centerline location and deviations from requirements.
 - 6. Variation of shaft from plumb.
 - 7. Shaft excavating method.
 - 8. Design and tested bearing capacity of bottom.
 - 9. Depth of rock socket.
 - 10. Levelness of bottom and adequacy of cleanout.
 - 11. Ground-water conditions and water-infiltration rate, depth, and pumping.
 - 12. Description, diameter, and top and bottom elevations of temporary or permanent casings.
 - 13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
 - 14. Shaft dimensions and variations from original design.
 - 15. Date and time of starting and completing excavation.
 - 16. Inspection report.
 - 17. Position of reinforcing steel.
 - 18. Concrete placing method, including elevation of consolidation and delays.
 - 19. Elevation of concrete during removal of casings.
 - 20. Locations of construction joints.
 - 21. Remarks, unusual conditions encountered, and deviations from requirements.
 - 22. Concrete testing results.
- C. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by Owner's testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.

1. Bearing Stratum Tests: Owner's testing agency will take undisturbed core samples from drilled-pier bottoms; test each sample for compression, moisture content, and density; and report results and evaluations.

D. Concrete: Sampling and testing of concrete for quality control may include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94/C 94M.
 - a. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test, but no fewer than one test for each concrete load.
 - b. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - c. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens, unless field-cured test specimens are required.
 - d. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier, but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and one specimen will be retained in reserve for later testing if required.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
4. Strength level of concrete will be considered satisfactory if averages of sets of 3 consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.45 MPa).
5. Test results will be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests will contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, concrete type and class, location of concrete batch in drilled pier, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
6. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as sole basis for acceptance or rejection.
7. Additional Tests: Testing and inspecting agency will make additional tests of concrete when test results indicate concrete strengths or other requirements have not been met.
 - a. Continuous coring of drilled piers may be required, at Contractor's expense, when temporary casings have not been withdrawn within specified time limits or where observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.

3.6 DISPOSAL OF MATERIALS

- A. Remove surplus excavated material and concrete and legally dispose of it off Owner's property.

END OF SECTION 02466

SECTION 03100 – CONCRETE FORMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Formwork for cast-in-place concrete including shoring, bracing and anchorage.
- B. Openings for other Work.
- C. Release agents and other related form accessories.
- D. Form stripping.

1.2 RELATED SECTION

- A. Section 03200 - Concrete Reinforcement
- B. Section 03300 - Cast-In-Place Concrete

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 347, Recommended Practice for Concrete Formwork.

1.4 DEFINITIONS

- A. Concealed: For Work required under this Section, the term "concealed" will mean "not exposed to view in finished construction."
- B. Exposed: For Work required under this Section, the term "exposed" will mean "exposed to view in finished construction."

1.5 QUALITY ASSURANCE

- A. Grading Rules. Rules of the following associations apply to materials furnished under this Section:
 - 1. Southern Pine Inspection Bureau (SPIB).
 - 2. Western Wood Products Association (WWPA).
- B. Tolerances: Follow ACI 301 (Table 4.3.1).

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.7 DESIGN CRITERIA

- A. Design, engineering, fabrication, erection, maintenance and removal of formwork shall be responsibility of Contractor.
- B. Construct forms following ACI 318, ACI 347, OSHA, state and local requirements.
- C. Provide forms with sufficient strength to withstand pressures resulting from concrete placement and vibration.
- D. Responsibility for properly bracing and shoring to support subsequent construction loads rests solely with Contractor.
- E. Responsibility for removal of forms at any time before concrete has obtained certified specified design strength rests solely with Contractor.
- F. The Engineer's efforts are aimed at designing a project which will be safe after full completion. The Engineer has no expertise in, and takes no responsibility for, construction means and methods or job Site safety during construction which are exclusively Contractor's responsibility. Processing and/or approving submittals made by Contractor which may contain information related to construction methods or safety issues, or participation in meetings where such issues might be discussed must not be construed as voluntary assumption by Engineer of any responsibility for safety procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS / PRODUCTS

- A. Use forms specified in the general notes of the structural drawings. Provide in largest practical sizes to minimize number of required joints.

2.2 MATERIALS

- A. Wood Form Materials:
 - 1. Reference general structural notes in sheet S1.1 for wood grade requirements.
- B. Preformed Steel Forms: Minimum 16 gauge (0.06"/1.5mm) matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- C. Form Release Agent: Colorless chemical form coating or mineral oil which will not stain concrete or absorb moisture.
- D. Form Ties: Standard coil or snap galvanized adjustable ties with 3/4" diameter plastic cones on exposed surfaces. Provide manufacturer's recessed plugs of gray plastic or concrete to seal tie holes.
- E. Nails, Spikes, Lag Bolts, Through Bolts and Anchorages: Sizes required; of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork.

- B. Verify that dimensions agree with drawings.

3.2 ERECTION / INSTALLATION / APPLICATION

- A. Follow ACI 301 and 347.
- B. Provide forms as follows:
 - 1. Concealed Surfaces: Rough or board form finish left by clean, straight formed lumber.
 - 2. Exposed Surfaces (Typical): Hardboard or plywood lined concrete forms.
- C. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to over-stressing by construction loads.
- D. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping.
- E. Align joints and make watertight. Keep form joints to minimum.
- F. Obtain approval before framing openings in structural members which are not shown.
- G. Provide 1" chamfer strips in exposed exterior corners of beams, girders, columns, walls or foundation forms, around tops of all foundation slabs and elsewhere shown.
- H. Provide temporary ports or openings in formwork required for cleaning out debris, adjusting reinforcing steel and to facilitate inspection.
- I. Coordinate with Work of other Sections which require attachment of components to formwork.
- J. Coat forms with non-staining form release agent. No other coating will be permitted unless specifically approved by Architect.
- K. Inserts, Embedded Parts and Openings:
 - 1. Provide formed openings required for items to be embedded in or passing through concrete Work.
 - 2. Locate and set in place items which will be cast directly into concrete.
 - 3. Coordinate with Work of other Sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, collars, thimbles, ties, sockets, nailing blocks, other inserts and components of other Work.
 - 4. Obtain required setting information before proceeding.
- L. Install accessories following manufacturer's instructions, straight, level and plumb. Ensure items are not disturbed during concrete placement.
- M. Form Removal:
 - 1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
 - 2. Loosen forms carefully. Do not wedge pry bars, hammers or tools against exposed concrete surfaces.
 - 3. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.
- N. Do not construct any masonry walls on concrete floors or walls until concrete has attained its design strength and forms and shoring have been removed.
- O. Terminate embedded form ties 1-1/2" from formed face of concrete. Construct ties so that ends and fasteners can be removed without causing spalling of face of concrete.

- P. Repair form tie holes as follows:
1. Below Grade Surfaces: Fill tie holes with waterproof bituminous mastic to prevent water infiltration.
 2. Above Grade Surfaces - Concealed: Fill tie holes with compatible materials flush with adjacent concrete.
 3. Above Grade Surfaces - Exposed: Fill tie holes with compatible materials flush with adjacent concrete. Repairs shall blend in inconspicuously with surrounding surfaces. Follow Section 03 30 00.
- Q. Finishes. Follow ACI 301 unless specifically shown otherwise.

3.3 TOLERANCES

- A. Formwork: Follow ACI 301.

3.4 FIELD QUALITY CONTROL

- A. Inspect erected formwork, shoring and bracing to ensure that Work follows formwork design and that supports, fastenings, wedges, ties and items are secure.

3.5 ADJUSTING AND CLEANING

- A. Clean forms as erection proceeds to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

END OF SECTION 03100

SECTION 03200 – CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel, welded wire fabric, tie wires and other related accessories.
- B. Work includes reinforcing for interior and exterior cast-in-place concrete.

1.2 RELATED SECTIONS

- A. Section 03300 - Cast-In-Place Concrete

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 301, Structural Concrete.
 - 2. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - 3. 318, Building Code Requirements for Reinforced Concrete.
- B. American Society for Testing and Materials (ASTM):
 - 1. A82, Cold Drawn Steel Wire for Concrete Reinforcement.
 - 2. A185, Welded Steel Wire Fabric for Concrete Reinforcement.
 - 3. A615, Deformed and Plain Billet Steel Bars for Concrete Reinforcement (including supplementary requirements)
- C. Concrete Reinforcing Steel Institute (CRSI):
 - 1. Manual of Practice.
 - 2. 63, Recommended Practice For Placing Reinforcing Bars.
 - 3. 65, Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

1.4 SUBMITTALS

- A. Submit:
 - 1. Shop drawings. Provide electronic (PDF) copies of each drawing.
 - a. Show reinforcing steel and wire fabric sizes, spacings, locations and quantities, bending and cutting schedules and supporting and spacing devices.
 - b. Indicate visual method of identification of bar strengths following ASTM standard for steel type used.
 - 2. Certified copies of mill test reports of reinforcement materials analysis (upon request).
- B. Provide submittals within 30 days after Contract date.

1.5 QUALITY ASSURANCE

- A. Maintain 1 copy of each referenced document at Site.
- B. Fabrication and Placement Tolerances: Follow ACI 301.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver to Site free of rust and scale, clearly marked as to bar strength.
- B. Store reinforcing materials on pallets or other materials off ground. Avoid surface contamination before placement and prevent bending or warping.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforcing Steel: ASTM A615, Grade 60 (60,000 psi yield strength) billet steel bars; unfinished. Provide in sizes shown on plans provide deformed bars typically and plain bars where dowels are shown.
- B. Stirrup Steel: #3 reinforcing bars may by ASTM A615 Grade 40.
- C. Welded Wire Fabric (WWF): ASTM A185, plain type; unfinished. Provide in sheet form not in rolls. Provide as sized if shown or as follows if not shown:
 - 1. Provide 1 layer of 6 x 6-W2.9 x W2.9 in sidewalk and toppings 4" or less in thickness.

2.2 ACCESSORIES

- A. Tie Wire: Minimum 16 gauge (0.06") annealed type.
- B. Chairs, Bolsters, Bar Supports and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions.
- C. Special Chairs, Bolsters, Bar Supports and Spacers Adjacent to Weather Exposed Concrete Surfaces: Stainless steel type; sizes and shapes required.

2.3 FABRICATION

- A. Fabrication: Follow CRSI Manual of Practice.
- B. Locate reinforcing splices not shown at points of minimum stress.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Foundations and Footings:

1. Clean excavations of loose debris and earth. Cut sides of excavations square and remove loose material.
 2. Pump out standing water from excavations before placing reinforcement. Remove and replace mud or frozen soil with lean concrete.
- B. Clean reinforcement completely before concrete placing. Reinforcement shall be free from loose, flaky rust, mud, oil or other coatings that would destroy or reduce bond with concrete at time concrete is placed. Reinspect reinforcement and clean off any dried cement, mortar or dirt when placement is delayed.
- C. Obtain Owner's Engineer's approval of reinforcement installations prior to placement of any concrete.

3.2 ERECTION / INSTALLATION / APPLICATION

- A. Position reinforcement following ACI 301, ACI 315 and drawn details.
- B. Provide reinforcing steel in concrete footings, foundation walls, thickened slabs, retaining walls and elsewhere shown.
- C. Provide corner reinforcing steel in footings at corners and at intersections of walls unless shown otherwise:
1. Bar size and spacing shall match wall or footing reinforcing.
 2. Return bars minimum of 36 diameters on each end.
 3. WELDING OF REINFORCING IS NOT PERMITTED.
- D. Provide the following minimum concrete cover requirements for reinforcing steel unless shown otherwise:
1. Concrete Cast Against and Permanently Exposed to Earth: 3".
 2. Concrete Exposed to Earth or Weather:
 - a. #5 Bars and Smaller: 1-1/2".
 - b. Others: 2".
- E. Provide minimum splice requirements for reinforcing steel shown or required by ACI 318. Stagger splices so that no more than 1/2 of horizontal reinforcing steel is spliced at any given cross section.
- F. Provide a bond breaker such as plastic sleeves at all dowel bars occurring at control and expansion joints.
- G. Place, support and secure reinforcement against displacement. Do not deviate from required position.
1. Provide bolsters and chairs required to maintain reinforcing steel at proper elevation in slab.
- H. Lap welded wire fabric minimum 6" or 1 full mesh on sides and 1 foot or 2 full meshes on ends and extend to within 2" of slab edges. Chair support welded wire fabric so that welded wire fabric is in upper half of slab while placing slabs on grade unless specifically shown otherwise.
- I. Carry welded wire fabric and reinforcing steel through control (contraction) joints but not through construction and expansion joints unless shown otherwise.
1. Grease dowels thoroughly and paper wrap to allow for horizontal movement at expansion joints.
 2. Cut alternate wires of welded wire fabric at control joints.
- J. Take care to avoid disturbing reinforcement and vapor retarder during placing of concrete. Remove and reinstall disturbed or improperly installed reinforcement when discovered or instructed by Owner's Engineer before continuing concrete placement.
- K. Accommodate placement of formed openings.

END OF SECTION 03200

SECTION 03300 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior and exterior plain and reinforced site-placed concrete, vapor retarders, expansion joints, curing compounds and other related accessories.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Masonry Wall Dowels.

1.3 RELATED SECTIONS

- A. Section 03200 - Concrete Reinforcement
- B. Section 04220 – Concrete Masonry Units

1.4 REFERENCES

- A. American Concrete Institute (ACI):

1. 301, Structural Concrete.
2. 302, Guide for Concrete Floor and Slab Construction.
3. 304, Measuring, Mixing, Transporting and Placing Concrete.
4. 305R, Hot Weather Concreting.
5. 308, Curing Concrete.
6. 309, Recommended Practice for Consolidation of Concrete.
7. 318, Building Code Requirements for Reinforced Concrete.

- B. American Society for Testing and Materials (ASTM):

1. C31, Making and Curing Concrete Test Specimens in the Field.
2. C33, Concrete Aggregates.
3. C39, Compressive Strength of Cylindrical Concrete Specimens.
4. C94, Ready Mixed Concrete.
5. C143, Test Method for Slump of Portland Cement Concrete.
6. C150, Portland Cement.
7. C171, Sheet Materials for Curing Concrete.
8. C172, Sampling Freshly Mixed Concrete.
9. C231, Air Content of Freshly Mixed Concrete by the Pressure Method.
10. C260, Air Entraining Admixtures for Concrete.
11. C309, Liquid Membrane - Forming Compounds for Curing Concrete.
12. C494, Chemical Admixtures for Concrete.
13. C618, Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.5 DEFINITIONS

- A. Concealed: For Work required under this Section, the term "concealed" will mean "not exposed to view in finished construction."

- B. Exposed: For Work required under this Section, the term "exposed" will mean "exposed to view in finished construction."

1.6 SUBMITTALS

- A. Submit: Provide electronic (PDF) copies of all required submittal information.
 - 1. Concrete mix designs. Follow ACI 301. Submit a mix design for each class of concrete required within 30 days after Contract date and prior to placing any concrete.
 - 2. Product data including installation requirements for curing/sealer compounds, mineral and chemical admixtures and joint devices.
 - 3. Concrete delivery tickets.
 - a. Submit to Owner's Engineer at Site.
 - b. Follow ASTM C94. Also include:
 - 1) Batch number.
 - 2) Mix by class of concrete and bag content with maximum aggregate size used
 - 3) Air content.
 - 4) Quantities and types of admixtures.
 - 5) Slump.
 - 6) Time of loading.
 - c. Delivery tickets not showing time of loading will be grounds for rejection of load.
 - 4. Testing laboratory reports.
 - a. Submit directly to Owner's Engineer, Contractor and ready-mix supplier.
 - 5. Certification or test results indicating compliance of material or source of material with these specifications (upon request).

1.7 QUALITY ASSURANCE

- A. Maintain 1 copy of each referenced document at Site.
- B. Acquire cement and aggregate from same source for all Work.
- C. Tolerances: Place and finish cast-in-place concrete within tolerance limits specified in ACI 301 and as follows:
 - 1. Formed Surfaces: Follow ACI 301 (Table 4.3.1.)
- D. Acceptance of Work: Presence or evidence of nonconforming Work shall be sufficient cause for Owner's Engineer to require entire section of concrete affected be torn out and rebuilt properly at Contractor's expense.
 - 1. Such unacceptable Work includes:
 - a. Horizontal or vertical misalignment.
 - b. Cracking.
 - c. Honeycombing.
 - d. Spalling.
 - e. Embedded debris.

2. If by tests or on-site observation, Owner's Engineer determines that any of Contract requirements have not been fully met in completion of this Work, he may require additional testing or retesting to determine composition, soundness and actual structural capacity of any concrete.
3. Costs for such testing shall be paid by Contractor if such tests subsequently establish that Work is unacceptable and by Owner if Work is found to be acceptable.
4. Remove and replace all unacceptable Work including related Work which was acceptable but which must be disturbed as a result of replacement if such tests establish that Work is unacceptable with regard to compliance with these specifications.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Concrete Delivery: Follow ACI 304 and ASTM C94.
- B. Deliver packaged materials in manufacturer's unopened, labeled containers.
- C. Store materials to provide protection from weather and damage.
- D. Deliver concrete in agitating or revolving type equipment. DO NOT USE NON-AGITATING EQUIPMENT.
- E. Discharge concrete at Site within 1-1/2 hours or 300 revolutions, whichever comes first, after water has been added to cement and aggregates or cement batches with aggregates unless a longer time is specifically authorized by Owner's Engineer.
- F. Owner's Engineer may require a reduction in this elapsed time during hot weather, when high early strength cement is being used or under other conditions contributing to quick stiffening of concrete.

1.9 PROJECT CONDITIONS

- A. Coordinate Work of other trades who will furnish and install items of Work (sleeves, piping, conduit, inserts, etc.) to be cast in concrete. Place no concrete until such items are in place.
- B. Place concrete at ambient temperatures between 50°F and 95°F.
- C. Follow instructions for special procedures at end of this Section should it be necessary to place concrete in colder or hotter weather.
- D. Protect freshly placed concrete from rainfall, water leaks, falling objects, traffic of any kind and other hazards to surfaces. Provide barricades and lights if necessary.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement:
 1. ASTM C150 Type II (Moderate).
 2. Cement shall be free of false set when tested following ASTM C451.
 3. Use same brand, type and source throughout.
- B. Aggregates:
 1. Fine Aggregate: ASTM C33; natural or manufactured sand, clean, hard and durable, uncoated grains, free from deleterious matter. Average fineness modulus shall be between 2.5 and 3.0.
 2. Coarse Aggregate: ACI 301 and ASTM C33.

- a. Interior and Concealed Exterior Applications: Crushed gravel or stone, durable uncoated particles free from deleterious matter.
- b. Exposed Exterior Applications: Crushed dolomite, granite or limestone.
- c. Grading: ASTM C33 No. 57. Exception: Use grade size No. 8 masonry core fill.

C. Admixtures:

1. Mineral Admixtures:

- a. Fly Ash: ASTM C618 Class C or Class F; maximum 25% fly ash may be used as a cement substitute; maximum 6% loss on ignition.
- b. Fly ash source must be approved by Owner's Engineer. Preapproved sources are:
 - 1) Class C: Boral Manufacturing

2. Chemical Admixtures:

- a. Air Entraining Admixtures: ASTM C260.
- b. Water Reducing Admixtures: ASTM C494 Type A (Water Reducing).
 - 1) Type E (Water Reducing and Accelerating) may be used during cold weather and Type D (Water Reducing and Retarding) during hot weather with Engineer's prior approval.
 - 2) Type F (Water Reducing - High Range) or Type G (Water Reducing High Range and Retarding) admixtures (superplasticizers) may be used with Engineer's prior approval.
- c. Calcium chloride, thiocyanates, corrosive admixtures or admixtures containing more than 0.05% chloride ions (total) are not permitted.

3. DO NOT USE ANY OTHER ADMIXTURES WITHOUT AEPSC'S PRIOR WRITTEN APPROVAL.

D. Water: Potable; free from objectionable quantities of foreign materials harmful to concrete such as silt, organic matter, acids, alkali, salt and other deleterious substances.

E. Vapor Retarders: Clear or black fungus resistant polyethylene or fabric reinforced plastic film recommended for below grade application; 10 mil thick. The vapor retarder should be installed according to ASTM E1643, "Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs."

F. Expansion Joint Filler Strips: ASTM D1751 non-extruding and resilient type, asphalt impregnated fiberboard or felt or ASTM D1752 closed cell foam with resiliency recovery of 95% if not compressed more than 50% of original thickness; 3/8" thick for interior and 1/2" thick for exterior unless shown otherwise.

G. Liquid Curing/Sealer Compound (Typical): ASTM C309 Type 1; approved by Asphalt and Vinyl Composition Tile Institute; 30% minimum solids content.

H. Sheet Curing Membranes: ASTM C171; absorptive mats, waterproof paper or polyethylene film.

2.2 CONCRETE MIXES

A. General Requirements:

- 1. Concrete Mixing: Follow ASTM C94. BATCH MIXING OF CONCRETE ON SITE IS NOT PERMITTED EXCEPT FOR MISCELLANEOUS MIXES.
- 2. Mixing Procedures: Follow ACI 301.
- 3. Handling and Weighing: Follow ACI 304.

4. Measure water, air entraining admixtures and water reducing admixtures by weight or volume. Measure all other materials by weight.
5. Provide admixtures for entrainment in concrete Work subject to vehicle abrasion or freeze - thaw cycles either during construction or afterwards. AIR ENTRAINED CEMENT IS NOT ACCEPTABLE.
6. Provide water reducing admixtures in all Classes of concrete Work.
7. No dry-packaged mixtures are allowed.
8. Provide fly ash as supplementary cementitious material in concrete Work. Fly ash content shall not exceed 25% of the cementitious material weight within a concrete batch.
9. Exposed concrete is to meet requirements for potentially destructive exposure.
10. Admixtures are to be added at batch plant.
11. Do not add water to mix on job unless previously approved by Owner's Engineer. Note amount of water added on delivery ticket.
12. Nominal maximum allowable slump of concrete (except for controlled density fill) is 4".
13. Follow Exhibit 03 30 00 for water/cementitious ratio of concrete.
14. Provide minimum 3 day compressive strength of 1800 psi for concrete used for floors.

B. Concrete Properties and Proportions:

1. Provide concrete meeting the following properties and performance specifications

a. Cast-In-Place Concrete (Class 1)

F'c	3,000 psi (28-day compressive strength)
Portland Cement	ASTM C 150 Type II
Fly Ash	ASTM C 618 Class C (Maximum of 25% of cementitious material)
Water/Cementitious Material Ratio	0.60 Maximum
Slump	5" (+/- 1") measured from the discharge of the truck
Coarse Aggregate	1" maximum with gradation requirements prescribed in Table 2 of ASTM C33 Size No. 57
Air Entrainment	Air entrainment shall not be used for concrete with exposed steel troweled surfaces
Total Air Content	3% Maximum (by volume)
Concrete Temperature	95°F Maximum

b. Drilled Pier Concrete (Class 2)

F'c	4,000 psi (28-day compressive strength)
Portland Cement	ASTM C 150 Type II
Fly Ash	ASTM C 618 Class C (Maximum of 25% of cementitious material)
Water/Cementitious Material Ratio	0.60 Maximum
Slump	7" (+/- 1") measured from the discharge of the truck
Coarse Aggregate	1" maximum with gradation requirements prescribed in Table 2 of ASTM C33 Size No. 57
Air Entrainment	Air entrainment shall not be used for concrete with exposed steel troweled surfaces
Total Air Content	3% Maximum (by volume)
Concrete Temperature	95°F Maximum

c. Masonry Grout Fill (Class 3)

F'c	3,000 psi (28-day compressive strength)
Portland Cement	ASTM C 150 Type II
Fly Ash	ASTM C 618 Class C (Maximum of 25% of cementitious material)
Slump	8" to 11" measured from the discharge of the truck
Coarse Aggregate	3/8" maximum with gradation requirements prescribed in Table 2 of ASTM C33 Size No. 8

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Site conditions and excavations for earth forms to verify that they are neatly and accurately cut and correctly located.
- B. Examine formwork to verify that it is sound and correctly located, that conditions are proper for concrete installation and that excavations are sufficient to permit placement, inspection and removal of forms.
- C. Examine reinforcement to verify requirements for concrete cover.
- D. Examine areas of Work to be cast to determine that substrates are properly installed, required reinforcement, inserts and embedded items are in place and that correct finish top of cast elevations can be obtained.
 - 1. Verify that conduit and piping is installed below slab. NO UTILITIES ARE TO BE BUILT INTO SLAB OR TOPPING.
 - 2. Verify depths of depressed conditions are correct for specified delayed finishes. Slabs to receive finishes over 1/8" in thickness shall be depressed as required to allow for alignment with adjacent finish materials.
 - 3. Verify base and sub-base slope correctly at floor drains. Slab thickness shall be maintained in sloped areas.
- E. Do not start Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Ensure availability of sufficient labor, equipment and materials to place concrete correctly following Project requirements and scheduled casting.
- B. Notify Owner's Engineer at least 48 hours in advance of placing any concrete. Place concrete only when Owner's Engineer is present unless this requirement is specifically waived. Excavations must be inspected and approved by soils engineer.
- C. Place no concrete before embedded items are in place and before forms, reinforcing and affected Work of other trades have been examined.
 - 1. Coordinate placement of joint devices with erection of formwork and placement of form accessories.
- D. Drill holes in previously poured concrete, insert steel dowels and pack solid with non-shrink grout in locations where new concrete is dowelled to existing Work including at bases and pads.
- E. Immediately Before Placing Concrete:
 - 1. Clean debris from forms, decks, base slabs, bottoms of forms, etc. to receive concrete.
 - 2. Thoroughly wet base of slabs poured directly on earth, sand, stone, concrete or gravel.
 - 3. Verify sizes and locations of openings required.
 - 4. Secure approval of conditions from Owner's Engineer. Allow a minimum of 1 hour for Owner's Engineer's inspection after installation of reinforcing and before placing concrete.

3.3 ERECTION / INSTALLATION /APPLICATION

- A. Follow ACI 301.

- B. Place concrete only when Owner's Engineer is present unless this requirement is specifically waived by Owner's Engineer upon notice of scheduled pour.
- C. Notify Owner's Engineer not less than 48 hours (excluding holidays and weekends) in advance of placing concrete.
- D. Provide concrete of following various classes unless shown otherwise.
 - 1. Class 1: Cast-In-Place Concrete
 - 2. Class 2: Drilled Pier Concrete
 - 3. Class 3: Masonry Grout Fill
- E. Provide uniform slope at rate shown on structural foundation plans. Exterior walkways shall slope as indicated on Architectural plans.
- F. Install vapor retarder under interior and exterior slabs, walks, bases and pads on grade.
 - 1. Lay film directly on slab base just before setting reinforcing and pouring concrete slabs. Provide widest widths practical and oriented to obtain least lineal footage of joint.
 - 2. Lap and seal joints. Lap film a minimum of 6" at joints with top lap placed in direction of spreading of concrete. Seal joints watertight by taping or applying sealant at overlapping edges and ends.
 - 3. Carry film up walls, columns, etc. and secure in place with cement or tape. Fold and cement corners or otherwise make vaporproof.
 - 4. Provide sealed contact with piping and other penetrating items. Cut film carefully around opening for pipes, ducts, conduit, wiring, etc. Tape film to insure maximum barrier effectiveness.
 - 5. Exercise care so that film is not punctured. Seal joints, cuts, punctures, etc. with tape, cement or hot iron.
 - 6. Trim exposed film at floor line after concrete has cured and hardened.
 - 7. Repair vapor retarder damaged during placement of concrete reinforcing.
- G. Provide sufficient workmen to allow for placement of concrete and other operations within time limits required in Article 1.07 herein.
- H. Keep delivery carts and buggies on runways. Do not allow them to bear on reinforcing or uncured concrete.
- I. Deposit concrete within 6 feet of its final location to avoid segregation due to rehandling or flowing. Do not drop concrete freely where reinforcing will cause segregation. Chuting procedure is subject to approval of Owner's Engineer. Maximum allowable drop is 5 feet. SPREADING WITH VIBRATORS IS PROHIBITED.
- J. Place concrete quickly and vibrate thoroughly with a vibratory screed or other device approved by Owner's Engineer. Maintain specified position of mesh and reinforcement. Follow ACI 309 for use and type of vibrators.
- K. Deposit concrete continuously, or when continuous placement is not possible, provide construction joints at locations approved by Owner's Engineer.
- L. Do not deposit partially set concrete, retempered concrete or any concrete failing slump or air content tests.
- M. Consolidate concrete by internal vibration to maximum practical density so that it is free from pockets of coarse aggregate and trapped air, fits tightly against subgrades, forms and embedded items and leaves smooth, dense surfaces.
- N. Operate vibrators using experienced workers and where possible use same operators throughout Project. DO NOT USE VIBRATORS AGAINST FORMS OR REINFORCEMENT.
- O. Finishes: Follow ACI 301 (Chapter 11). Perform finishing using only experienced, skilled workers.
 - 1. Flatwork:

- a. Slab finish shall be as noted on structural foundation plans. Reference structural general notes for flatness requirements pertaining to surface finish.
 - b. Detectable Warning Finish: For exterior handicapped curb cuts (ramp only not on flared sides), textured or imprinted concrete using rollers or aluminum tools to produce 0.9" diameter x 0.2" high (nominal) truncated domes at 2.35" on center following requirements of Americans With Disabilities Act (ADA).
2. Vertical and Miscellaneous Work:
- a. Exposed Surfaces: Smooth, Do Not Rub Cement Paste on Exposed Concrete Surfaces.
 - b. Concealed Surfaces: Rough form finish.
- P. Control (Contraction) Joints:
1. General Requirements:
 - a. Provide joints in walks, pads, slabs and toppings shown or specified.
 - b. Make joints approximately 1/8" wide and minimum depth of 1/4 slab thickness.
 - c. Locate as shown or as follows if not shown. Verify final locations with Owner's Engineer before proceeding.
 2. Interior Locations:
 - a. Provide sawed control joints where shown or at maximum 20 feet on center in each direction in slabs and toppings if not shown.
 - b. Install sawed joints immediately after final finishing to depth of 1/4 slab thickness with Soff-Cut saw.
 - c. Saw control joints 1/8" wide unless otherwise approved. A construction joint may be located where sawed joint is required.
- Q. Curing and Protection: Follow ACI 308.
1. Prevent excessive moisture loss from formed surfaces. Cure formed surfaces by moist-curing or application of curing compound for remainder of curing period if forms are removed before 7 days have elapsed.
 2. Provide 1 application of liquid curing/sealer compound immediately after finishing of concrete on interior and exterior concrete slabs.
 - a. Exception #1: Floors scheduled to receive ceramic tile and quarry tile shall be sheet membrane/water (moist) cured for minimum of 10 days.
 - 1) Begin water curing as soon as concrete has hardened sufficiently to prevent damage from water or cover material.
 - 2) Water curing shall consist of ponding or with sprinkling, spraying or covering with wet burlap, sand or waterproof barrier such as polyethylene or building paper.
 - 3) Maintain 100% coverage continuously over water cured slabs for minimum of 4 days for ponding and for 7 days for spraying and membrane curing.

3.4 FIELD QUALITY CONTROL

- A. Test and inspect materials and operations as Work progresses. Failure to detect defective Work shall not prevent rejection when defect is discovered nor shall it obligate Owner for final acceptance.
- B. Costs for any retesting resulting from Work found to be in non-compliance shall be paid for by Contractor.
- C. Strength: ASTM C31, C39 and C172.
 1. Conduct strength tests of all classes of concrete (except miscellaneous mixes).

2. Secure composite samples following ASTM C172. For strength tests, a sample shall be obtained from same batch of concrete on a representative, random basis. A sample consists of six specimens.
3. Mold and cure each sample following ASTM C31.
4. Test 1 specimen at 7 days, test 2 specimens at 28 days and 1 specimen at 56 days following ASTM C39. Results shall be average of strengths of 2 specimens, except that if 1 specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded.
5. Record exact location of Work represented by each sample on test reports.
6. Provide a sample for each amount or fraction thereof of each class of concrete placed each day as follows:
 - a. 0-100 Cubic Yards: 1 Sampling of 4 Cylinders.

D. Air Content: ASTM C231.

E. Slump: ASTM C143.

3.5 ADJUSTING AND CLEANING

- A. Provide materials, methods and finishes for cleaning, patching and other repairs consistent with similar concrete Work in place, approved by Owner's Engineer before beginning repair Work and performed at Contractor's expense.
- B. Repair any slabs which do not meet finish requirements performing all grinding, filling of cracks or patching and leveling procedures as required. Replace slabs which cannot be successfully repaired.
- C. Point carefully around piping, conduit and other penetrations on both interior and exterior surfaces.
- D. Obtain Owner's Engineer prior approval of any corrective measures for slabs which are dusting or showing other signs of improper curing. These may include additional applications of sealer or hardener, grinding or covering with coating or topping.
- E. Remove from interior and exterior exposed surfaces any stain-producing elements such as pyrites, nails, wire, reinforcing steel and form ties immediately prior to final acceptance.
- F. Remove stains completely. Use of weak acids or patented cleaners is acceptable but surface is to be completely neutralized after use.
- G. Blend in surfaces of exposed repairs inconspicuously with surrounding surfaces.

3.6 PROTECTION

- A. Protect newly placed concrete from weather and construction traffic damage.

3.7 SPECIAL PROCEDURES

- A. It is Project intent to continue concrete Work required to keep Project on schedule throughout summer and winter.
- B. Hot Weather Concreting:
 1. Follow ACI 305R.
 2. Obtain approval to use a retarder in concrete.
 3. Temperature of concrete shall not exceed 95°F.
 4. Cool water and aggregate to lower temperature of concrete.
 5. Cool subgrade and forms by sprinkling with water immediately before placing.

6. Schedule trucks to reduce waiting time at Site.
 7. Cure immediately after finishing.
- C. Replace any concrete injured or destroyed by reason of freezing, hot or cold weather at Contractor's own expense including cost of replacing any Work embedded in concrete.

END OF SECTION 03300

SECTION 04220 – CONCRETE MASONRY UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete masonry units, lintels, mortar and other related accessories.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Reinforcing steel.
- B. Masonry accessories.

1.3 RELATED SECTIONS

- A. Section 03200 – Concrete Reinforcement
- B. Section 03300 – Cast-In-Place Concrete

1.4 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 530, Building Code Requirements for Masonry Structures.
 - 2. 530.1, Specifications for Masonry Structures.
- B. American Society for Testing and Materials (ASTM):
 - 1. C33, Concrete Aggregates.
 - 2. C90, Load-Bearing Concrete Masonry Units.
 - 3. C140, Methods of Testing Concrete Masonry Units.
 - 4. C150, Portland Cement.
 - 5. C331, Lightweight Aggregates for Concrete Masonry Units.
 - 6. C618, Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
- C. Portland Cement Association (PCA): Recommended Practices For Laying Concrete Block.

1.5 DEFINITIONS

- A. Concealed: For Work required under this Section, the term "concealed" will mean "not exposed to view in finished construction."
- B. Exposed: For Work required under this Section, the term "exposed" will mean "exposed to view in finished construction."

1.6 SUBMITTALS

- A. Submit: Provide electronic (PDF) copies of all required submittal information.

1. Provide independent test reports following ASTM C140 for sampling and testing of CMU. Test reports shall be dated within six months of start of project. Test reports shall include net area compressive strength, absorption and density results, average width, height and length of each unit, minimum face shell thickness, average face shell thickness, minimum web thickness, average web thickness, and all other test reporting requirements as noted in ASTM C140.
2. Color samples for precolored units.
3. Masonry unit assembly components such as horizontal wire reinforcement, control joint material and masonry veneer ties.

1.7 QUALITY ASSURANCE

- A. Follow ACI 530 and 530.1.
- B. Maintain 1 copy of each referenced document at Site.
- C. Manufacturer: Current NCMA member.
- D. Provide units from single manufacturing source to ensure uniform texture for continuous and visually related areas.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver to Site only units properly cured and following these specifications.
- B. Protect masonry units from damage and against moisture and weather, particularly against freezing and thawing. Maintain hollow concrete masonry units in their initial dry state until after they are laid up in wall.
- C. Stack masonry units in dry place, off ground on prepared plank platform and in manner to promote circulation of air through and around block. Protect stacked block by shed roof or tarpaulin arranged to allow for circulation of air around and above stacked block.
- D. Carefully handle masonry units. Do not build units into Work with chipped edges, spalls or other damage to their appearance which would show in finished wall.
- E. Do not store adjacent to materials which can cause staining or discoloration.

1.9 PROJECT CONDITIONS

- A. Do not erect masonry when, in Owner's Engineer's opinion, atmospheric conditions or limited facilities prevent proper setting, bonding and curing.
- B. Protect tops of masonry walls against weather. Use strong, non-staining waterproof membrane secured with metal masonry wall clamps or properly weighted down. Maintain this protection during construction of walls and after their completion, properly anchored, repaired and replaced until tops of walls are covered by Work of others.
- C. Leave necessary openings for passage of pipes, drains, ducts, wires and utility lines. Form chases shown, required or directed. Return and solidly close all openings at completion of Work of other trades. Remove rubbish and sweep out area before closing up any pipe chase, duct space or similar limited access or inaccessible area.
- D. Coordinate with other trades and make provisions that will permit installation of their Work in manner to avoid cutting and patching. Build in items furnished by other trades as Work progresses.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150 Type 1.
- B. Lime: ASTM C207 Type S.
- C. Pozzolans: ASTM C618.
- D. Aggregates: ASTM D33 normal weight or ASTM C331 lightweight. Provide either normal, medium or light weight units unless shown otherwise.
- E. Mortar: Type S, following ASTM C270 Unit Proportion Requirements using preblended masonry cement.
- F. Integral Water Repellent: ASTM E514 Class E.
 - 1. Approved Product: Grace Construction Products' "Dry-Block" admixture.
- G. Integral Color: Integral color pigment mixed with cement and aggregates during fabrication to match local licensee's color selection(s).

2.2 CONCRETE BLOCK

- A. Hollow Units: ASTM C90 Type I; 1900 psi minimum compressive strength (net).

2.3 FABRICATION:

- A. Follow ACI and NCMA.
- B. Provide the following finishes and colors:
 - 1. Exterior Concrete Block: Manufacturer's regular (smooth) molded finish and precolored during fabrication.
- C. Provide integral water repellent in all exterior concrete block and exterior split face block units.
- D. Provide concrete masonry units with modular dimension; standard units 7-5/8" high, 1'-3-5/8" long and 3/8" less nominal widths or thicknesses shown or required, with permissible variation of 1/16".
- E. Provide special units for 90° corners, bond beams, bullnosed corners, control joint fillers, etc. shown or required.
- F. Cure units minimum 14 days in presence of moist air following ASTM C426.
 - 1. Provide block properly cured to 30% of maximum absorption. Questionable block will be tested and shipment rejected if average moisture content is found to exceed specification limits.
 - 2. Do not build in block with moisture content exceeding specification requirements into Work. Dry block containing excess moisture to acceptable maximum either by further air drying or use of heat before being used.
 - 3. No extension of time for completion will be allowed due to delay cause by failure of Contractor to maintain stored block at acceptable moisture content.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive Work.
- B. Inspect materials for defects before starting installation.
- C. Reject any chipped or broken block. DO NOT BUILD DAMAGED UNITS INTO WORK.

3.2 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied to other sections.
- B. Provide temporary bracing during installation of masonry Work. Maintain in place until building structure provides permanent bracing.

3.3 ERECTION / INSTALLATION / APPLICATION

- A. Follow ACI and NCMA.
- B. See Sections under which materials to be installed are furnished for additional installation requirements.
- C. Use thoroughly dry concrete block with sharp, square, unbroken corners and edges and no cracks. DO NOT WET MASONRY UNITS.
- D. Take special care in handling and storage of units for exposed block Work. Do not install chipped or marred block where exposed.
- E. Lay block in running bond with each course lapping block below by 1/2 block unless shown otherwise.
- F. Lay solid block units with full mortar coverage on head and bed joints and hollow block units with face shell bedding on head and bed joints. Mortar hollow block unit web joints in load bearing piers or pilasters, in starting course on footings or solid foundation walls and next to cores grouted solid.
 - 1. Do not shift or tap masonry after mortar has achieved initial set. Remove mortar and replace where adjustments must be made.
 - 2. Buttering corners of joints or excessive furring of mortar joints are not permitted.
- G. Build walls and partitions true to dimension, plumb and square, laid to line in level courses, accurately spaced and coordinated with other Work. Keep individual face units "in plane" with walls rising together. Use double lines in multiple-tier walls with each tier plumb and all units "in plane."
- H. Lay out Work to avoid fractional pieces. Interlock external corners. Set partitions on structural floor slabs before finish floor is laid unless shown otherwise.
- I. Perform required cutting with power equipment which will produce true, straight, clean edges free of chipping and undamaged surfaces. CUTTING WITH HAMMER AND CHISEL WILL NOT BE PERMITTED. Use 100% solid block where webs would be exposed. Minimum length of cut units on exposed Work shall be 1/2 unit.
- J. Cut units accurately to fit around pipes, ducts, openings, structural framing, etc. and slush voids full.

- K. Take particular care to embed conduits and pipes within block without fracturing exposed shells and to fit units around switch, receptacle and other boxes set in walls. Grind and cut units before building in service where electric conduit, outlets, switch boxes and similar items occur.
- L. Fill voids and joints between block and different types of materials with mortar.
- M. Make joints approx. 3/8" wide. Line up joints vertically. Remove burrs with burlap or carpet after tooling.
- N. Neatly tool interior and exterior joints below grade and in exposed masonry firm to slightly concave profile when mortar is thumbprint hard unless shown otherwise. Cut off flush and brush off surplus as Work progresses. Tool vertically then horizontally. Furnish all masons with joint tools of same diameter. Exception: Strike flush interior concealed joints (such as in chases and plenums) or those covered with directly applied finish materials.
- O. Install vertical and horizontal masonry reinforcing where shown. Grout cores solid full length of reinforcing with masonry core grout specified in Section 03300. Maintain position of reinforcing within 1/2" of dimensioned position.
- P. Fill voids receiving anchor bolts, wedge anchors, expansion bolts, etc. solid with masonry grout specified under Section 03300.
- Q. Provide solid masonry bearing surface under lintels, beams, bearing plates, etc. as shown. Provide the following minimum solid bearing (as applicable) if not shown:
 - 1. Lintels: Solid masonry bearing for full thickness of wall by length of bearing plus 8" by 8" high.
 - 2. Beams: Solid masonry bearing for full thickness of wall by length of bearing plus 1'-4" by 2 ft high.
- R. Provide solid masonry for course directly below corbelled masonry walls. Max corbel for each course is 1".
- S. Provide closure, lintels, bond beams, jamb units, sash, corners headers and other special shapes shown or required. Provide standard manufactured sizes or cut full size block for fractional course heights and lengths. Provide sash blocks or other shapes designed to receive specified control joint filler strips.
- T. Provide bullnosed units at exterior corners unless shown otherwise. Field grind to Owner's Engineer's satisfaction all external corners not installed bullnosed.
 - 1. Exception: Provide square cornered blocks at window jambs.
- U. Step back unfinished Work for joining with new Work. Tooothing will not be permitted unless specifically approved by Owner's Engineer. Remove loose masonry and mortar and clean thoroughly before new Work is started.
- V. Build in chases, openings, reinforcement, anchors, access doors, lintels, flashings and other items required. Provide centering required to properly support masonry until mortar attains design strength. Build in sleeves except where shown to be installed in other Sections.
- W. Build hollow metal door frames into wall. Plumb and brace. Thoroughly embed frame anchors. Slush frame jambs full with mortar. Allow 1/4" for caulking around frame in exterior walls and 1/8" on interior unless shown otherwise. Rake out joints for caulking.
- X. Fill masonry units solid with mortar 2 cores wide at each door jamb and 1 core wide at each window jamb for full height of opening.
- Y. Hold block down approximately 2" below roof structural members such as beams, joists and roof deck subject to deflection at non-bearing walls.
- Z. Provide control and expansion joints in all block Work. Reference Architectural Contract Drawings for masonry joint locations. Joints spacing shall not exceed 22 ft. on center nor shall a joint be located within two feet of an opening.

- AA. Build in control joint filler strips in control joints as masonry is laid up allowing for caulking on each side of wall. Reference architectural for caulking material. Exception: Do not carry horizontal joint reinforcement through control or expansion joints.
- BB. Maintain lateral support of intersecting masonry non- load bearing walls with wire mesh ties placed across joint between walls and spaced 1'-4" on center vertically.
- CC. Install concealed masonry flashing where shown. Provide clean smooth surfaces set in full mortar bed and cover with full mortar bed. Seal penetrations and joints with mastic.
- DD. Build in exposed sheet metal flashing, expansion joints and reglets occurring in masonry. Cut out mortar joint and set flashing or reglet in new mortar bed in existing construction.
- EE. Build in bond beams grouting full and carefully position reinforcing where shown. Lap rebars a minimum length of 48 bar diameters. Field modify standard units required to receive required reinforcing where bond beam units are not available in specified finish.
- FF. Any masonry Work found deficient in respect to these specifications will require entire wall to be removed and relayed at Contractor's expense.

3.4 TOLERANCES

- A. Maximum Variation From Unit to Adjacent Unit: 1/32".
- B. Maximum Variation From Plane of Wall: 1/4" in 10 feet and 1/2" in 20 feet or more.
- C. Maximum Variation From Plumb: 1/4" per story non-cumulative; 1/2" in 2 stories or more.
- D. Maximum Variation From Level Coursing: 1/8" in 3 feet, 1/4" in 10 feet and 1/2" in 30 feet.
- E. Maximum Variation From Joint Thickness: 1/8" in 3 feet.
- F. Maximum Variation From Cross Sectional Thickness of Walls: 1/4".

3.5 ADJUSTING AND CLEANING

- A. Replace any masonry units which are loose or damaged and repair defective mortar joints. Make these repairs such that evidence of repair is not apparent.
- B. Remove surplus mortar, drippings, splatter, etc. from exterior and interior masonry as Work progresses.
- C. Clean, point & dry brush all exposed Work at end of each working day. Fill holes from line pins and nails.
- D. Point joints to provide a neat uniform appearance. Cut out unrepairable defective joints. Fill solidly with mortar and tool to match adjacent Work. DO NOT CORRECT IMPERFECTIONS WITH SPACKLE.
- E. Thoroughly rub out exposed Work to remove any projections. Fill indentations flush with surface.
- F. Clean masonry surfaces upon completion from top down with water and fiber brushes to remove stains. ACID CLEANING OF MASONRY IS NOT PERMITTED.

END OF SECTION 04220

SECTION 05120 - STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
 - 2. Architecturally exposed structural steel.
 - 3. Grout.
- B. Related Sections include the following:
 - 1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Division 5 Section "Steel Deck" for field installation of shear connectors.
 - 3. Reference Architectural specifications for surface preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.
- B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Submit shop drawings of all structural steel members. Provide electronic (PDF) copies of each drawing. Shop drawings shall include fabrication piece drawings and field erection drawings. Structural construction drawings shall not be photocopied and submitted.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned bolted connections.
 - 5. For structural steel connections indicated to comply with design loads, include structural analysis data signed and sealed by a qualified professional engineer responsible for their preparations.
- C. Welding certificates.
- D. Qualification Data: For Installer and fabricator.

- E. Mill Test Reports: Submit mill test reports upon request by project engineer. Mill test reports shall be signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Direct-tension indicators.
 - 4. Tension-control, high-strength bolt-nut-washer assemblies.
 - 5. Shear stud connectors.
 - 6. Shop primers.
 - 7. Nonshrink grout.

- F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Erector Qualifications: A qualified erector who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE. In lieu of AISC certification, erector may, at the general contractor's recommendation and request, provide an in-house quality control program indicating compliance with minimum steel erection quality control requirements noted in AISC 360 – 10 "Specification for Structural Steel Buildings", Chapter N, subsection N2.

- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, under Building QMS Certification Program, Category BU. In lieu of AISC certification, fabricator may, at the general contractor's recommendation and request, provide an in-house quality control program indicating compliance with quality control procedures meeting minimum fabrication requirements noted in AISC 360 – 10 "Specification for Structural Steel Buildings", Chapter N, subsection N2.

- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303 "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. AISC 360 "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
 - 3. AISC's "Specification for the Design of Steel Hollow Structural Sections."
 - 4. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
 - 5. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

- E. Mockups: Build mockups of architecturally exposed structural steel to set quality standards for fabrication and installation.
 - 1. Coordinate finish painting requirements with Division 9 painting Sections.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M, ASTM A 572/A 572M, Grade 50 (345).
- B. Channels, Angles Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M for general use, and ASTM A 572/A 572M, Grade 50 (345) for metal building built-up plate section members.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 1. Weight Class: As indicated on structural drawings.
 2. Finish: Primed.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts;
 1. Finish: Plain
 2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8.) compressible-washer type.
 - a. Finish: Plain.
- B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round head steel structural bolts with splined ends; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 1. Finish: Plain.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- D. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
 1. Configuration: Straight.
 2. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 4. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.

5. Finish: Plain.
- E. Headed Anchor Rods: ASTM F 1554, Grade 36 straight.
 1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 3. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 4. Finish: Plain.
 - F. Threaded Rods: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6).
 1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 2. Washers: ASTM F 436 (ASTM F 436M) hardened and ASTM A 36/A 36M carbon steel.
 3. Finish: Plain.
 - G. Turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.
 - H. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.
 - I. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
 1. SSPC-Paint 25, Type I, zinc oxide, alkyd, linseed oil primer.

2.4 GROUT

- A. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.
 1. Camber structural-steel members where indicated.
 2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 3. Mark and match-mark materials for field assembly.
 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

5. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
 6. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning"
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.

3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.8 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings-- Allowable Stress Design and Plastic Design".
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

- G. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 - 1. In addition to visual inspection, field welds may be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 05120

SECTION 10800 TOILET ACCESSORIES

PART 1 GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of each type of toilet accessory is indicated on drawings and schedules.

Types of toilet accessories required include the following:

QUALITY ASSURANCE:

Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

Products: Provide products of same manufacturer for each type of accessory unit and for units exposed in same areas, unless otherwise acceptable to Architect.

SUBMITTALS:

Product Data: Submit manufacturer's technical data and installation instructions for each toilet accessory.

Setting Drawings: Provide setting drawings, templates, instructions, and directions for installation of anchorage devices in other work.

PART 2 PRODUCTS:

ACCEPTABLE MANUFACTURERS:

Bobrick Washroom Equipment, Inc.
Bradley Corporation

MATERIALS, GENERAL:

Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22 gage minimum, unless otherwise indicated.

Mirror Glass: FS DD G 451, Type I, Class 1, Quality q2, 1/4" thick, with silver coating, copper protective coating, and non metallic paint coating complying with FS DD M 411.

Galvanized Steel Mounting Devices: ASTM A 386, hot dip galvanized after fabrication.

Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.

FABRICATION:

General: Stamped names or labels on exposed faces of toilet accessory units are not permitted, except where otherwise indicated; unobtrusive labels on surfaces not exposed to view are acceptable. Where locks are required for a particular type of toilet

accessory, provide same keying throughout project. Furnish two keys for each lock.

Surface Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

- **Handicap Mirror:** Equal to Bobrick model no. B-1556 - 2448, Framed Mirror. Provide (4) four units to be located by Architect.

PART 3 - EXECUTION

INSTALLATION:

Install toilet accessory units in accordance with manufacturers' instructions, using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated. General Contractor to provide for solid 2x wood blocking at toilet accessories mounted at gypsum drywall partitons.

ADJUSTING AND CLEANING:

Adjust toilet accessories for proper operation and verify that mechanisms function smoothly.

Clean and polish all exposed surfaces after removing protective coatings.

END OF SECTION 10800

REVISIONS	BY
1	Addendum #1 (2-7-23)



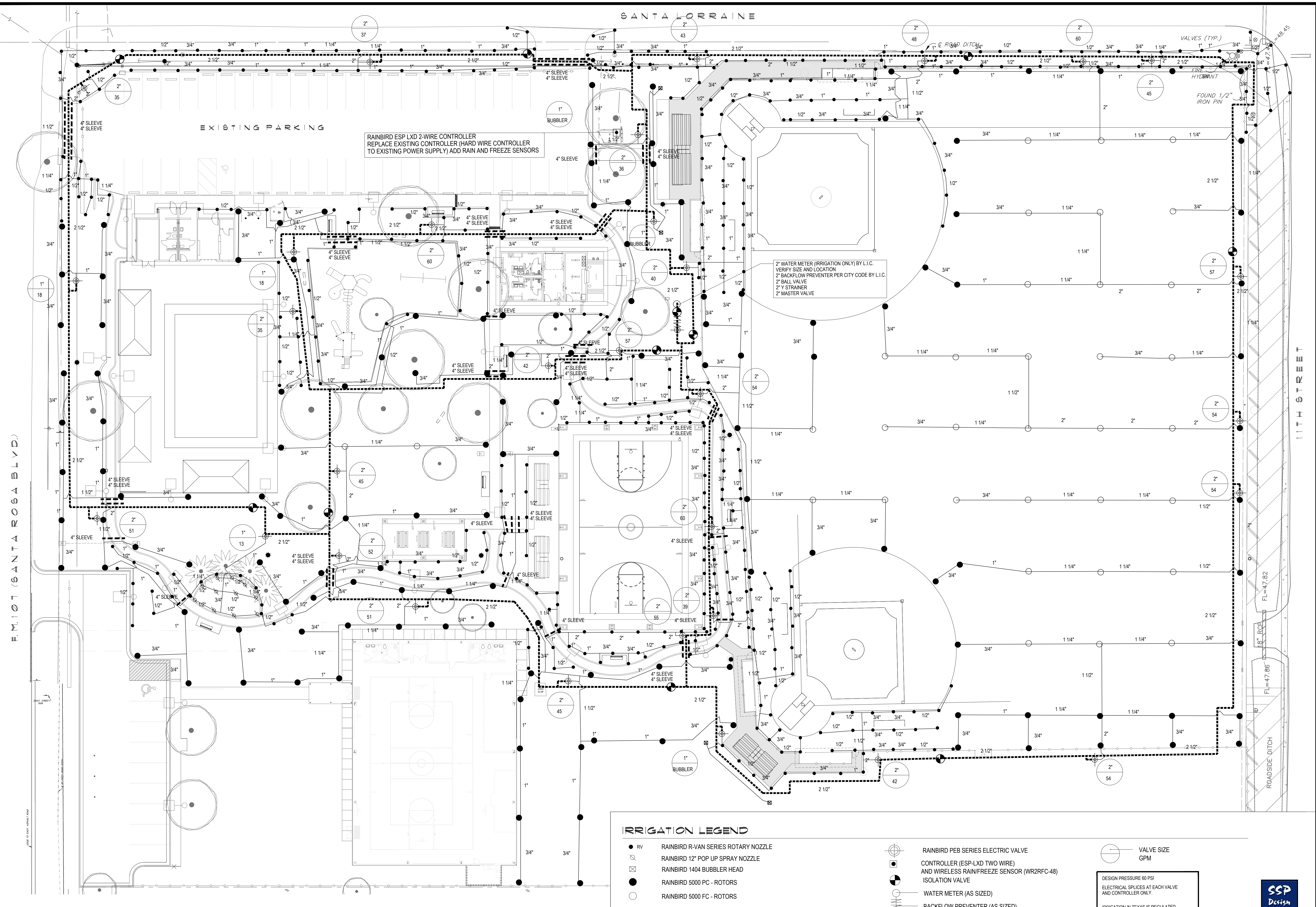
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CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS

LITH STREET

F.M.107 (SANTA ROSA BLVD.)



RAINBIRD ESP LX4 2-WIRE CONTROLLER
REPLACE EXISTING CONTROLLER (HARD WIRE CONTROLLER TO EXISTING POWER SUPPLY) ADD RAIN AND FREEZE SENSORS

2" WATER METER (IRRIGATION ONLY) BY I.I.C.
VERIFY SIZE AND LOCATION
2" BACKFLOW PREVENTER PER CITY CODE BY I.I.C.
2" BALL VALVE
2" Y STRAINER
2" MASTER VALVE

IRRIGATION LEGEND

- RV RAINBIRD R-VAN SERIES ROTARY NOZZLE
- ⊗ RAINBIRD 12" POP UP SPRAY NOZZLE
- ⊗ RAINBIRD 1404 BUBBLER HEAD
- RAINBIRD 5000 PC - ROTORS
- RAINBIRD 5000 FC - ROTORS
- ▲ RAINBIRD QUICK COUPLER VALVE (33-DLRC) QUICK COUPLERS SHALL BE CONNECTED TO MAINLINE ADD ONE ZONE THAT ACTIVATES MASTER VALVE AND ACTIVATES THE QUICK COUPLERS, LABEL ON COLORED ZONING DIAGRAM - LOCATED ALONG MAINLINE 200' SPACING
- ⊕ RAINBIRD PEB SERIES ELECTRIC VALVE
- ⊕ CONTROLLER (ESP-LX4 TWO WIRE) AND WIRELESS RAIN/FREEZE SENSOR (WR2RFC-48) ISOLATION VALVE
- WATER METER (AS SIZED)
- BACKFLOW PREVENTER (AS SIZED)
- CLASS 200 PVC LATERAL PIPING
- - - CLASS 200 PVC MAINLINE
- - - SCH. 40 PVC SLEEVING (AS SIZED)
- VALVE SIZE GPM

DESIGN PRESSURE 60 PSI
ELECTRICAL SPLICES AT EACH VALVE AND CONTROLLER ONLY.

IRRIGATION IN TEXAS IS REGULATED BY THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ)
MC-1781 P.O. BOX 13087 AUSTIN, TX 78711-3087, TCEQ'S WEBSITE IS: www.tceq.state.tx.us



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1 IRRIGATION PLAN
SCALE: 1" = 20'-0"



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Gomez Mendez Saenz Inc.
Architects-Planners
Interior Designers

Date: February 1, 2023
Scale: As Noted
Project Architect: Roan G. Gomez, AIA
Drawn By: JO
Job No. CC PARKS SANTA ROSA
Sheet:

IRRIGATION LEGEND

- RV RAINBIRD R-VAN SERIES ROTARY NOZZLE
- ⊗ RAINBIRD 12" POP UP SPRAY NOZZLE
- ⊗ RAINBIRD 1404 BUBBLER HEAD
- RAINBIRD 5000 PC - ROTORS
- RAINBIRD 5000 FC - ROTORS
- ▲ RAINBIRD QUICK COUPLER VALVE (33-DLRC) QUICK COUPLERS SHALL BE CONNECTED TO MAINLINE ADD ONE ZONE THAT ACTIVATES MASTER VALVE AND ACTIVATES THE QUICK COUPLERS. LABEL ON COLORED ZONING DIAGRAM - LOCATED ALONG MAINLINE 200' SPACING
- ⊕ RAINBIRD PEB SERIES ELECTRIC VALVE
- CONTROLLER (ESP-LXD TWO WIRE) AND WIRELESS RAIN/FREEZE SENSOR (WR2RFC-48) INCL. TESTING AND TRAINING
- ⊖ ISOLATION VALVE
- WATER METER (AS SIZED)
- ⊕ BACKFLOW PREVENTER (AS SIZED)
- CLASS 200 PVC LATERAL PIPING
- - - CLASS 200 PVC MAINLINE
- - - SCH. 40 PVC SLEEVING (AS SIZED)
- VALVE SIZE
- GPM

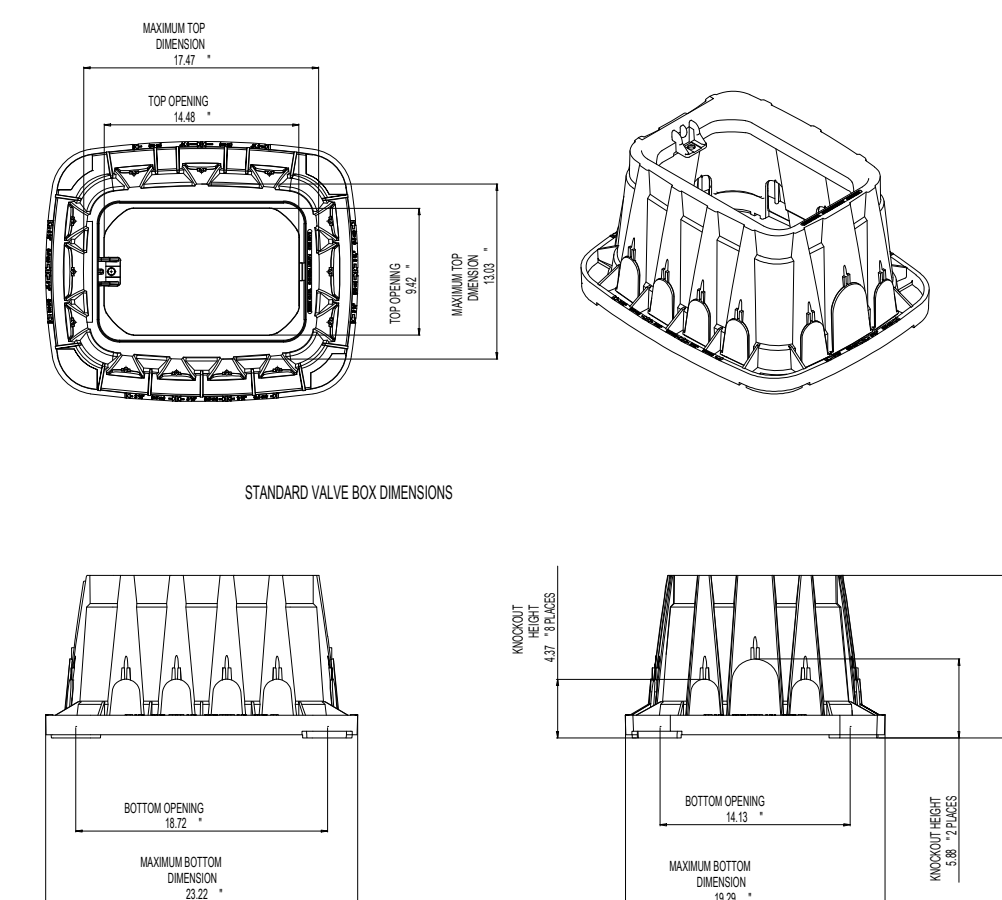
DESIGN PRESSURE 60 PSI
ELECTRICAL SPLICES AT EACH VALVE AND CONTROLLER ONLY.
IRRIGATION IN TEXAS IS REGULATED BY THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) MC-178/ P.O. BOX 13087, AUSTIN, TX 78711-3087. TCEQ'S WEBSITE IS: www.tceq.state.tx.us

BUBBLER PIPING CHART

NUMBER OF BUBBLERS	SIZE OF PIPE
1 - 5	1/2"
6 - 10	3/4"
11 - 20	1"
21 - 30	1 1/4"
31 - 40	1 1/2"

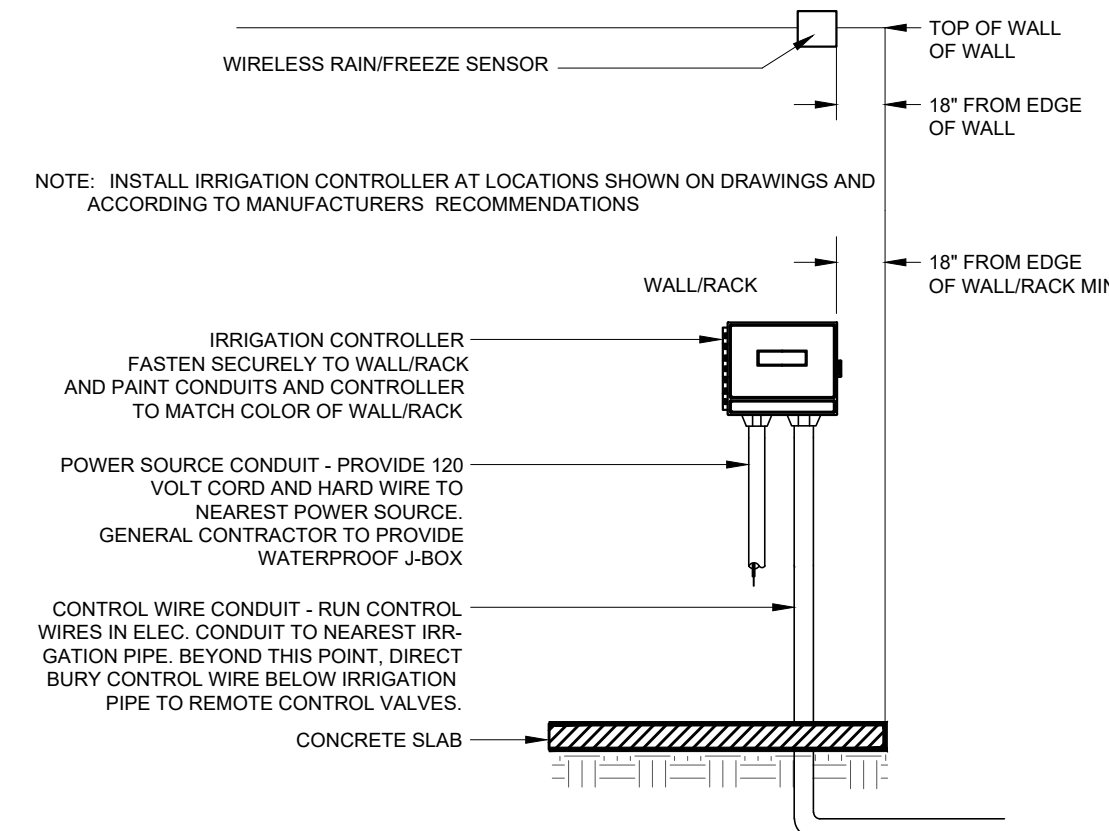
IRRIGATION NOTES

- All equipment numbers reference Rainbird equipment catalog unless otherwise indicated.
- LAWN SPRAY HEADS are RVAN installed as per detail.
- SHRUB SPRAY HEADS are RVAN installed as per detail.
- ELECTRIC CONTROL VALVES shall be PEB installed as per detail shown. Size valves as shown on plans. Valves shall be installed in valve boxes large enough to permit manual operation, removal of solenoid and/or valve cover without any earth excavation. (Refer to Specifications)
- AUTOMATIC CONTROLLER shall be installed at location shown. Power (120V) shall be located in a junction box within five feet (5') of controller location. Power supply and junction box to be provided by General Contractor.
- All 24 volt valve wiring is to be UF 14 single conductor. All wire splices are to be permanent and waterproof. (Refer to Specifications)
- SLEEVES shall be supplied and installed by Irrigation Contractor. Sleeve material shall be Schedule 40. Bore under existing pavement as required. Sizes as indicated on plans.
- Ten days prior to start of construction, contractor shall verify static water pressure. If static pressure is less than 50 PSI, do not start work until notified to do so by SSP Design.
- All mainline and lateral piping shall have a minimum of 12 inches of cover. All piping under paving shall have a minimum of 18 inches of cover. (Refer to Specifications)
- The irrigation contractor shall coordinate installation of the system with the landscape contractor so that all plant material will be watered in accordance with the intent of the plans and specifications.
- The irrigation contractor shall select the proper arc and radius for each nozzle to insure 100% and proper coverage of all lawn areas and plant material. All nozzles in parking lots and planting beds shall be low angle to minimize overspray on pavement surfaces. No water will be allowed to spray on building.
- The irrigation contractor shall warranty all system components for a period of one year plus 20 days. (Refer to Specifications).
- See specifications for further instructions and project requirements. Contractor shall follow specification section 328000 - Site Irrigation for any discrepancies between plans and specifications.

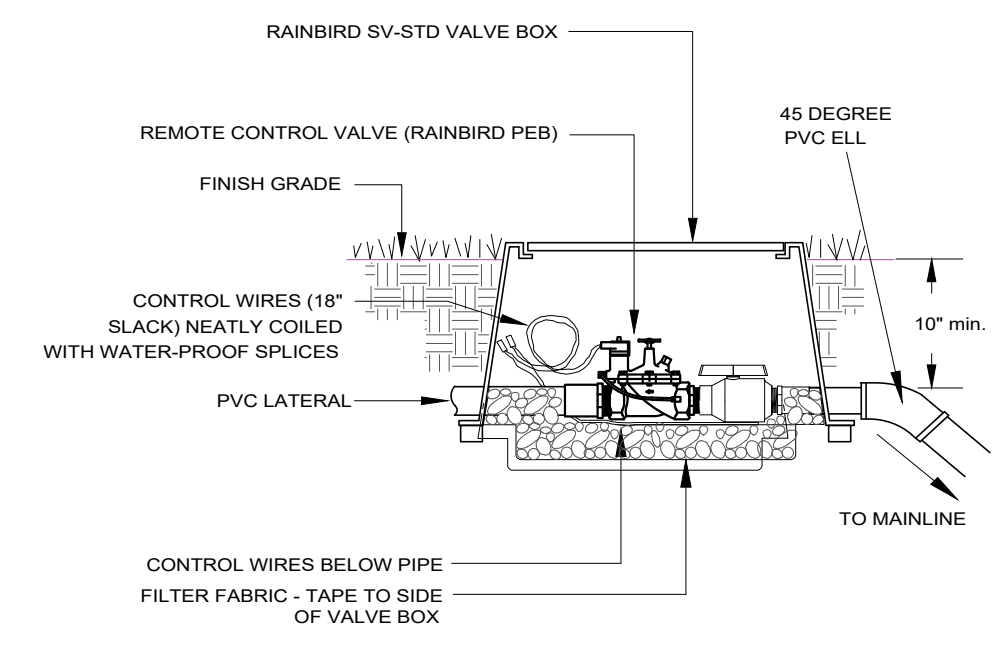


ALL VALVE BOXES SHALL BE RAINBIRD VB-STD OR APPROVED EQUAL
ALL VALVE BOXES SHALL HAVE FILTER FABRIC AND 4" OF GRAVEL AT BASE

1 VALVE BOX (VB-STD)
NOT TO SCALE

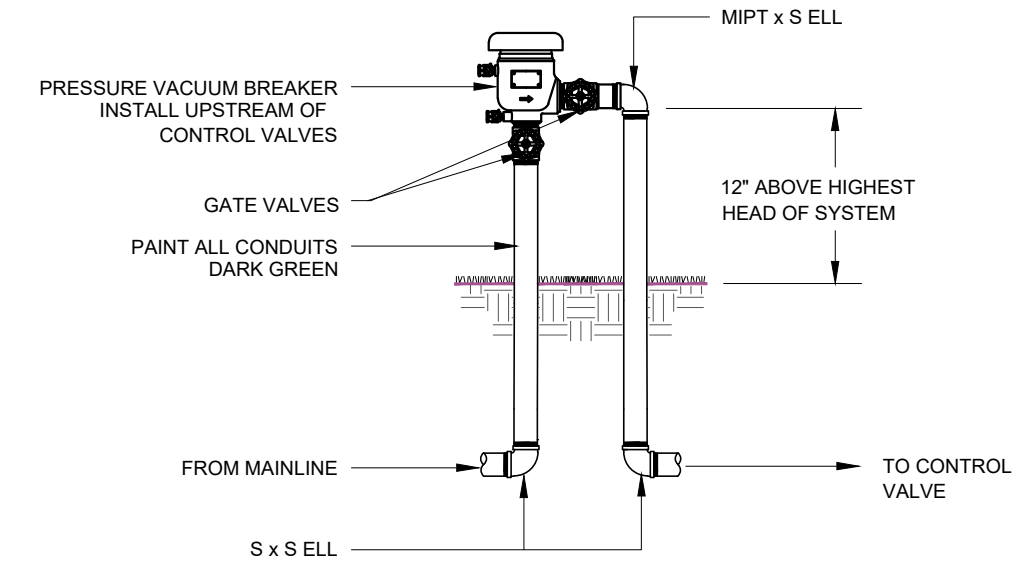


2 WALL/RACK MOUNTED CONTROLLER
NOT TO SCALE

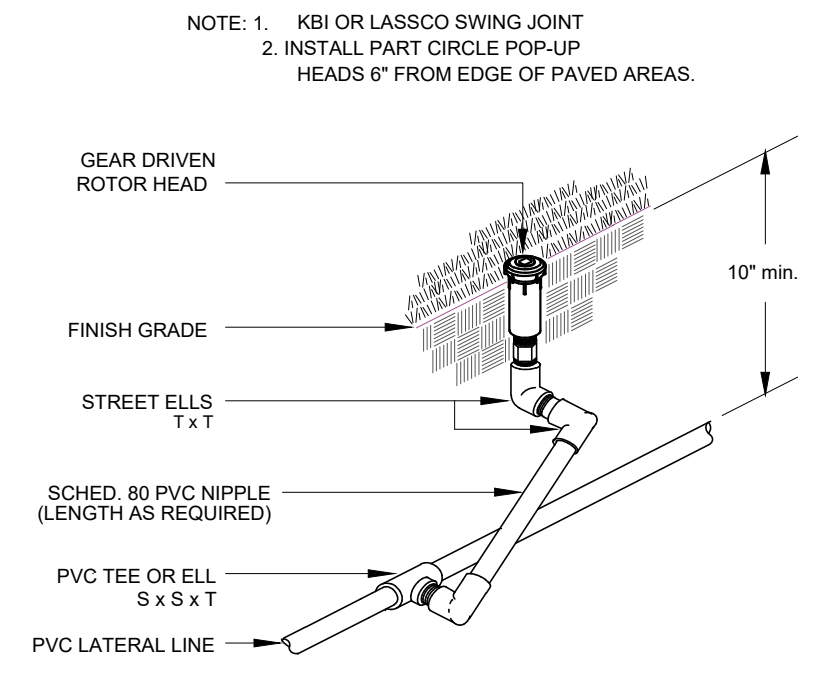


ALL VALVE BOXES SHALL HAVE FILTER FABRIC AND 4" OF GRAVEL AT BASE

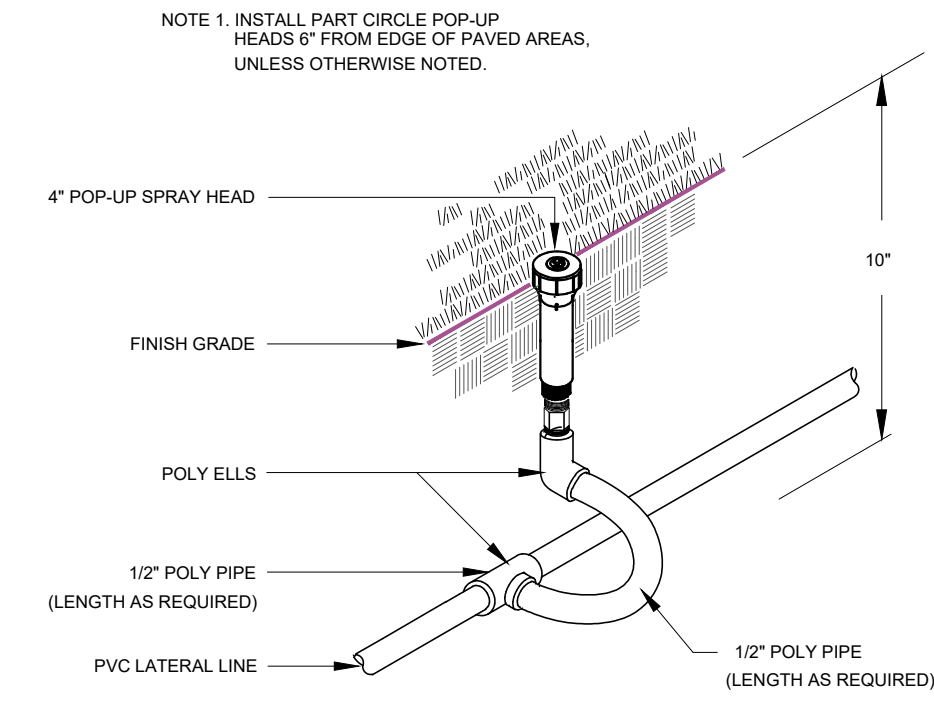
3 REMOTE CONTROL VALVE
NOT TO SCALE



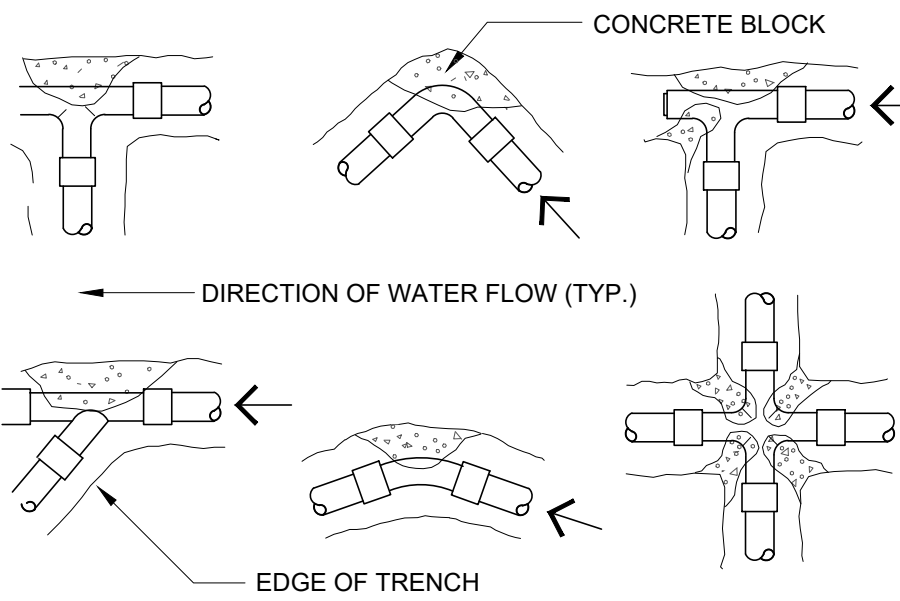
4 PRESSURE VACUUM BREAKER
NOT TO SCALE



5 ROTOR POP-UP
NOT TO SCALE



6 LAWN POP-UP HEAD
NOT TO SCALE



THRUST BLOCK BEARING AREA (SQ. FT.)

PIPE SIZE	1 1/4" - 2 1/2"	3"	4"
TEES/ELLS	1.00	1.00	1.25
90 BENDS	1.00	1.25	2.00
45 BENDS	1.00	1.00	2.4

NOTE: INSTALL THRUST BLOCK AT ALL MAINLINE BENDS, TEES OR ELLS AS SHOWN BELOW. THRUST BLOCKS SHALL BE MINIMUM OF (1) CU. FT. READY-MIX CONCRETE OR 2500 PSI 28 DAY CONCRETE.

7 THRUST BLOCK DETAIL
NOT TO SCALE



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Project Architect: Roan G. Gomez, AIA
Drawn By: IO
Job No. CC PARKS SANTA ROSA
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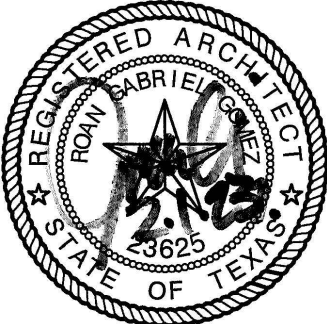
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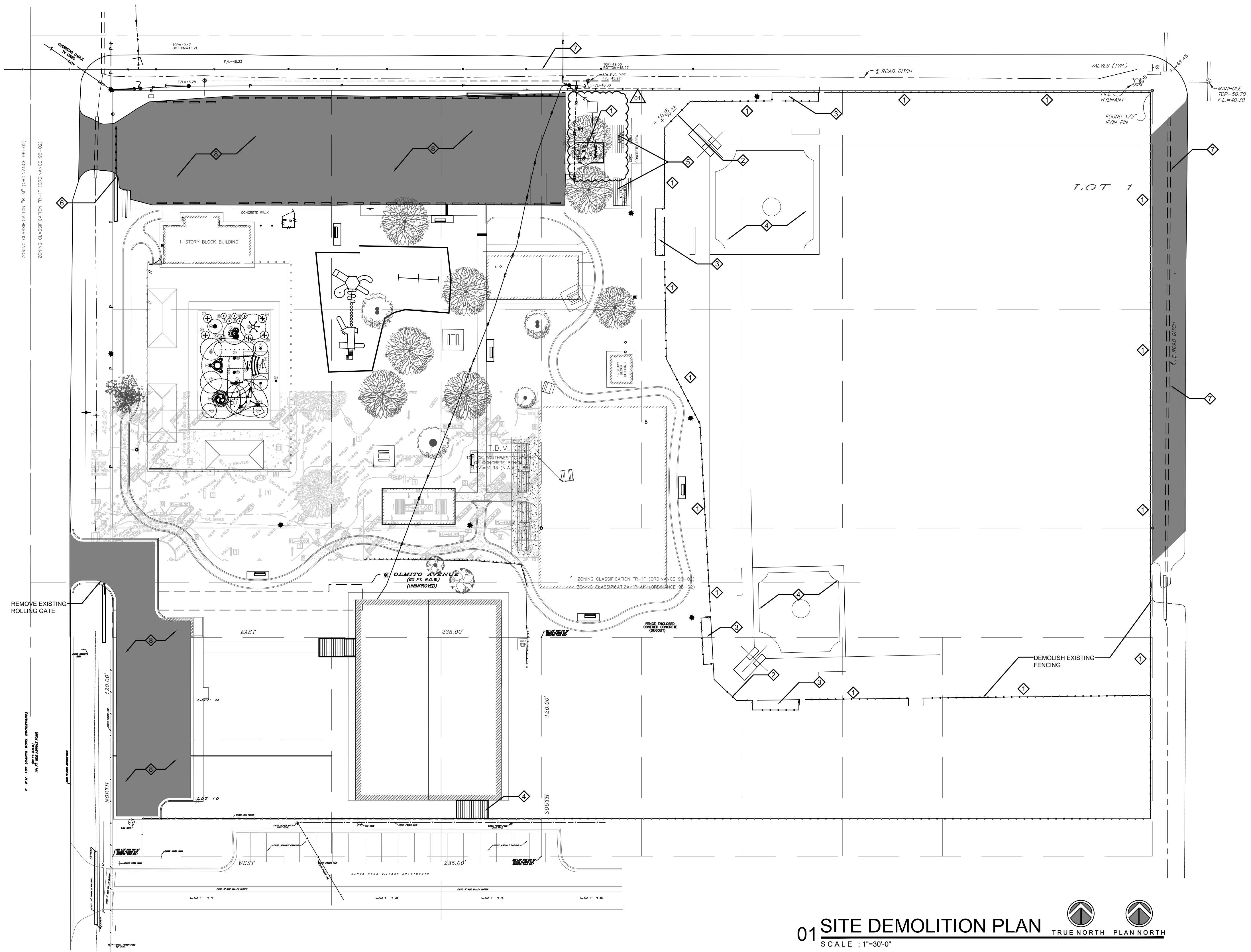
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 Project Architect: Roan G. Gomez, AIA
 Drawn By: RN
 Job No. SANTA ROSA - PHASE 2
 Sheet:

D1.01

- KEYED DEMOLITION NOTES:**
- ① DEMOLISH EXISTING CHAIN LINK FENCING.
 - ② DEMOLISH EXISTING CHAIN LINK BACKSTOP.
 - ③ DEMOLISH EXISTING COVERED DUGOUTS.
 - ④ CLEAR VEGETATION AND STRIP TOPSOIL.
 - ⑤ DEMOLISH EXISTING CONCRETE PAD AND BLEACHERS.
 - ⑥ DEMOLISH EXISTING ACCESS GATE.
 - ⑦ CLEAR VEGETATION FOR ADDITIONAL PAVING IMPROVEMENTS.
 - ⑧ PREPARE ASPHALT PARKING AREAS FOR IMPROVEMENTS.
 - ⑨ XX



01 SITE DEMOLITION PLAN
 SCALE : 1"=30'-0"

- DEMOLITION NOTES:**
- A. GENERAL CONTRACTOR TO TAKE CARE NOT TO DAMAGE EXISTING FOUNDATION, STRUCTURAL STEEL BEAMS / COLUMNS, SURROUNDING BUILDINGS AND VARIOUS SURFACES OUTSIDE OF DEMOLITION AREA. SHOULD ANY DAMAGE OCCUR OUTSIDE OF DEMOLITION AREA, THE GENERAL CONTRACTOR WILL BE RESPONSIBLE TO REPAIR OR REPLACE DAMAGED ITEMS.
 - B. GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING AND DISPOSING DEBRIS & MATERIAL AWAY FROM SITE ACCORDING TO LOCAL & STATE REGULATIONS.
 - C. PATCH TO MATCH ALL FINISHES DISTURBED BY THE DEMOLITION AND IMPROVEMENTS.
 - D. REFER TO CIVIL AND MEP DOCUMENTS FOR ADDITIONAL WORK TO BE PERFORMED IN THESE AREAS.
 - E. PRE BID - GENERAL CONTRACTOR IS TO BE RESPONSIBLE FOR FAMILIARIZING THEMSELVES WITH THIS PROJECT SITE AND INCLUDE IN BID ALL NECESSARY DEMOLITION REQUIRED FOR IMPROVEMENTS, WHETHER NOTED OR NOT.
 - F. PRE BID - GENERAL CONTRACTOR IS TO BE RESPONSIBLE FOR NOTIFYING ARCHITECTS OFFICE WITH AN RFI IN THE CASE DISCREPANCIES WITH PLANS AND EXISTING CONDITIONS ARE PRESENT.
 - G. IT IS RECOMMENDED THAT PHOTOS OF BOTH INTERIOR AND EXTERIOR OF THE PROJECT BE TAKEN TO SHOW EXISTING CONDITIONS.
 - H. ANY MATERIAL AND/OR EQUIPMENT SCHEDULED TO BE REMOVED THAT CAN BE SALVAGED MUST BE TURNED OVER TO THE OWNER FOR THEIR USE & DISPOSITION. IF SO DIRECTED BY THE OWNER, GENERAL CONTRACTOR SHALL PROPERLY DISPOSE OF ANY TRASH OR DEBRIS FOLLOWING LOCAL & STATE REGULATIONS.
 - I. COORDINATE WITH ARCHITECT AND/OR ENGINEERS PRIOR TO ANY DEMOLITION ITEMS THAT ARE UNCLEAR.

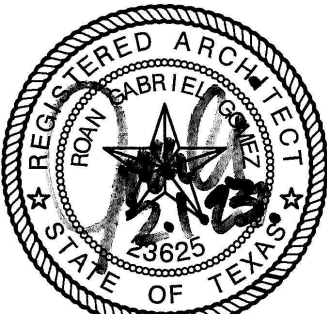
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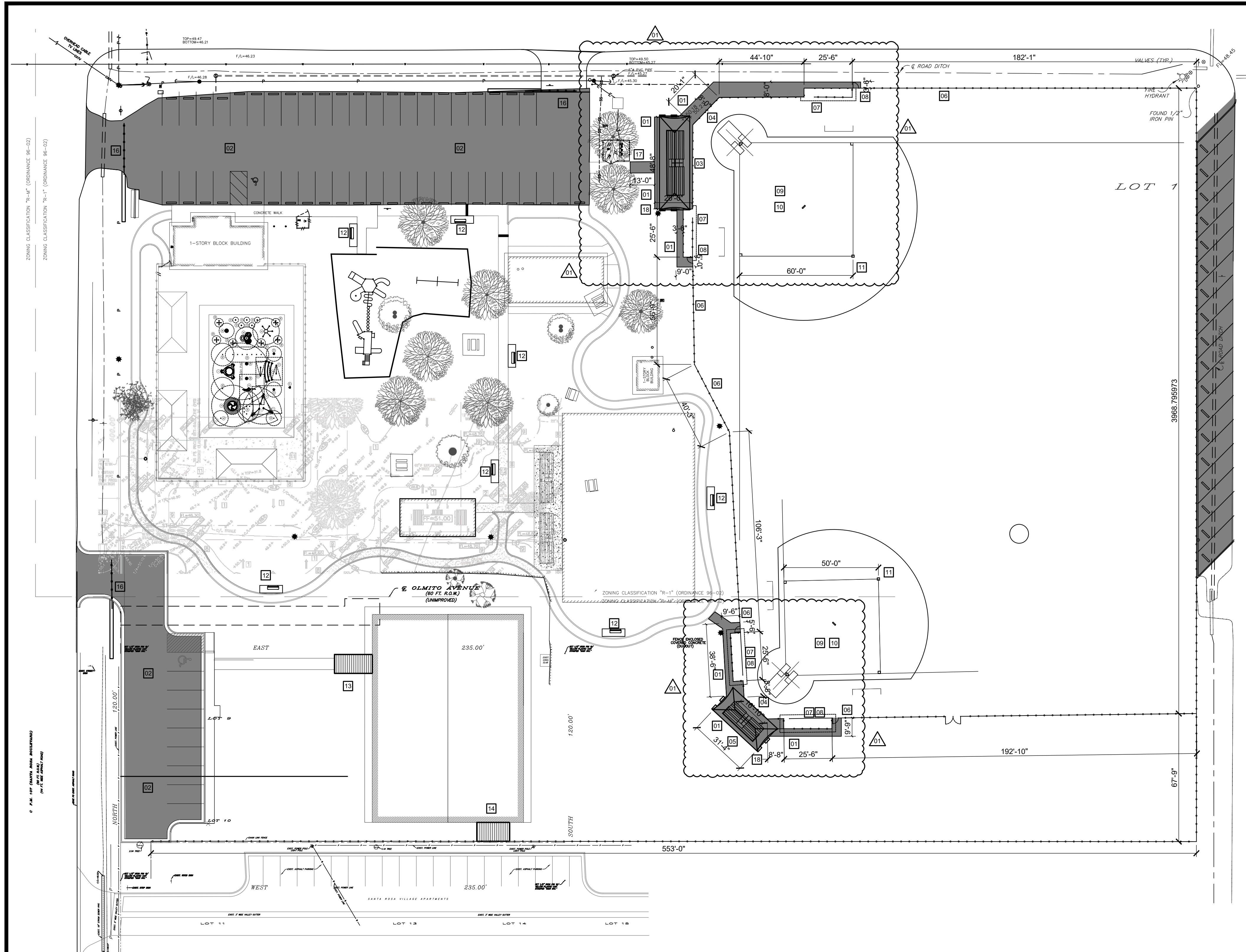
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Drawn By: RN
Job No.: SANTA ROSA - PHASE 2
Sheet:

A1.01



KEYED NOTES

- 01 CONCRETE WALK AS DIMENSIONED, REFER TO DTL'S 01, 02, 03 THIS SHEET
- 02 ASPHALT OVERLAY AT EXISTING LOTS
- 03 PROVIDE (1) -33' X 5 ROW PICKET GUARD RAIL ALUMINUM BLEACHERS, FASTEN TO CONCRETE FOUNDATION. MODEL # BGS-126 BY BELSON OUTDOORS 1-800-323-5664. WWW.BELSON.COM
- 04 20'-0" HIGH GALVANIZED CHAIN LINK BACKSTOP.
- 05 PROVIDE (1) -21' X 5 ROW PICKET GUARD RAIL ALUMINUM BLEACHERS, FASTEN TO CONCRETE FOUNDATION. MODEL # BGS-008 BY BELSON OUTDOORS 1-800-323-5664. WWW.BELSON.COM
- 06 4'-0" HIGH GALVANIZED CHAIN LINK FENCE WITH DOUBLE 4'-0" GATES TO BE LOCATED BY ARCHITECT.
- 07 25'-0" WIDE DUGOUTS WITH FULL HEIGHT CHAIN LINK SURROUND
- 08 PREFINISHED METAL CANOPY AT DUGOUTS
- 09 CLAY BASEBALL INFIELD. REFER TO LANDSCAPE FOR ADDITIONAL INFORMATION
- 10 IRRIGATION SYSTEM AT BASEBALL FIELDS. REFER TO LANDSCAPE FOR ADDITIONAL INFORMATION
- 11 BASEBALL FIELD LIGHTING - REFER TO ELECTRICAL
- 12 PARK BENCHES. REFER TO LANDSCAPE
- 13 9'-0" TALL PREFINISHED METAL WALKWAY CANOPY
- 14 CONCESSION ROOM ADDITION
- 15 CONCESSION ROOM ADDITION
- 16 28'-0" WIDE, 6'-0" TALL ROLLING CHAIN LINK TRAFFIC GATE ON V-TRACK. REFER TO SHEET A1.02
- 17 6'-0" HIGH GALVANIZED CHAIN LINK FENCE WITH (1) 4'-0" GATES TO BE LOCATED BY ARCHITECT.
- 18 FABRIC SHADE STRUCTURES AS SPECIFIED.

01 OVERALL SITE PLAN

SCALE : 1/16"=1'-0"

SITE NOTES:

- 1) FINISH GRADE TO BE 6" BELOW FINISH FLOOR ELEVATION SLOPE AWAY FROM ALL IMPROVEMENTS AT A RATE OF 1/4" PER FOOT FOR THE FIRST 10'-0"; THEN AT A RATE OF 1/8" PER FOOT FOR THE NEXT 20'-0"
- 2) SIDE WALK SLOPE IS NOT TO EXCEED 1:20 WITH A CROSS SLOPE OF 1:50 AT ANY INSTANCE.
- 3) REFER TO CIVIL, LANDSCAPE AND MECHANICAL DRAWINGS FOR ADDITIONAL WORK TO BE PERFORMED UNDER THIS CONTRACT.
- 4) PLAY FIELDS, TRAFFIC STRIPPING & TRAFFIC SIGNS NOT SHOWN FOR CLARITY. REFER TO ARCHITECTURAL SHEETS A1.09 THRU A1.13 FOR NOTATION AND REQUIREMENTS
- 5) AT ALL ENTRIES OF NEW BUILDINGS WARP CONCRETE SIDEWALKS SO AS TO PROVIDE A FLAT SURFACE WITH FINISHED FLOOR
- 6) GENERAL CONTRACT TO TAKE CARE NOT TO DAMAGE EXISTING SODDED AREA OR VARIOUS ELEMENTS OUTSIDE THE LIMITS OF WORK AND SHALL PROVIDE PROTECTION NECESSARY TO PREVENT DAMAGE TO EXISTING STRUCTURES TO REMAIN IN PLACE. SHOULD ANY DAMAGE BE CAUSED BY THE CONSTRUCTION PROCESS OUTSIDE OF REMOVAL & SITE CLEARING AREA, THE GENERAL CONTRACTOR IS TO BE RESPONSIBLE TO REPAIR OR REPLACE DAMAGED AREAS AT NO COST TO THE OWNER.
- 7) PROVIDE TEMPORARY CONSTRUCTION FENCE - ENSURE THAT CONSTRUCTION SITE IS SECURE FROM ANYONE THAT MAY VISIT THE SITE - ENSURE CONSTRUCTION FENCE IS A MINIMUM OF 6'-0" HIGH CHAIN LINK FENCE OR APPROVED EQUAL



ZONING CLASSIFICATION "R-1" (ORDINANCE 96-02)
ZONING CLASSIFICATION "R-1" (ORDINANCE 96-02)

© P.L.L.C. (OWNER'S AREA ARCHITECTURE)
BY: [Signature]

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REVISIONS	BY
02/10/2023	RN



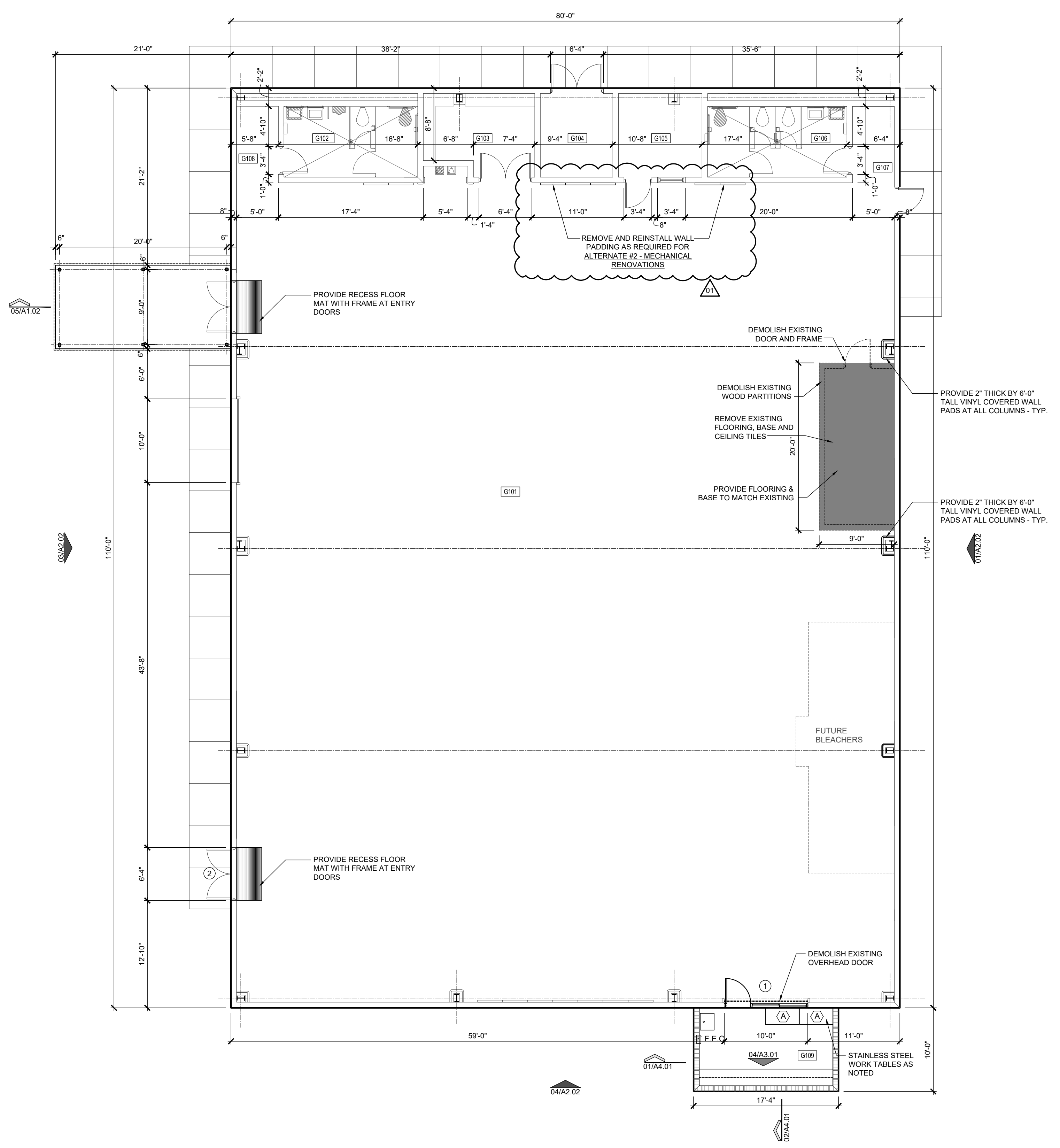
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CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS



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Interior Designers
Date: JANUARY 2023
Scale: As Noted
Project Architect: Roan G. Gomez, AIA
Drawn By: RN
Job No: SANTA ROSA - PHASE 2
Sheet:

A2.01



ROOM FINISH SCHEDULE										
ROOM NO.	ROOM NAME	BASE	FLR	WALLS				CLG.	CLG HEIGHTS	REMARKS
				N	S	E	W			
G101	GYMNASIUM	PTD	EXIST	PTD	PTD	PTD	PTD	EXIST	VARIES	3'-4" EPOXY WAINSCOT
G103	STORAGE	PTD	EXIST	PTD	PTD	PTD	PTD	EXT.SAC	9'-0"	REMOVE AND REINSTALL CEILING & GRID
G104	MECHANICAL	PTD	EXIST	PTD	PTD	PTD	PTD	EXT.SAC	9'-0"	REMOVE AND REINSTALL CEILING & GRID
G105	OFFICE	PTD	EXIST	PTD	PTD	PTD	PTD	EXT.SAC	9'-0"	REMOVE AND REINSTALL CEILING & GRID
G106	TOILET	PTD	EXIST	PTD	PTD	PTD	PTD	EXIST	8'-8"	
G107	TOILET *	PTD	EXIST	PTD	PTD	PTD	PTD	EXIST	8'-8"	
G108	VESTIBULE	PTD	EXIST	PTD	PTD	PTD	PTD	EXIST	VARIES	3'-4" EPOXY WAINSCOT
G109	VESTIBULE	PTD	EXIST	PTD	PTD	PTD	PTD	EXIST	VARIES	3'-4" EPOXY WAINSCOT
G109	CONCESSION	PTD	EPOXY	PTD	CMU/PTD	CMU/PTD	CMU/PTD	SAC 1	10'-0"	3'-4" EPOXY WAINSCOT

* WALLS TO BE PAINTED WITH EPOXY PAINT AS SPECIFIED

LEGEND	
EXIST	EXISTING TO REMAIN
EXT.SAC	CEILING TO BE REMOVED AND REINSTALLED TO ACCOMMODATE HVAC REPLACEMENT AND REPAIRS- ALTERNATE #2 WITH SUSPENSION
PTD	PAINTED
CMU/PTD	CONC. MASONRY UNIT PAINTED
EPOXY	EPOXY FLOOR PAINT
SAC	SUSPENDED ACOUSTICAL CEILING

- 01 FLOOR PLAN**
SCALE 1/8" = 1'-0"
- PLAN NORTH
- GENERAL NOTES:
- PAINT ALL INTERIOR CONCRETE MASONRY WALLS - COLOR AS SELECTED BY ARCHITECT'S OFFICE
 - PAINT ALL EXPOSED INTERIOR STRUCTURAL STEEL FRAMING COLOR AS SELECTED BY ARCHITECT'S OFFICE
 - PROVIDE FOR BULLNOSE CMU AT ALL EXTERIOR CORNER CONDITIONS AT WALL AND SILL CONDITIONS - EXCEPT FOR FIRST CMU AT WALL BASE
 - PROVIDE FOR TWO (2) 8" HIGH ACCENT STRIPES & ONE (1) 12" HIGH PAINTED STRIPE AT GYMNASIUM.
 - PROVIDE PAINTED 'BOYS AND GIRLS CLUB LOGO' ON THE INTERIOR WALL OF ROOM G101.
 - PATCH TO MATCH EXISTING FINISHES DISTURBED BY DEMOLITION WORK.
 - PROVIDE TWO (2) ADVANCE TABCO STAINLESS STEEL WORK TABLES - MS-244 TO BE LOCATED IN ROOM G109.
 - REFER TO MECHANICAL AND STRUCTURAL DRAWINGS FOR DUCT PENETRATION ENLARGEMENTS. PATCH TO MATCH EXISTING FINISHES WHERE ENLARGEMENTS ARE LOCATED.

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GENERAL STRUCTURAL NOTES

THESE GENERAL NOTES SHALL APPLY UNLESS OTHERWISE SPECIFICALLY NOTED ON PLANS OR DETAILS. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND SHALL COORDINATE ALL STRUCTURAL PLANS AND DETAILS WITH ARCHITECTURAL & MECHANICAL DRAWINGS BEFORE STARTING WORK. THE ENGINEER SHALL BE NOTIFIED OF ANY DISCREPANCIES PRIOR TO CONSTRUCTION. THE ENGINEER ASSUMES NO RESPONSIBILITY FOR CONTRACTOR MEANS AND METHODS OF CONSTRUCTION OR SITE SAFETY. DESIGN, CONSTRUCTION, WORKMANSHIP AND MATERIALS SHALL COMPLY WITH THE CONTROLLING PROVISIONS OF THE 2018 EDITION OF THE **INTERNATIONAL BUILDING CODE (IBC)**.

DESIGN CRITERIA:

- BASIS FOR DESIGN AND CODE COMPLIANCE
 - GOVERNING BUILDING CODE.....IBC 2018 EDITION
- WIND DESIGN BASED ON ASCE 7-16 REQUIREMENTS:
 - ULTIMATE DESIGN WIND SPEED.....138 MPH (V_{asd}=107 MPH)
 - RISK CATEGORY.....II
 - WIND EXPOSURE CATEGORY.....B
 - INTERNAL PRESSURE COEFFICIENT (G_{cp}).....+/-0.18
 - K_{zt}.....1.0
 - K_d.....0.85
- GRAVITY DESIGN
 - ROOF:
 - DEAD LOAD.....SELF-WEIGHT OF STRUCTURE & ROOFING SYSTEM
 - LIVE LOAD.....20 PSF (REDUCIBLE)
- THE CONTRACTOR IS SOLELY RESPONSIBLE FOR ALL TDI WINDSTORM FIELD INSPECTIONS AND WINDSTORM CERTIFICATION OF ALL BUILDINGS. CONTRACTOR SHALL REFERENCE SPEC. 011100.
- THESE BUILDINGS ARE DESIGNED TO MEET ASCE 7-16 WIND PRESSURES. ALL COMPONENTS AND CLADDINGS (E.G. WINDOWS, DOORS, ARCHITECTURAL SIDINGS AND ROOF PANELS); MUST MEET MINIMUM WIND CODE REQUIREMENTS. CONTRACTOR MUST SUBMIT COMPONENT AND CLADDING WIND PRESSURE RATINGS AND REQUIRED ATTACHMENT PROCEDURES TO THE TDI APPOINTED QUALIFIED INSPECTOR (AQI) FOR REVIEW.
- THE GENERAL CONTRACTOR MUST SUBMIT COMPONENT AND CLADDING WIND PRESSURE AND REQUIRED ATTACHMENT PROCEDURES TO THE AQI FOR REVIEW. SUBMITTAL INFORMATION SHALL INCLUDE A THIRD PARTY TESTING REPORT OF THE SUBMITTED ASSEMBLY; REFERENCE EXTERIOR COMPONENTS & CLADDINGS NOTES FOR ADDITIONAL REQUIREMENTS. THE GENERAL CONTRACTOR SHALL CONTACT THE AQI TO COORDINATE AND SCHEDULE REQUIRED PERIODIC INSPECTION OF EXTERIOR COMPONENTS AND CLADDINGS.
- THE GENERAL CONTRACTOR IS RESPONSIBLE FOR PROVIDING CONSTRUCTION SERVICES AS NEEDED TO SATISFY THE REQUIREMENTS OF THE DRAWINGS, THE SPECIFICATIONS, THE REFERENCED BUILDING CODE AND THE TEXAS DEPARTMENT OF INSURANCE WINDSTORM INSPECTION PROGRAM. ALL CONSTRUCTION ADMINISTRATION COSTS ASSOCIATED WITH FIELD INSPECTIONS, SUBMITTAL PREPARATION, SUBMITTAL REVIEW, INSPECTION COORDINATION, INCLUDING ALL GENERAL CONDITIONS, OVERHEAD AND PROFIT, SHALL BE INCLUDED IN THE GENERAL CONTRACTOR'S BID.

FOUNDATION DESIGN CRITERIA

- FOUNDATION DESIGN IS IN ACCORDANCE WITH THE INTERNATIONAL BUILDING CODE, AND IS BASED ON THE GEOTECHNICAL REPORT NO. AB421-024-00 PREPARED BY RABA KISTNER, INC., MCALLEN, TEXAS, DATED NOVEMBER 23, 2021.
- BEARING CAPACITY:
 - GRADE BEAMS & FOOTINGS (TOTAL LOAD)1.3 KSF
 - POTENTIAL VERTICAL RISE (PVR)1 INCH
- GROUNDWATER WAS ENCOUNTERED AT **12 FEET** BELOW THE GROUND SURFACE ELEVATION DURING DRILLING OPERATIONS (MAY FLUCTUATE WITH SEASON). CONTRACTOR SHALL DETERMINE ACTUAL GROUNDWATER LEVELS JUST PRIOR TO CONSTRUCTION EXCAVATION ACTIVITIES.
- THE GEOTECHNICAL ENGINEER OF RECORD SHALL BE RETAINED TO PERFORM TESTING AND INSPECTIONS DURING SITE PREPARATION AND PLACEMENT OF BUILDING PAD FILL AS REQUIRED BY SPECIFICATIONS AND GENERAL STRUCTURAL NOTES.

FOUNDATION NOTES

- REMOVE **AT LEAST 18 INCHES** OF THE EXISTING SITE SOIL, VEGETATION, TREE ROOTS, DEBRIS, ETC., FROM THE PROPOSED BUILDING AREA TO A DISTANCE OF 5'-0" OUTSIDE THE BUILDING AREA (EXTERIOR OF THE FOUNDATION, INCLUDING ATTACHED IMPROVEMENTS SUCH AS SIDE WALKS AND CANOPIES). DEPTH OF REMOVAL SHALL BE VERIFIED BY THE GEOTECHNICAL ENGINEER AT THE TIME OF CONSTRUCTION.
- AFTER TOP SOIL HAS BEEN REMOVED, THE SUBGRADE SHALL BE PROOF-ROLLED WITH APPROPRIATE CONSTRUCTION EQUIPMENT WEIGHING AT LEAST 15 TONS UNTIL THE GRADE OFFERS A RELATIVELY UNYIELDING SURFACE. SOFT SOIL AND YIELDING AREAS, AND AREAS CONTAINING ORGANIC MATTER AND/OR DEBRIS, SHALL BE OVER EXCAVATED AND REPLACED WITH COMPACTED SELECT FILL IN ACCORDANCE WITH THE REQUIREMENTS BELOW.
- PROOFROLLING OPERATIONS AND EXCAVATION/BACKFILL ACTIVITIES SHOULD BE PERFORMED DURING A PERIOD OF DRY WEATHER AND OBSERVED BY THE GEOTECHNICAL ENGINEER OR HIS REPRESENTATIVE TO DOCUMENT SUBGRADE CONDITIONS AND PREPARATION. IF SUBGRADE SOILS ARE ALLOWED TO BECOME WET OR SATURATED, REMOVAL AND REPLACEMENT OF SOFT SOILS OR CHEMICAL TREATMENT PROCEDURES SUCH AS LIME STABILIZATION SHALL BE PERFORMED AT THE CONTRACTOR'S EXPENSE. THE GEOTECHNICAL ENGINEER SHALL BE CONTACTED FOR ADDITIONAL RECOMMENDATIONS, IF REQUIRED.
- SCARIFY, MOISTURE CONDITION, AND COMPACT THE TOP 6" OF THE EXPOSED SUBGRADE TO 98% OF STANDARD PROCTOR MAXIMUM DRY DENSITY AT OPTIMUM TO +3% ABOVE THE OPTIMUM MOISTURE CONTENT, IN ACCORDANCE WITH TEST METHOD ASTM D-698. MOISTURE CONTENT SHALL BE AS NOTED IMMEDIATELY PRIOR TO PLACING SELECT FILL.
- RESTORE GRADE USING SELECT FILL, **MINIMUM OF 18 INCHES** OR AS REQUIRED TO PROVIDE THE SPECIFIED **FINISH FLOOR ELEVATION**, WHICHEVER IS GREATER, AND PROPER SITE DRAINAGE. COMPACTED IN ACCORDANCE WITH THE REQUIREMENTS BELOW. FINISH FLOOR ELEVATIONS SHALL BE VERIFIED WITH ARCHITECT AND CIVIL ENGINEER.
- SELECT FILL SHALL BE COMPACTED IN THE FIELD IN LIFTS NOT TO EXCEED 8" LOOSE MEASURE (6" COMPACTED LIFT) TO A MINIMUM OF 98% OF STANDARD PROCTOR MAXIMUM DRY DENSITY AT -2% TO +2% OF THE OPTIMUM MOISTURE CONTENT, AS EVALUATED BY ASTM D-698.
- SELECT FILL SHALL BE FREE OF ORGANIC OR OTHER DELETERIOUS MATERIALS, HAVE A MAXIMUM PARTICLE SIZE OF 4" OR ONE-HALF THE LOOSE LIFT THICKNESS, WHICHEVER IS SMALLER, AND A PLASTICITY INDEX (PI) BETWEEN 7-18. SOILS PROPOSED FOR USE SHOULD BE CLASSIFIED IN ACCORDANCE WITH USCS ASTM D2487 AND WILL BE CONSIDERED SATISFACTORY WHEN CLASSIFIED AS: **SC GC** OR **CL**. IF BLENDED OF MIXED SOILS ARE INTENDED FOR USE, THE GEOTECHNICAL ENGINEER SHOULD BE CONTACTED TO PROVIDE ADDITIONAL RECOMMENDATIONS AND REQUIREMENTS.

FOUNDATION NOTES CONTINUED:

- FOUNDATION CONCRETE SHALL NOT BE PLACED ON SELECT FILL SOILS THAT HAVE BEEN DISTURBED BY RAINFALL OR WATER SEEPAGE. IF BEARING SOILS ARE SOFTENED BY WATER INTRUSION, OR BY DESICCATION, THE UNSUITABLE SOILS SHALL BE REMOVED FROM THE FOUNDATION EXCAVATION AND BE REPLACED WITH PROPERLY COMPACTED SELECT FILL PRIOR TO PLACEMENT OF FOUNDATION CONCRETE. ALL SOIL REMOVAL AND REPLACEMENT COSTS, INCLUDING ASSOCIATED COSTS TO REMOVE AND REINSTALL REINFORCEMENT AND VAPOR BARRIER MATERIALS, SHALL BE THE SOLE RESPONSIBILITY OF THE GENERAL CONTRACTOR. DEPTH OF SOIL REMOVAL AND RECOMPACTION REQUIREMENTS SHALL BE COORDINATED WITH THE GEOTECHNICAL ENGINEER.
 - SAMPLES OF PROPOSED SELECT FILL SHALL BE FURNISHED TO THE TESTING LABORATORY 7 DAYS PRIOR TO INSTALLATION TO PERMIT TIME FOR SPECIFICATION COMPLIANCE INSPECTION AND REVIEW BY THE GEOTECHNICAL ENGINEER.
 - LABORATORY MOISTURE-DENSITY CURVES SHALL BE DEVELOPED FOR SUBGRADE AND FILL. PROCTOR CURVES AND FIELD DENSITY TESTS SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW. A MINIMUM OF ONE (1) IN PLACE DENSITY TEST PER 2,000 SQUARE FEET OF SLAB AREA SHALL BE TAKEN ON EACH LIFT DURING PLACEMENT OF SELECT FILL. DENSITY REPORTS SHALL BE TRANSMITTED TO ENGINEER WITHIN 3 DAYS AFTER TESTS ARE MADE.
 - GRAIN SIZE ANALYSIS AND ATTERBERG LIMITS TESTS SHALL BE PERFORMED DURING FILL PLACEMENT AT A RATE OF ONE TEST PER 5,000 CUBIC YARDS OF FILL BROUGHT TO THE SITE. SAMPLES FOR TEST SHALL BE TAKEN FROM JOBSITE MATERIALS.
 - SITE SHALL BE GRADED SO THAT WATER DOES NOT POND WITHIN 10 FEET OF THE PERIMETER FOUNDATION BEAM DURING OR AFTER CONSTRUCTION. THE SLOPE OF THE GROUND SURFACE AWAY FROM THE STRUCTURE SHOULD BE A MINIMUM OF THREE (3%) PERCENT FOR A DISTANCE OF AT LEAST TEN (10') FEET. ELEVATION OF GROUND SURFACE ADJACENT TO THE FOUNDATION SHOULD BE AT LEAST 6 INCHES BELOW FINISH FLOOR.
 - FINAL DRAINAGE IS VERY IMPORTANT TO THE PERFORMANCE OF THE FOUNDATION. LANDSCAPING, PLUMBING, AND DOWNSPOUT DRAINAGE ARE ALSO VERY IMPORTANT. IT IS VITAL THAT ALL ROOF DRAINAGE BE TRANSPORTED AWAY FROM BUILDINGS SO THAT NO AREAS OF WATER POND AROUND BUILDINGS, WHICH CAN RESULT IN SOIL VOLUME CHANGE UNDER THE FOUNDATION. PLUMBING LEAKS SHOULD BE REPAIRED AS SOON AS POSSIBLE IN ORDER TO MINIMIZE THE MAGNITUDE OF MOISTURE CHANGE UNDER THE SLAB. LARGE TREES AND SHRUBS SHOULD NOT BE PLANTED IN THE IMMEDIATE VICINITY OF THE STRUCTURE, SINCE THE ROOT SYSTEMS CAN CAUSE A SUBSTANTIAL REDUCTION IN SOIL VOLUME IN THE VICINITY OF THE TREE DURING DRY PERIODS. BUSHES AND TREES SHOULD BE PLANTED A REASONABLE DISTANCE AWAY FROM THE STRUCTURE SO THAT THEIR CANOPY OR "DRIP LINES" DOES NOT EXTEND BEYOND THE PERIMETER OF THE FOUNDATION. WATERING OF VEGETATION SHOULD BE PERFORMED IN A TIMELY AND CONTROLLED MANNER. PROLONGED WATERING SHOULD BE AVOIDED.
- ### LIGHT POLE DRILLED PIERS
- CONCRETE MIX FOR ALL DRILLED PIERS SHALL BE DESIGNED TO ACHIEVE MINIMUM OF 4,000 PSI 28-DAY COMPRESSIVE STRENGTH WHEN PLACED WITH A SEVEN (7) INCH (±1) INCH SLUMP.
 - THE CONTRACTOR SHALL COORDINATE POLE BASE PLATE/ANCHOR BOLT DIMENSIONS WITH POLE SUPPLIER PRIOR TO PLACING PIERS. CONFLICTS SHALL BE COORDINATED WITH ENGINEER.
 - INSTALL ALL PIERS AT THE LOCATIONS AND TO THE DEPTHS INDICATED ON THE DRAWINGS. BID SHALL INCLUDE ALL LABOR, EQUIPMENT, MATERIAL AND GENERAL CONDITIONS REQUIRED FOR INSTALLATION OF STRAIGHT SHAFT DRILLED PIERS, AS SHOWN ON THE DRAWINGS.
 - IF DIRECTED BY THE ARCHITECT/ENGINEER, PIERS SHALL BE ADJUSTED IN THE FIELD AS REQUIRED TO MEET DESIGN REQUIREMENTS.
 - PRIOR TO DEVELOPMENT OF THE PIER REINFORCEMENT SUBMITTALS, THE GENERAL CONTRACTOR, FOUNDATION CONTRACTOR, DRILLER, AND THE GEOTECHNICAL ENGINEER SHALL HAVE A PRE-CONSTRUCTION MEETING TO DISCUSS THE CONTRACTOR'S PROPOSED PIER INSTALLATION PROCEDURES. AT THE MEETING, THE CONTRACTOR NEEDS TO PERFORM A "TEST" PIER TO DETERMINE CURRENT SUBSURFACE WATER LEVELS AND THE CONSTRUCTABILITY OF THE DRILLED PIERS SPECIFIED. THE TEST PIER WILL NEED TO BE INSPECTED BY THE GEOTECHNICAL ENGINEER OF RECORD FOR APPROVAL OF THE PROPOSED INSTALLATION PROCEDURES AND/OR ISSUANCE OF ADDITIONAL RECOMMENDATIONS, AS REQUIRED.
 - DRILL PIERS TO THE EXACT SIZE SHOWN. SHAFTS SHALL BE BORED PLUMB WITH A TOLERANCE OF TWO INCHES. INSTALL OFFSET STAKES ON OPPOSITE SIDES OF THE PIER AND USE TO MAINTAIN THE PIER CENTERS AND TO CHECK THE PIER PLUMBNESS. FOOTING BOTTOMS SHALL BE INSPECTED FOR A MAXIMUM OF ONE INCH (1") OF LOOSE DIRT AND TWO INCHES (2") OF GROUND WATER IMMEDIATELY PRIOR TO POURING CONCRETE. IF MACHINE CLEANING IS NOT SATISFACTORY TO ARCHITECT/ENGINEER, HAND CLEANING WILL BE REQUIRED.
 - EACH PIER SHAFT AND DRILLING OPERATIONS SHALL BE INSPECTED BY QUALIFIED GEOTECHNICAL PERSONNEL TO ENSURE PROPER BEARING AT SCHEDULED ELEVATION AND TO VERIFY STRATAS NOTED IN THE GEOTECHNICAL REPORT. INSPECTIONS SHALL ALSO VERIFY PIER SHAFT DIAMETER, DEPTH, REINFORCEMENT SIZE, QUANTITIES AND LOCATIONS. INSPECTION REPORTS SHALL BE TRANSMITTED TO ENGINEER WITHIN 3 DAYS OF INSPECTION.
 - PROVIDE SUITABLE ACCESS AND LIGHTING FOR INSPECTION OF THE EXCAVATIONS FOR CLEANLINESS AND FOR CORRECTNESS OF DIMENSIONS AND ALIGNMENT.
 - DUE TO SUBSURFACE STRATIGRAPHY AND WATER LEVELS ENCOUNTERED, IF THE CONTRACTOR CANNOT INSTALL THE RECOMMENDED PIER AT THE REQUIRED DEPTH, THE ENGINEER MUST BE CONTACTED IMMEDIATELY.
 - PRECAUTIONS SHOULD BE TAKEN DURING THE PLACEMENT OF THE PIER REINFORCEMENT AND CONCRETE TO PREVENT LOOSE EXCAVATED MATERIAL FROM FALLING INTO THE EXCAVATION.
 - PLACEMENT OF CONCRETE SHALL BE ACCOMPLISHED AS SOON AS POSSIBLE AFTER EXCAVATION IS COMPLETE, REINFORCING CAGE IS PLACED, INSPECTED AND APPROVED. THE CONCRETE SHOULD NOT BE ALLOWED TO RICOCHET OFF THE WALLS OF THE PIER EXCAVATION NOR OFF OF THE REINFORCING STEEL. PLACEMENT OF CONCRETE SHALL COMPLY WITH AMERICAN CONCRETE INSTITUTE (ACI) 318-05 CODE "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE", ACI 336.3R-14 ENTITLED "SUGGESTED DESIGN AND CONSTRUCTION PROCEDURES FOR PIER FOUNDATIONS", U.S. DEPARTMENT OF TRANSPORTATION-FEDERAL HIGHWAY ADMINISTRATION PUB. NO. FHWA/TD-99-025 "MANUAL ON DRILLED SHAFTS: CONSTRUCTION PROCEDURES AND DESIGN METHODS" AND ADSC: THE INTERNATIONAL ASSOCIATION OF FOUNDATION DRILLING CONTRACTORS PUB. NO. ADSC-TL-4, AUGUST 1999.
 - NO PIER EXCAVATION SHALL BE LEFT OPEN OVERNIGHT WITHOUT CONCRETING.


CONCRETE:

- ALL CONCRETE WORK SHALL CONFORM TO THE AMERICAN CONCRETE INSTITUTE SPECIFICATION, A.C.I. #301 AND BUILDING CODE REQUIREMENTS, A.C.I. #318, LATEST EDITION.
- ALL DETAILING, FABRICATION AND ERECTION OF REINFORCING BARS, UNLESS OTHERWISE NOTED, MUST FOLLOW THE A.C.I. "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE", A.C.I. #315, LATEST EDITION.
- CONCRETE SHALL HAVE A MINIMUM COMPRESSION STRENGTH OF 3,000 PSI AT 28 DAYS.
- A MAXIMUM OF 25% FLYASH MAY BE USED AS A CEMENT SUBSTITUTE AND SHALL CONFORM TO ASTM C618, CLASS C. THE WATER/CEMENT RATIO SHALL NOT EXCEED 0.6 AND SLUMPS SHALL BE 5 INCHES (±1 INCH). AGGREGATE SHALL BE WELL-GRADED, 1" MAXIMUM FOR THE SLAB ON GRADE, 1" MAXIMUM FOR CAST-IN-PLACE BEAMS AND ABOVE GRADE SLABS. COARSE AGGREGATE SHALL MEET ASTM C33, GRADATION #57. A QUALIFIED TESTING LABORATORY SHALL BE RETAINED TO FURNISH MIX DESIGNS FOR ALL CLASSES OF CONCRETE. A SAMPLE OF FOUR CYLINDERS SHALL BE TAKEN NOT LESS THAN ONCE A DAY, NOR LESS THAN ONCE FOR EACH 100 YD³ OF CONCRETE. ONE CYLINDER SHALL BE TESTED AT 7 DAYS AND TWO AT 28 DAYS. THE FOURTH CYLINDER MAY BE DISPOSED OF AFTER 45 DAYS IF NOT USED.
- ADMIXTURES CONTAINING WATER SOLUBLE CHLORIDE IONS GREATER THAN 0.06% BY WEIGHT OF CEMENT SHALL NOT BE USED.
- REINFORCING BARS SHALL BE NEW BILLET STEEL CONFORMING TO ASTM A-615, GRADE 60. #3 BARS MAY BE GRADE 40.
- STANDARD PROTECTIVE COVER OF REINFORCING BARS UNLESS OTHERWISE NOTED SHALL BE:
 - WHERE CAST AGAINST DIRT OR FILL 3 IN.
 - EXPOSED TO EARTH OR WEATHER 2 IN.
 - SLABS AND WALLS 1 IN.
 - OTHER 1-1/2 IN.
- ALL ACCESSORIES SHALL BE IN ACCORDANCE WITH THE A.C.I. "MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE", A.C.I. #315, LATEST EDITION.
- SLAB MAT TO BE SUPPORTED BY MASONRY BRICK BATTS (MIN OF 1/2 BRICK) SPACED AT 4 FEET ON CENTER EACH WAY (MAX). BEAM CAGES SUPPORTED BY BATTS AT 4 FEET ON CENTER.
- VERTICAL CONSTRUCTION JOINTS IN FLOOR SHALL BE COORDINATED WITH STRUCTURAL ENGINEER PRIOR TO FORMING SLAB. CRACK CONTROL JOINTS SHALL BE PROVIDED AT LOCATIONS SHOWN ON THE PLANS. CONTROL JOINTS SHALL BE SAWCUT (IMMEDIATELY SUBSEQUENT TO FINISHING SLAB) WITH "SOFF-CUT" SYSTEM. JOINTS SHALL BE CLEANED AND FILLED WITH "SONOLASTIC SL1" WITHIN TWO (2) DAYS AFTER SAWCUTTING. NO HORIZONTAL JOINTS WILL BE PERMITTED IN SLABS OR BEAMS UNLESS APPROVED BY THE ENGINEER.
- PROVIDE 2 TOP & BOTTOM CORNER BARS AT ALL DISCONTINUOUS GRADE BEAMS AND FOUNDATION CORNERS. CORNER BARS SHALL BE 4'-0" IN LENGTH (2'-0" LEGS). SIZE OF THE CORNER BARS SHALL MATCH THE SIZE OF THE GRADE BEAM REINFORCING AS SHOWN BY STRUCTURAL DRAWINGS.
- MAINTAIN A MINIMUM OF ONE AND ONE-HALF (1-1/2) TIMES THE MAXIMUM COARSE AGGREGATE SIZE BETWEEN ALL REINFORCING BARS (EXCEPT AT LAPS).
- BARS SCHEDULED OR DETAILED "CONT" SHALL BE LAPPED 48 BAR DIAMETERS (24 INCHES MINIMUM) UNLESS OTHERWISE NOTED.
- WHERE CONCRETE IS TO HAVE UNEXPOSED SURFACES, THE FORMS MAY BE CONSTRUCTED OF #2 LUMBER OR BETTER. WHERE SURFACES ARE EXPOSED, SUCH AS FOR FINISH PAINTING OR STUCCO DASH, THE FORMS SHALL BE COMMERCIAL STANDARD DOUGLAS FIR, MOISTURE-RESISTANT CONCRETE FORM PLYWOOD; MINIMUM 5-PLY AND AT LEAST 9/16" THICK, OR FORMS LINED WITH COMMERCIAL STANDARD DOUGLAS FIR, CONCRETE FORM EXTERIOR, 3-PLY, NOT LESS THAN 1/4" THICK. WHERE CONCRETE IS EXPOSED, A SMOOTH SURFACE IS REQUIRED, FREE FROM FINS, HONEYCOMB, FORM MARKS OR OTHER DEFECTS.
- EXPOSED SURFACES OF CONCRETE AT THE PERIMETER OF THE FOUNDATION SHALL BE FORMED WITH 2X10 #2 LUMBER OR BETTER. A SMOOTH SURFACE IS REQUIRED, FREE FROM FINS, HONEYCOMB, FORM MARKS OR OTHER DEFECTS.
- CONSTRUCT FORMS SO THAT JOINTS ARE LEAKPROOF. MAINTAIN FORMS SUFFICIENTLY RIGID TO PREVENT DEFORMATION UNDER LOAD.
- CONCRETE MAY BE PLACED WITH CHUTES UP TO 25' MAXIMUM. SLUMP SHALL NOT EXCEED 6" AT TRUCK DISCHARGE POINT.
- CONCRETE PLACED BY PUMPING SHALL MEET THE FOLLOWING REQUIREMENTS:
 - COARSE AGGREGATE SHALL BE GRADED FROM A MAXIMUM OF 1" DOWN
 - MAXIMUM ALLOWABLE INCREASE IN CEMENT FACTOR SHALL BE 1/2 SACK PER CUBIC YARD OVER NORMAL MIX DESIGN.
 - MAXIMUM WATER CEMENT RATIO SHALL BE 7-1/2 GALLONS PER SACK OF CEMENT. IF MORE WORKABILITY IS REQUIRED, AN ADMIXTURE MAY BE USED.
 - MAXIMUM WEIGHT RATIO OF FINE AGGREGATES TO COARSE AGGREGATES SHALL NOT EXCEED 2/3.
 - REFER TO A.C.I. #301, LATEST EDITION, SECTION 800, FOR OTHER PUMPING REQUIREMENTS.
 - IN NO CASE SHALL CONCRETE BE PUMPED THROUGH AN ALUMINUM TUBE.
 - SLUMP SHALL NOT EXCEED 6" AT TRUCK DISCHARGE POINT.
- FLOOR FINISH (TOLERANCES)
 - STEEL TROWEL FINISH 1/8" IN 10'
 - FLOAT FINISH 1/4" IN 10'
 - SCRATCH FINISH 1/2" IN 10'
- CONCRETE TO BE CURED IN ACCORDANCE WITH ACI RECOMMENDATIONS. PROPOSED METHOD OF CURING TO BE COORDINATED WITH ENGINEER PRIOR TO CONCRETE PLACEMENT.
- SHOP DRAWINGS SHALL BE PREPARED FOR ALL REINFORCING STEEL AND SUBMITTED FOR REVIEW BY ENGINEER. SUBMITTALS SHALL INCLUDE ELECTRONIC (PDF) COPIES OF EACH DRAWING. ENGINEERING DRAWINGS SHALL NOT BE REPRODUCED AND USED AS SHOP DRAWINGS.
- THE CONTRACTOR SHALL REVIEW AND ANNOTATE SHOP DRAWINGS BEFORE SUBMITTING THEM TO THE ARCHITECT/ENGINEER FOR REVIEW. THE CONTRACTOR SHALL ALLOW ARCHITECT/ENGINEER 10 WORKING DAYS FOR REVIEW OF SHOP DRAWINGS.
- ENGINEER TO BE NOTIFIED 48 HOURS PRIOR TO PLACEMENT OF FOUNDATION AND OF STRUCTURAL CONCRETE TO SCHEDULE REQUIRED OBSERVATIONS.

CONCRETE MASONRY

- ~~THE GENERAL CONTRACTOR PROJECT SUPERINTENDENT, TESTING LABORATORY AND THE MASONRY FOREMAN~~ SHALL REVIEW PRIOR TO THE START OF MASONRY WORK TO REVIEW PROJECT REQUIREMENTS AND PROCEDURES.
- AN INDEPENDENT TESTING LAB SHALL VERIFY PLACEMENT OF VERTICAL REINFORCING IN WALLS AND HORIZONTAL REINFORCING IN BOND BEAMS AND LINTELS PRIOR TO PLACEMENT OF GROUT. INDEPENDENT TESTING LAB SHALL PROVIDE CONTINUOUS VISUAL OBSERVATIONS OF GROUTING PROCEDURES. RECORD OF TEST MIXES, MORTAR, INSTALLATION OF EMBEDDED STEEL CONNECTORS, AND GENERAL PLACEMENT OF MASONRY UNITS AND MORTAR JOINTS. INSPECTION REPORTS ARE TO BE GENERATED DAILY BY THE TESTING LAB. INSPECTION SUMMARY REPORTS SHALL BE EMAILED TO THE STRUCTURAL ENGINEER IN ELECTRONIC (PDF) FORMAT.
- ALL CONCRETE MASONRY SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE LOCAL BUILDING CODES AND THE AMERICAN CONCRETE INSTITUTE (ACI 530-13/ ASCE 5-13/ TMS 402-16). DESIGN IS BASED ON MASONRY COMPRESSIVE STRENGTH (f_m) OF 2,000 PSI.
- HOT AND COLD WEATHER CONSTRUCTION PROCEDURES SHALL BE UTILIZED AS REQUIRED BY THE SPECIFICATIONS AND ACI 530.1.
- HOLLOW CONCRETE MASONRY UNITS SHALL BE DOMESTIC LIGHTWEIGHT MOISTURE CONTROLLED TYPE I UNITS, CONFORMING TO ASTM C-90.
- MASONRY UNITS SHALL HAVE A MINIMUM AVERAGE COMPRESSIVE STRENGTH OF 2,000 PSI (NET AREA) WHEN TESTED IN ACCORDANCE WITH ASTM C-140, "METHODS OF SAMPLING AND TESTING CONCRETE MASONRY UNITS".
- MORTAR PROPORTIONS FOR REINFORCED MASONRY SHALL BE ESTABLISHED PER ASTM C270. PROPORTION SPECIFICATIONS, TYPE S USING MASONRY CEMENT. FIELD TESTS OF MORTAR SHALL BE PERFORMED BY A QUALIFIED TESTING LABORATORY IN ACCORDANCE WITH ASTM C780 AT A RATE OF ONE TEST PER 2,000 SF OF WALL SURFACE TO DETERMINE BATCH-TO-BATCH UNIFORMITY OF MORTAR. REFERENCE SPECIFICATIONS FOR NON REINFORCED MASONRY.
- GROUT FOR ALL REINFORCED HOLLOW MASONRY UNIT WALLS SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3,000 PSI WITH A MAXIMUM 3/8" AGGREGATE. A MID RANGE WATER REDUCING AGENT SUCH AS "POLYHEED" (MASTER BUILDERS) SHALL BE USED. SLUMP TO BE BETWEEN 8 AND 11 INCHES. **ALL GROUT SHALL BE PUMPED**. PLACING OF GROUT TO FOLLOW AMERICAN CONCRETE INSTITUTE (ACI) RECOMMENDATIONS REGARDING **LOW & HIGH LIFT GROUTING**. MAXIMUM LIFT OF GROUT SHALL NOT EXCEED 6'-0" UNLESS APPROVED BY THE ENGINEER PRIOR TO START OF GROUTING. GROUT TO BE TESTED BY A QUALIFIED TESTING LABORATORY AT A RATE OF ONE TEST PER 25 CY OF GROUT IN ACCORDANCE WITH ASTM C1019.
- REINFORCING STEEL SHALL CONFORM TO ASTM A-615, GRADE 60. ALL BAR REINFORCING SHALL BE LAPPED 48 BAR DIAMETERS (MIN). BARS SHALL BE PLACED WITHIN 1/2" (CENTERLINE OF BAR TO FACE OF MASONRY) OF LOCATION SHOWN IN STRUCTURAL PLANS. BARS SHALL BE HELD IN POSITION DURING GROUTING WITH BAR POSITIONERS. POSITIONERS SHALL BE LOCATED AT THE BOTTOM AND TOP OF THE WALL AND AT 8 TO 10 FOOT INTERVALS. BARS SPLICED BY NON-CONTACT LAP SPLICES SHALL NOT BE SPACED TRANSVERSELY FARTHER APART THAN ONE-FIFTH THE REQUIRED LENGTH OF LAP NOR MORE THAN 8 INCHES.
- VERTICAL BARS SHALL EXTEND TO THE TOP OF THE PARAPET WALL OR BOND BEAM WHEN A 16" DEEP BEAM IS SPECIFIED. HOOKED DOWELS SHALL BE PROVIDED AT ROOF BOND BEAMS (W/O PARAPETS) LESS THAN 16" DEEP. DOWELS SHALL BE 30" LONG WITH 12" HOOKS.
- ALL EXTERIOR MASONRY WALLS SHALL BE REINFORCED WITH 9 GA. HOT DIPPED GALVANIZED HORIZONTAL WIRE REINFORCEMENT (LADDER TYPE) EMBEDDED IN MORTAR JOINTS AT 16" O.C. NOMINAL WIDTH OF JOINT REINFORCING SHALL EQUAL WALL THICKNESS. (INTERIOR WALLS MAY BE MILL GALVANIZED). WIRE REINFORCEMENT SHALL CONFORM TO ASTM DESIGNATION A-82, AND SHALL BE LAPPED AT LEAST 8" WITH AT LEAST ONE CROSS WIRE WITHIN THE LAP. JOINT REINFORCING SHALL BE INSTALLED IN THE FIRST AND SECOND MORTAR BED JOINTS IMMEDIATELY ABOVE AND BELOW ALL OPENINGS. WIRE REINFORCING SHALL BE DISCONTINUOUS AT CONTROL JOINTS.
- EXTERIOR WALLS SHALL BE BONDED WITH CONCRETE MASONRY UNITS AT BUILDING CORNERS.
- ONE GROUTED #5 BAR SHALL BE PROVIDED AROUND THE PERIMETER OF ALL WALL OPENINGS AND AT BUILDING CORNERS UNLESS NOTED OTHERWISE ON THE STRUCTURAL PLANS.
- NEATLY TOOL INTERIOR AND EXTERIOR JOINTS IN MASONRY TO FORM A SLIGHTLY CONCAVE PROFILE WHEN MORTAR IS THUMBPRINT HARD UNLESS SHOWN OTHERWISE. ALL MORTAR JOINTS SHALL BE TOOLED THE ENTIRE HEIGHT OF WALL.
- BOND BEAMS SHALL BE REINFORCED WITH TWO CONTINUOUS #5 BARS UNLESS NOTED OTHERWISE ON THE STRUCTURAL PLANS. REINFORCING SHALL BE CONTINUOUS AT ALL CORNERS AND INTERSECTING WALLS. (PROVIDE CORNER BARS). WHERE SIDE WALL AND END WALL BOND BEAMS DO NOT COURSE CONTINUE THE LOWER BOND BEAM AROUND THE BUILDING CORNER TO THE FIRST VERTICAL REINFORCED CELL.
- CONTROL JOINTS SHALL BE CONSTRUCTED WITH SLOTTED MASONRY UNITS AND FACTORY MOLDED JOINT FILLER. JOINTS SHALL BE CALKED WITH AN APPROVED MATERIAL. JOINTS SHALL BE PROVIDED AT MAXIMUM SPACING OF 22 FT. AND AT ALL LOCATIONS WHERE COLUMNS ARE PLACED IN CMU CELLS. (EXTERIOR AND INTERIOR WALLS). JOINT LOCATIONS, IF NOT SHOWN ON PLANS, SHALL BE COORDINATED WITH ARCHITECT.
- CONTROL JOINTS **SHALL NOT** EXTEND THROUGH BOND BEAMS UNLESS INDICATED ON THE STRUCTURAL PLANS.
- CONTROL JOINTS IN CMU WALLS SHALL NOT BE LOCATED CLOSER THAN 2'-0" FROM AN EDGE OF OPENING WITHOUT REVIEW OF STRUCTURAL ENGINEER.
- COLUMNS WHICH EXTEND THROUGH BOND BEAMS SHALL BE WRAPPED WITH 2 LAYERS OF 30# BUILDING PAPER. REINFORCING SHALL BE CONTINUOUS PAST COLUMNS WHEN ADEQUATE CLEARANCE EXISTS.
- LINTELS OVER ALL OPENINGS IN INTERIOR MASONRY PARTITIONS, NOT OTHERWISE COVERED, ARE TO BE OF STANDARD CMU LINTEL BLOCK WITH THICKNESS EQUAL TO WALL THICKNESS. DEPTH SHALL BE 8" FOR OPENINGS UP TO 6'-0", REINFORCED WITH TWO #5's, LOCATED 2-1/2" ABOVE THE BOTTOM EXTERIOR FACE OF THE UNIT.

NO.	REVISIONS	BY



GMS ARCHITECTS
1150 Paredes Line Rd.
Brownsville,
Texas 78526
(956) 546-0110
Fax (956) 546-0196

CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS PHASE II

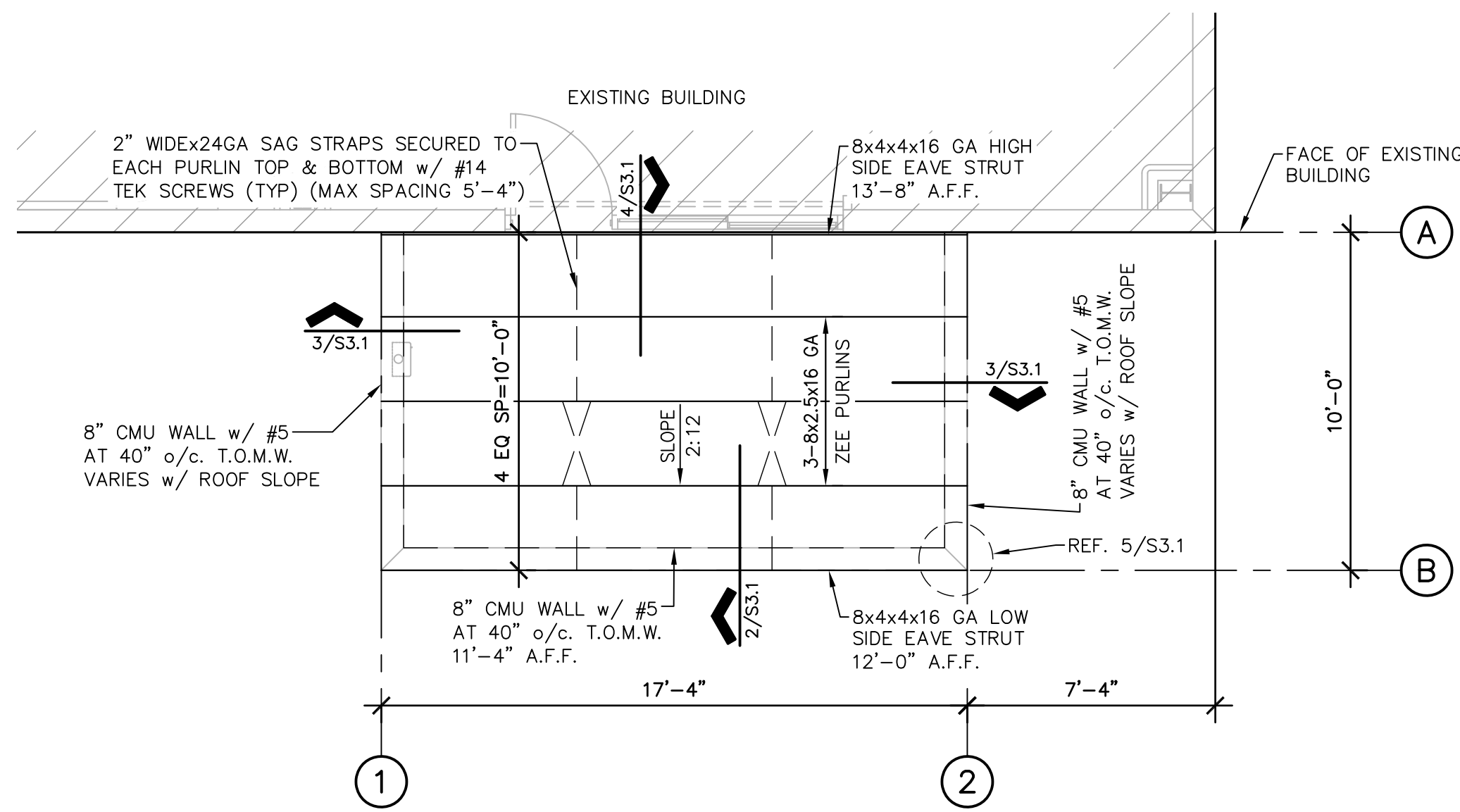


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Gomez Mendez Saenz Inc.
Architects-Planners
Interior Designers
Date: February 16, 2023
Scale: As Noted
Drawn By: LC
Checked: BD
Job No. 192-599
Sheet:



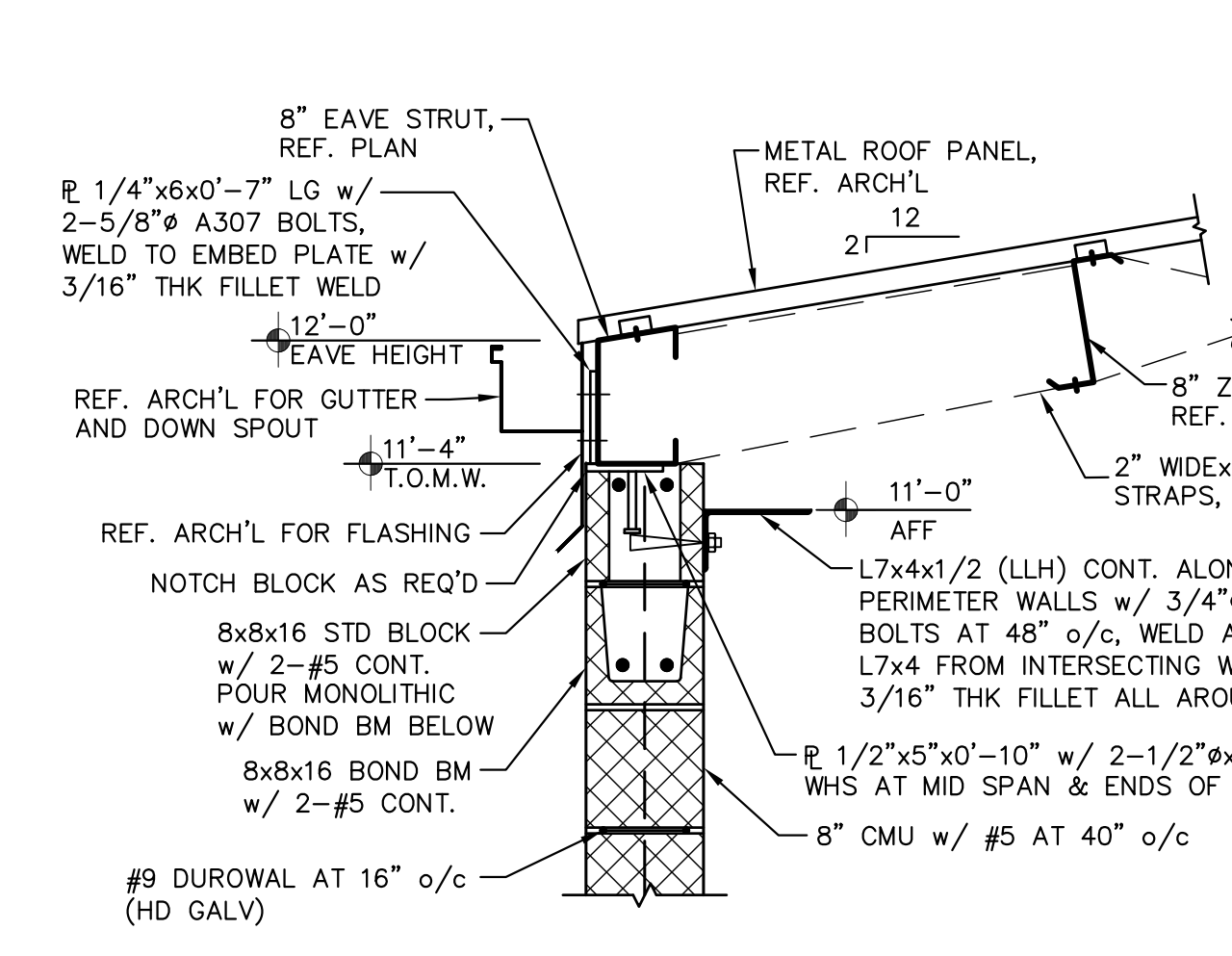
GREEN, RUBIANO & ASSOCIATES
CONSULTING STRUCTURAL ENGINEERS
1220 WEST HARRISON
HOUSTON, TEXAS 77051
(850) 428-4461 GREENRUBIANO.COM
FIRM REGISTRATION # E-1416

S1.1

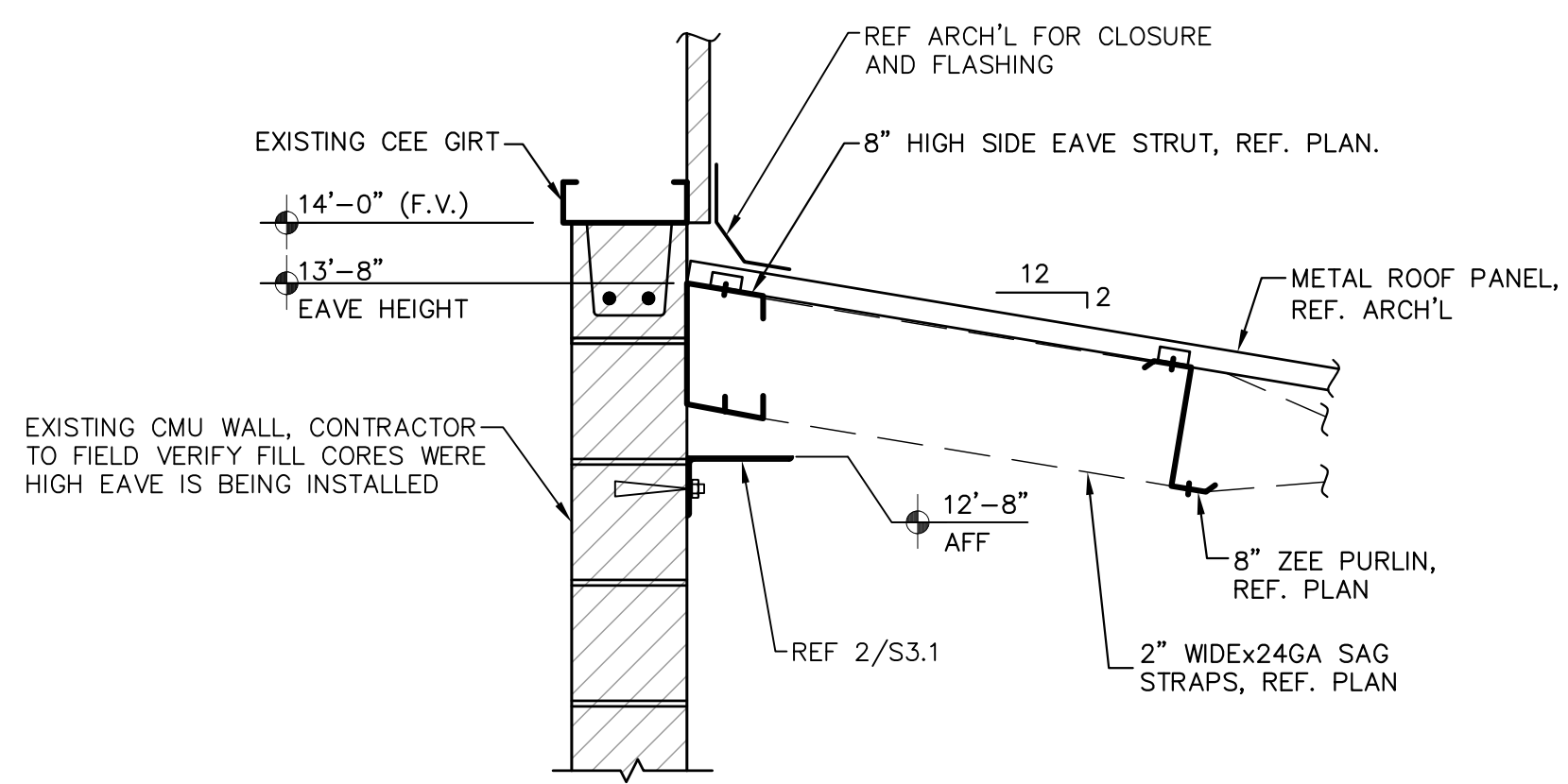


1 ROOF FRAMING PLAN

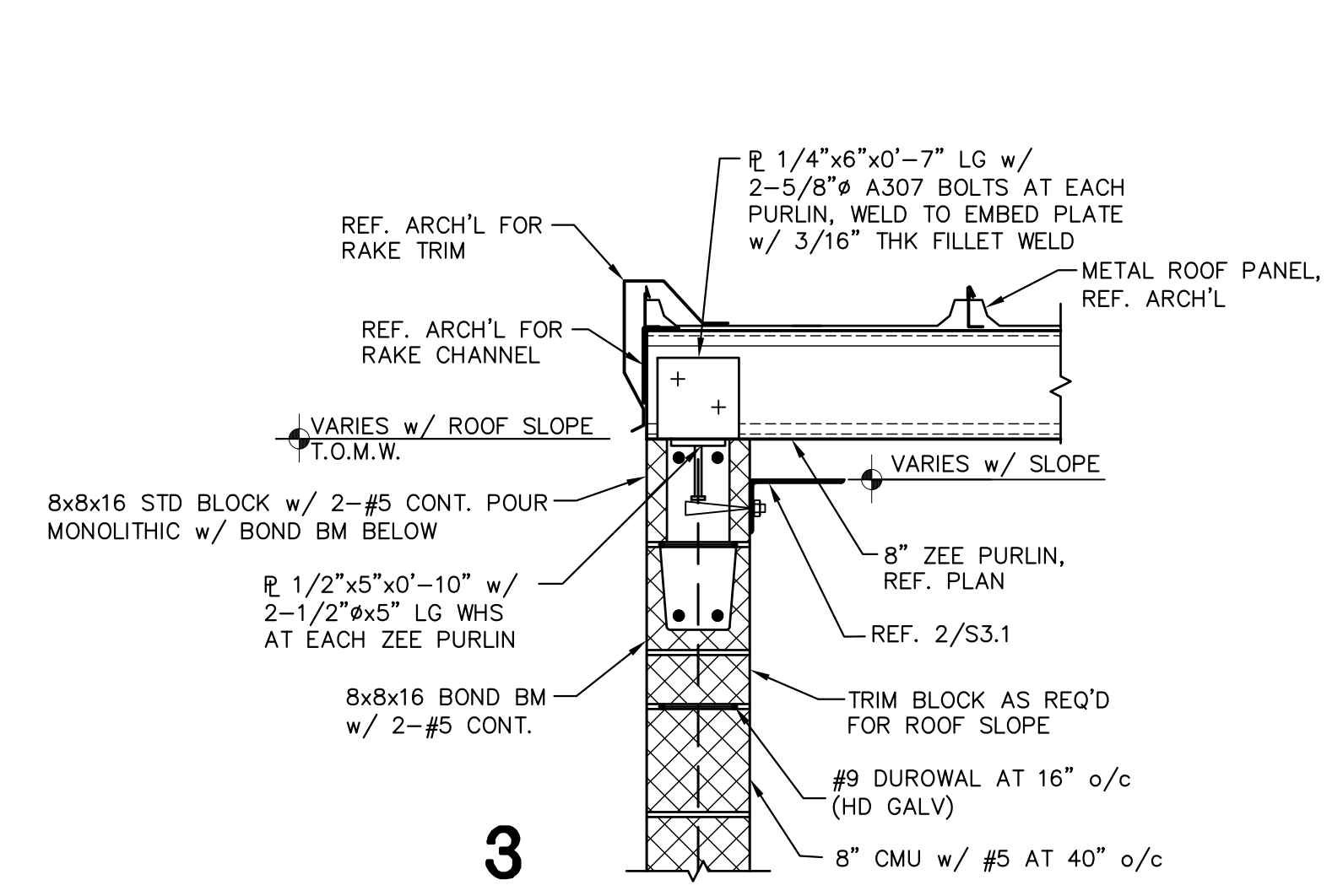
- 1/4" = 1'-0"
PLAN NORTH
- NOTES:
- REFERENCE ARCHITECTURAL AND CIVIL FOR ORIENTATION & LOCATION OF BUILDING.
 - ALL COMPONENTS SHALL BE DESIGNED, FABRICATED AND ERRECTED IN ACCORDANCE WITH THE LATEST SPECIFICATIONS AND STANDARDS OF THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION, AND THE LIGHT GAGE STRUCTURAL INSTITUTE.
 - PURLINS AND EAVE STRUTS SHALL BE FABRICATED FROM STEEL HAVING A MINIMUM YIELD OF 57 KSI. ALL MEMBERS SHALL BE PAINTED WITH ONE COAT OF RED OXIDE OR APPROVED SHOP COAT. PURLINS SHALL BE SHOP PUNCHED AND LAPPED AS SHOWN ON THE ROOF FRAMING PLANS. EAVE STRUTS SHALL BE INSTALLED WITH BOLTED CONNECTIONS. PURLINS AND EAVE STRUTS TO BE SECURED WITH 5/8" DIAMETER BOLTS (A307 GRADE).
- MINIMUM SECTION PROPERTIES:
- 8x2.1/2x16 GA ZEE PURLIN Ix = 7.78 IN.4 Sx = 1.80 IN.3
8x4x4x16 GA EAVE STRUT Ix = 8.98 IN.4 Sx = 1.84 IN.3
- SAG STRAPS SHALL BE LOCATED AS SHOWN ON THE PLANS. STRAPS SHALL BE FABRICATED FROM STEEL HAVING A MINIMUM YIELD OF 50 KSI. THE STRAPS SHALL BE SECURED TO THE TOP AND BOTTOM FLANGES OF ALL PURLINS WITH #14 TEK SCREWS.



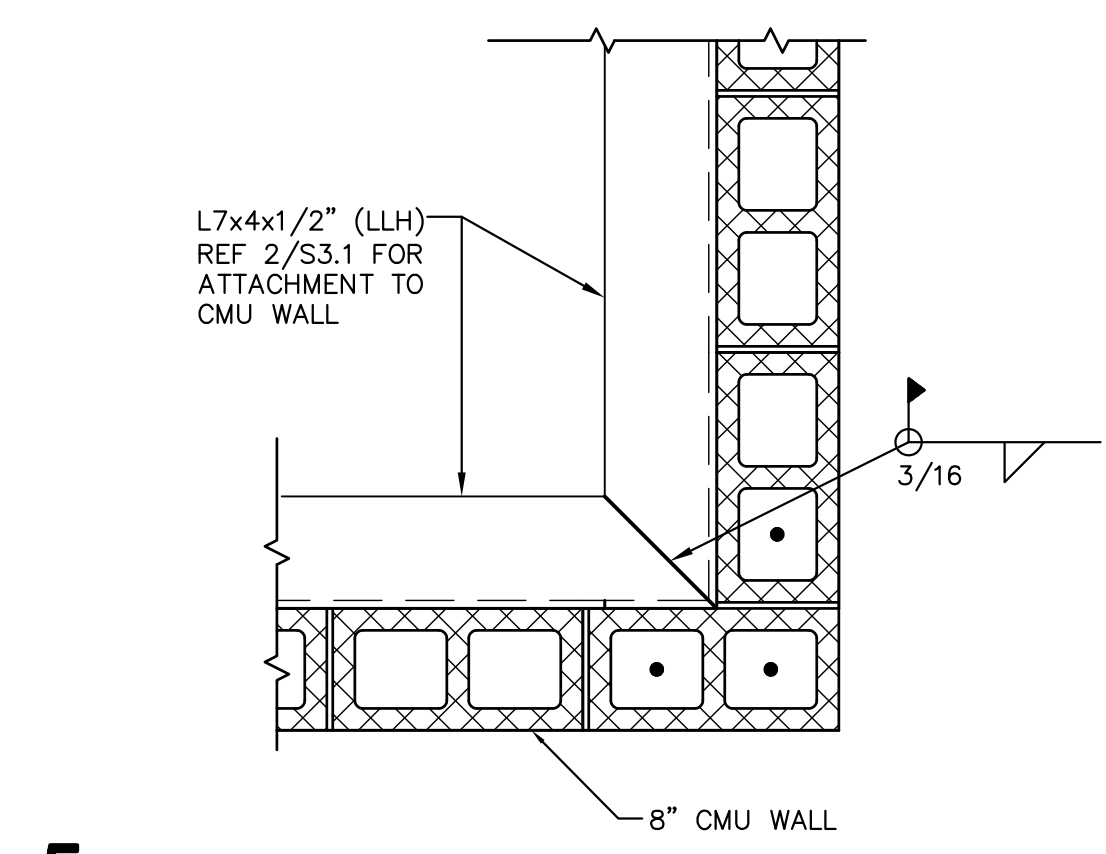
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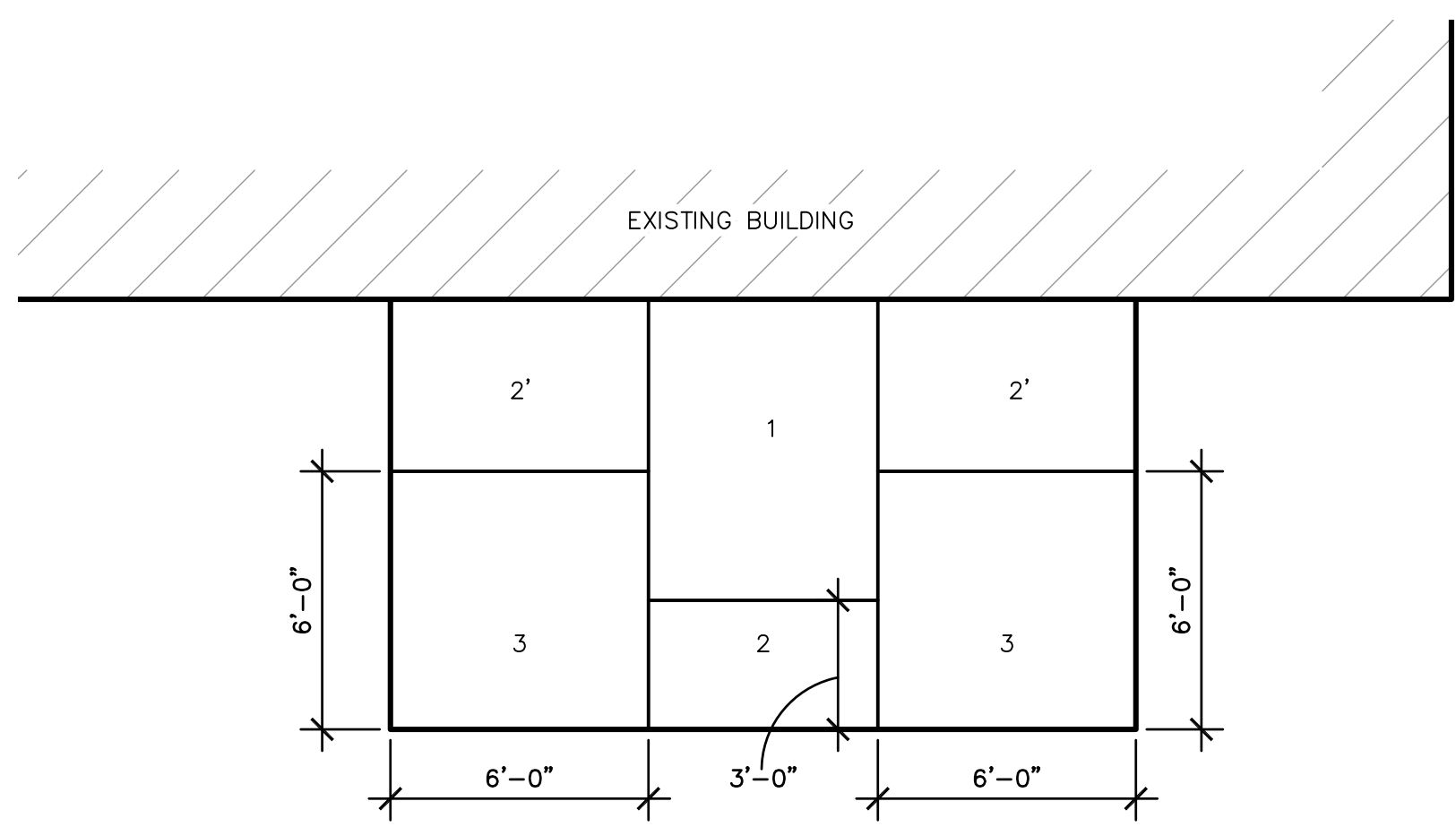
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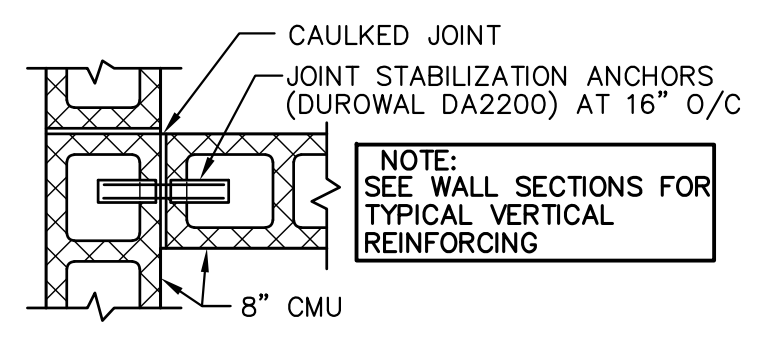
5 TYPICAL SPANDREL ANGLE CORNER DETAIL



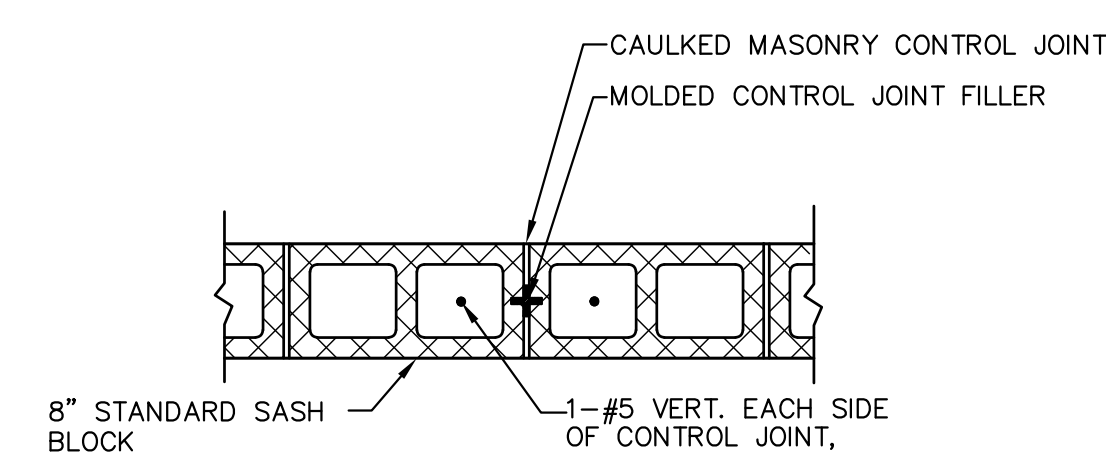
SANTA ROSA PARK IMPROVEMENT ADDITION
ROOF DESIGN WIND PRESSURE

DESIGN WIND PRESSURE FOR ROOF COMPONENTS & CLADDING	
ZONE	P- (UPLIFT)
1	-23 PSF
2	-26 PSF
2'	-31 PSF
3	-35 PSF

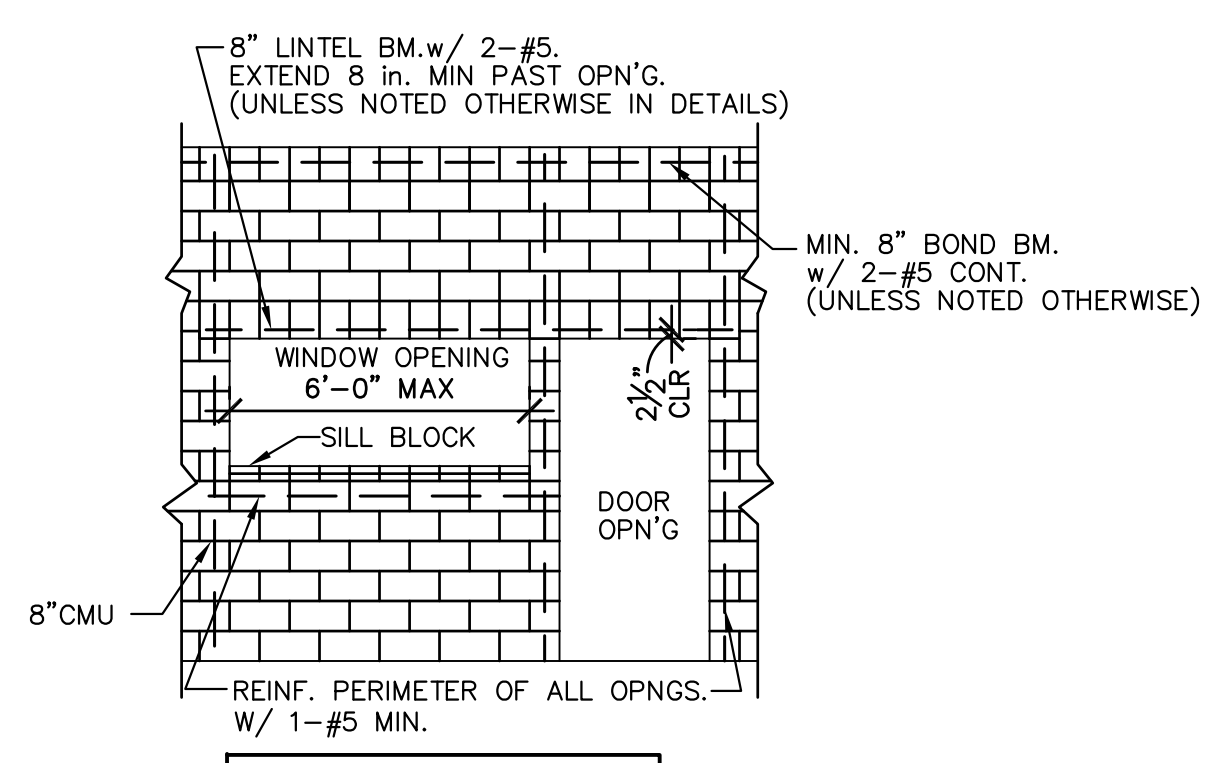
EXTERIOR FINISHES, DOORS & WINDOWS MAXIMUM DESIGN WIND PRESSURES
P+ = +19 PSF TOWARDS THE SURFACE
P- = -25 PSF AWAY FROM THE SURFACE



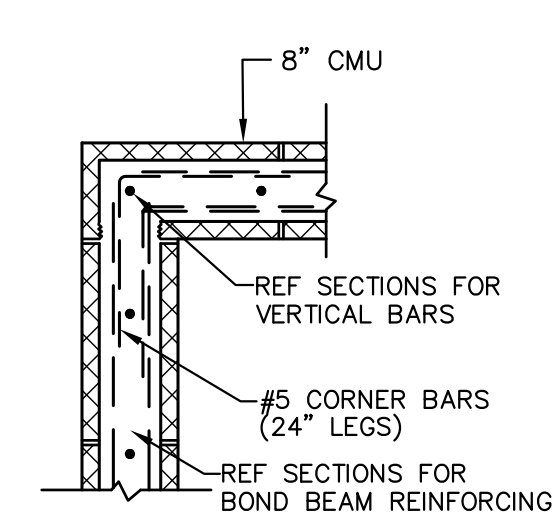
6 TYPICAL UNBONDED WALL INTERSECTION



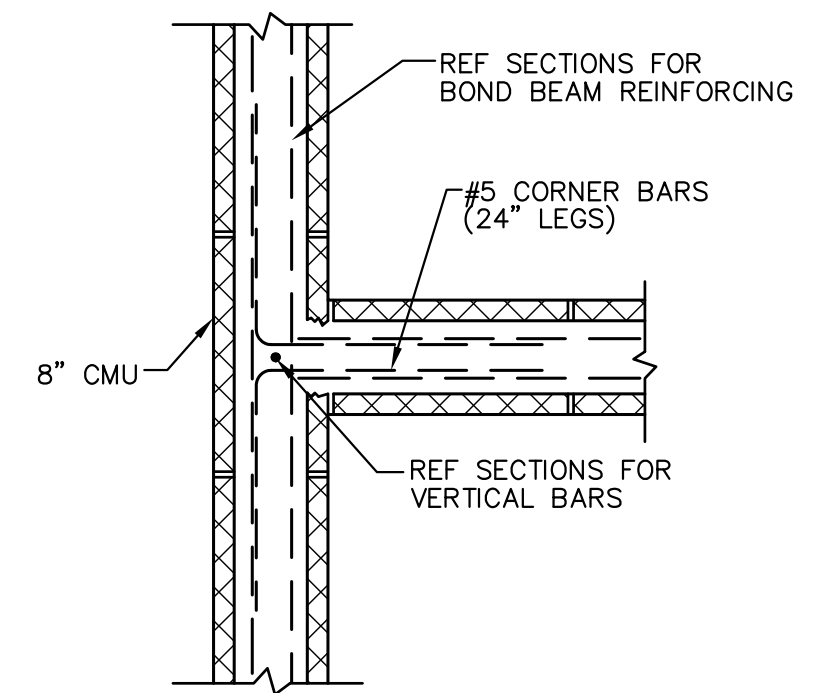
7 TYPICAL CRACK CONTROL JOINT



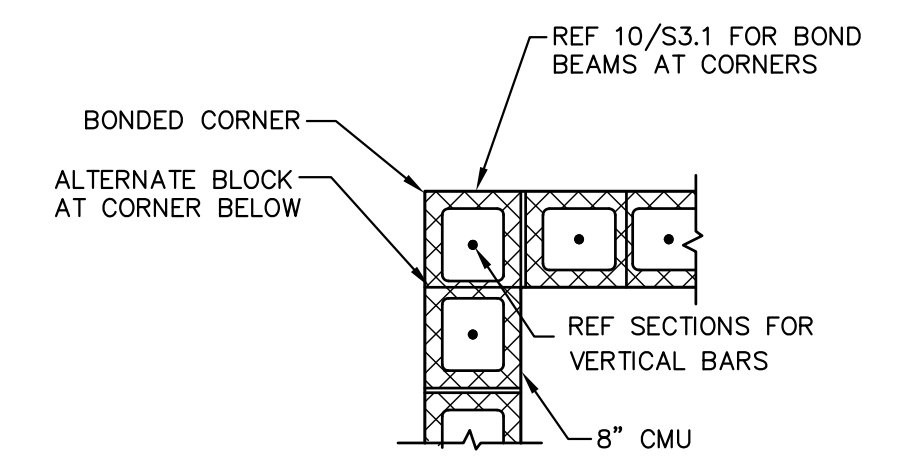
9 TYPICAL REINFORCING AT OPENINGS
(NON LOAD-BEARING WALLS ONLY)



10 BOND BEAM AT EXTERIOR CORNERS



8 TYPICAL BOND BEAM AT INTERSECTING WALL



11 BONDED CORNER

February 16, 2023

Cameron County Parks – Santa Rosa Park Improvements Phase II

ADDENDUM NO. 1



A. PURPOSE AND INTENT

This addendum is issued for the purpose of modifying the plans and specifications for the project referenced above. This addendum shall become part of the contract and all contractors shall be bound by its content. All aspects of the specifications and drawings not covered herein shall remain the same. The General Conditions and the Special Conditions of the specifications shall govern all parts of the work and apply in full force to this addendum.

B. CLARIFICATIONS

The following Summary of Work is intended as an aid to achieve an understanding of the various alternate bids electrical scope of work, as is not intended to be all-inclusive. Detailed descriptions of work and requirements are given in the drawings.

Alternate #1 (Solar lighting):

Provide all labor and materials for the addition of solar pole lighting types "P1" and "P2", intended for the illumination of existing parking lots.

Alternate #2 (Mechanical unit repairs and replacement):

Provide all labor and materials for the disconnection and removal of materials related to the existing to be removed HVAC equipment, installation and materials for the new HVAC equipment, and upgrades to the electrical service and distribution equipment. Items include, but are not limited to:

1. Upgrade of electrical service to 120/208V, 3 phase, 4-wire system at the Youth Center Building.
2. Electrical service pad mounted transformer upgrade.
3. Electric meter upgrade.
4. Replacement of building main disconnect at Youth Center Building.
5. Replacement of electrical service primary and secondary.
6. Replacement of panelboard "A" feeder.
7. Replacement of panelboard "A" in Youth Center Building.
8. Disconnection and removal of existing Eaton 125A, 120/240V, 1 ϕ panelboard and re termination of existing to remain branch circuits to new panelboard "A".
9. Relocation of existing FACP document box.

10. Location adjustment of Fire Alarm Control Panel and Fire Alarm Communicator to maintain required clearance from new HVAC Equipment.
11. Provide data drop for HVAC DDC controls.
12. Connection of new HVAC equipment.

Alternate #3 (Sports Lighting):

Provide all labor and materials for the retrofit of the existing sports lighting and the addition of a new sports lighting pole. Items include, but are not limited to:

1. Replacement of existing panelboard feeding sports lighting branch circuits.
2. Replacement of existing Musco sports lighting control cabinet.
3. Retrofit of existing sports lighting from HID to LED type.
4. Addition of new sports lighting pole/fixtures, including associated feeder.

C. SPECIFICATIONS:

1. Revised the Table of Contents to include drawings and specifications added by this addendum. See attached.
2. The following specification sections were added for Division 23. See attached.
 - a. 230010 Summary of Mechanical Work
 - b. 230513 Common Motor Requirements for HVAC Equipment
 - c. 230517 Sleeves and Sleeve Seals for HVAC Piping
 - d. 230518 Escutcheons for HVAC Piping
 - e. 230529 Hangers and Supports for HVAC Piping and Equipment
 - f. 230548.13 Vibration Controls for HVAC Piping and Equipment
 - g. 230553 Identification for HVAC Piping and Equipment
 - h. 230593 Testing, Adjusting, and Balancing for HVAC
 - i. 230713 Duct Insulation
 - j. 230719 HVAC Piping Insulation
 - k. 230800 Commissioning of HVAC
 - l. 230900 Instrumentation and Controls for HVAC
 - m. 230993 Sequence of Operations for HVAC Controls
 - n. 232300 Refrigerant Piping
 - o. 232923 Variable-Frequency Motor Controllers
 - p. 233113 Metal Ducts
 - q. 233300 Air Duct Accessories
 - r. 233713 Diffusers, Registers, and Grilles
 - s. 236200 Packaged Compressor and Condenser Units
 - t. 237313 Modular Indoor Central-Station Air-Handling Units
 - u. 238126 Split System Air Conditioning System

3. Section 265668 – Exterior Athletic Lighting: Revise the last paragraph to read as follows:

“The information supplied herein shall be used for the purpose of complying with the specifications for this project. By signing below, I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section”.

Manufacturer: _____ Signature: _____

Contact Name: _____ Date: ____/____/____

Contractor: _____ Signature: _____

D. DRAWINGS:

1. Mechanical Drawings M2.1, M3.1, M4.1, and M5.1 were added. See attached.
2. Sheet EP1.1: Revised Electrical and Plumbing Site Plan. See attached.
3. Sheet E2.1: Revised Luminaire Schedule, Symbol Legend, and Images. See attached.
4. Sheet E3.1: Revised Gymnasium Lighting and Electrical Plan. See attached.
5. Sheet E4.1: Revised Electrical Schedules and Electrical Riser Diagrams. See attached.
6. Sheet E4.2: Electrical Panel Schedules sheet was added. See attached.
7. Sheet E5.1: Revised Electrical Details. See attached.
8. Sheet E5.2: Revised Electrical Details. See attached.
9. Sheet DP2.1: Revised Plumbing Plan Room Names and Titles. See attached.
10. Sheet P3.1: Revised Plumbing Room Names and Titles. See attached.
11. Sheet P4.1: Revised Plumbing Schedules. See attached.

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February 16, 2023

DIVISION 1: GENERAL REQUIREMENTS

019113 General Commissioning Requirements

DIVISION 22: PLUMBING

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220517 Sleeves and Sleeve Seals for Plumbing Piping
220518 Escutcheons for Plumbing Piping
220523 General-Duty Valves for Plumbing Piping
220529 Hangers and Supports for Plumbing Piping and Equipment
220553 Identification for Plumbing Piping and Equipment
220719 Plumbing Piping Insulation
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221316 Sanitary Waste and Vent Piping
221319 Sanitary Waste Piping Specialties
223300 Electric, Domestic-Water Heaters
224000 Plumbing Fixtures

DIVISION 23: HEATING, VENTILATION, AND AIR-CONDITIONING

230010 Summary of Mechanical Work
230513 Common Motor Requirements for HVAC Equipment
230517 Sleeves and Sleeve Seals for HVAC Piping

230518	Escutcheons for HVAC Piping
230529	Hangers and Supports for HVAC Piping and Equipment
230548.13	Vibration Controls for HVAC Piping and Equipment
230553	Identification for HVAC Piping and Equipment
230593	Testing, Adjusting, and Balancing for HVAC
230713	Duct Insulation
230719	HVAC Piping Insulation
230800	Commissioning of HVAC
230900	Instrumentation and Controls for HVAC
230993	Sequence of Operations for HVAC Controls
232300	Refrigerant Piping
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233113	Metal Ducts
233300	Air Duct Accessories
233713	Diffusers, Registers, and Grilles
236200	Packaged Compressor and Condenser Units
237313	Modular Indoor Central-Station Air-Handling Units
238126	Split System Air Conditioning System



DIVISION 26: ELECTRICAL

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260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
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260923	Lighting Control Devices
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262726	Wiring Devices
262813	Fuses
262816	Enclosed Switches and Circuit Breakers
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265621	Exterior Lighting
265668	Exterior Athletic Lighting
267210	Fire Alarm System

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MECHANICAL:

M2.1	MECHANICAL GENERAL NOTES
M3.1	MECHANICAL DEMOLITION AND NEW PLANS
M4.1	MECHANICAL SCHEDULES AND ELEVATIONS
M5.1	MECHANICAL DETAILS

1
ADD

ELECTRICAL:

E2.1	ELECTRICAL SYMBOL LEGEND AND IMAGES
E3.1	GYMNASIUM LIGHTING AND ELECTRICAL PLANS
E4.1	ELECTRICAL SCHEDULES AND ELECTRICAL RISER DIAGRAMS

E4.2	ELECTRICAL PANEL SCHEDULES
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E5.1	ELECTRICAL DETAILS
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1
ADD

E5.2	ELECTRICAL DETAILS
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PLUMBING:

DP2.1	CONCESSION DEMOLITION PLAN
P3.1	NEW CONCESSION PLUMBING, WASTE AND VENT PLAN
P4.1	PLUMBING FIXTURE SCHEDULES AND DETAILS



SECTION 230010 – SUMMARY OF MECHANICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 23 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. The following Summary of Work is intended as an aid to achieve an understanding of the various elements of work included in the project, and is not intended to be all-inclusive. Detailed descriptions of work and requirements are given in drawings and specifications.
- B. Mechanical Contract Documents were prepared for the Project by:
 - Ethos Engineering,
 - 1126 South Commerce Street
 - Harlingen, Texas 78550
 - Phone Number: (956) 230-3435
- C. Scope of Work: Refer to drawings for a detailed Scope of Work.
 - 1. Provide all materials and labor associated with new fully-operational mechanical and controls systems for the project “[Cameron County Santa Rosa Phase-2](#)”, including but not limited to the following:
 - 2. Demolition: Demolish equipment and materials as shown on the drawings. Owner has right of first refusal. Dispose of removed items that owner no longer wishes to keep.
 - a. Remove and dispose of split system, support assembly, ductwork, refrigerant, condensate drain piping, miscellaneous materials, controls, and devices associated with demolished equipment which will no longer be used, including and not limited to, hangers, supports, mounting hardware, conduit and power wiring, etc.
 - b. Save existing smoke detectors, wiring and safeties for reuse. Document devices that are not in working order.
 - c. Clear area and prepare for new work.
 - 3. New Work: See drawings for scope of work under Base Bid and work under Alternate Bid 2.
 - a. Space conditioning mini-split units with direct-expansion cooling.
 - b. Space conditioning split system units with modular indoor central station AHUs, direct-expansion cooling with staged compressors, electric heaters, true VAV operation with variable speed drives, and accessories for a complete and operational system.
 - c. Ductwork, diffusers, grilles, dynamic fire dampers, control dampers, OA intake louvers, and other accessories.
 - d. Testing, Adjusting, & Balancing (TAB) shall not be provided under the mechanical contract. General contractor to provide TAB. Coordinate work.
 - e. [Provide Full-DDC controls for work under this phase.](#) Coordinate with equipment manufacturer, and integrate controls as needed to ensure that all safeties and warranties are retained.

SECTION 230010 – SUMMARY OF MECHANICAL WORK

- 1) Use BACnet interface to monitor additional parameters and alarm codes from equipment controllers.
 - 2) Controls contractor is responsible for all controls relays, contactors, power to DDC panels, dampers, and other controls equipment. Although contractor may coordinate with other trades to provide miscellaneous electrical and mechanical work, the final responsibility for achievement of control sequences lies with controls contractor.
 - 3) Install adjustable limited-range thermostats and integrate with new BAS. Connect to Central Operator's station via communications network.
- f. Shop drawing submittals for all mechanical systems including but not limited to equipment, ductwork and piping.
 - g. Coordination drawings for placing of mechanical systems in relation to work by other disciplines.
 - h. Contractor is responsible for providing [wind-storm certification inspections and certifications](#) for exterior mounted equipment. Contractor must notify Inspector prior to installing equipment, and apprise inspector of work scheduling involving equipment requiring wind inspection / certification, so that inspections may be carried out at required stage(s) of construction. Cost for inspection shall be borne by the Contractor. Inspector shall be certified by the Texas Department of Insurance (see www.tdi.state.tx.us for a list of certified Inspectors).
 - i. Coordinate electrical work with Div. 26 as required.
 - j. Coordinate fire alarm related work with Fire Alarm Contractor. Provide smoke detectors, wiring and controls for units, 2000 cfm and larger, where none exist.
4. Painting: See Division 9 specifications. Paint all exposed piping, ductwork, insulation, hangers, accessories in interior exposed areas. Paint exterior pipe supports. Coordinate paint type, color and scope of work with Architect.

1.3 ALLOWANCES

- A. Allowances are included in the Division 1 specifications.

1.4 COORDINATION

- A. All mechanical work shall be done under sub-contract to a General Contractor. Mechanical Contractor shall coordinate all work through General Contractor, who is ultimately responsible for the entire project.
- B. Prior to bidding, Mechanical Contractor shall coordinate all work in Division-23 for integration with TAB, plumbing, electrical, controls work and general construction. A detailed list of inclusion and exclusions shall be provided to General Contractors at least three days prior to the end of the period set aside to request clarifications so that coordination of any missing items may be addressed and clarified by Architect/Engineer as needed.
- C. All electrical work required for operation of mechanical systems shall be coordinated through the General Contractor prior to bidding to ensure that all starters, disconnects, VFD's, conduit and wiring are provided as part of the project. All components needed for a full operational installation of systems shall be provided.

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- D. All controls required for operation of mechanical systems shall be coordinated prior to bidding, to ensure that all equipment, materials, sensors, devices and labor are provided as part of the project. All components needed for a full operational installation of systems shall be provided. Mechanical Contractor shall coordinate and supervise installation of all controls systems.
- E. All questions, requests for information, submittals, and correspondence from the Div. 23 Contractor shall be submitted via the General Contractor, who will forward to the Architect, who will then forward to the Engineer.
- F. Div. 23 Contractor shall not make any changes to design without written authorization from the Engineer. If changes are requested by the Owner, Architect, General Contractor, Suppliers, Manufacturers, or any others, Contractor should issue a written RFI for response by the Engineer.
- G. Div. 23 Contractor shall issue seven days written notice prior to any activities that require the presence of the Engineer at the job-site. This applies to all inspections required by specifications, and particularly to those where work will be covered.
- H. Cooperate fully with other contractors so that work under those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Ensure that systems are ready for controls and electrical connections when needed so as to not delay construction.
- I. Contractor shall coordinate with other divisions for power and control of mechanical systems. It is not the intent of this specification to dictate who will conduct work, only to state the requirements of conducting the work.
- J. Coordinate with Div. 1 for work sequence and optimization of construction schedule.
- K. Coordinate with Div. 21 for Fire Suppression System.
- L. Coordinate with Div. 22 for Plumbing System.
- M. Coordinate with Div. 26 electrical contractor for providing power to mechanical equipment, and for Fire Alarm Systems interface with mechanical systems.
- N. Coordinate TAB activities with TAB Contractor.
- O. [Coordinate commissioning activities with Commissioning Agent.](#)
- P. Issue written notification of the following tasks and allow five (5) days for Engineer to respond and schedule an inspection as required. Failure to issue written notification may result in work having to be redone to allow for proper inspection. It is contractor's responsibility to make sure Engineer receives notification.
 - 1. Upon completion of ductwork and prior to testing and insulating.
 - 2. Metal duct leakage testing.
 - 3. Above ceiling inspections prior to ceiling tile installation.
 - 4. When ready to request manufacturer's start-up of each piece of equipment.
 - 5. When ready for Systems Readiness Checklists (Commissioning).
 - 6. When ready for Functional Performance testing (Commissioning).
 - 7. When ready for an inspection by TAB contractor prior to developing detailed TAB Plan.
 - 8. When ready to conduct complete Automation System software demonstration.

SECTION 230010 – SUMMARY OF MECHANICAL WORK

9. When ready for Substantial Completion Inspection.
10. When ready for Final Inspection.

Q. General

1. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.
2. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.
3. The Mechanical, Electrical, Plumbing, and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
4. When the mechanical, electrical and plumbing drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

1.5 WORK SEQUENCE

A. Locate Utilities:

1. Coordinate with power, water, sewer, telephone, communications, and other utilities as well as designated Owner's personnel to locate all utilities prior to digging in any area.
2. Obtain any approvals required from utilities to relocate utilities.
3. Cost of relocating or bypassing utilities indicated on drawings shall be included in Base Bid.
4. Where several new utilities must share a common area or path, coordinate with other trades so that the proper clearances are maintained and utilities may be installed in compliance with all requirements.
5. Refer to Civil Plans for coordination of connection points from site utilities to buildings.

B. Coordinate with Division 1 requirements to optimize construction schedule.

C. Provide equipment and material submittals, coordination drawings and shop drawings as required by specifications.

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- D. Submit detailed mechanical Schedule of Values with Submittals. Mechanical Submittals will not be accepted without a detailed Schedule of Values.
- E. Sequence construction in coordination with work by other disciplines.

1.6 CONTRACTOR USE OF PREMISES

- A. Use of the Site: Limit use of the premises to work in areas indicated. Confine operations to areas within contract limits indicated. Do not disturb portions of the site beyond the areas in which the Work is indicated.
 - 1. Driveways and Entrances: Keep driveways and entrances to construction site clear and available to other Contractors, Owner, and A/E personnel at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Site Safety: Take every precaution to ensure the site does not present a threat to the safety of occupants and/or workers. Minimal safety requirements include, but are not limited to the following:
 - 1. Temporary fencing around construction areas.
 - 2. Yellow caution tape and construction barricades along open trenches during the day. Trenches shall be covered at night and warning lights provided on construction barricades.
 - 3. Temporary fencing around equipment while site work is in progress.

1.7 SUBMITTALS

- A. Manufacturer's standard dimensioned drawings, performance and product data shall be edited to delete reference to equipment, features, or information which is not applicable to the equipment being supplied for this project.
- B. Provide all mechanical submittals at the same time in one or multiple bound volumes. Include originals from manufacturer. **All submittals shall be in native pdf and searchable format.** Faxes and copies of faxes are not acceptable.
- C. Provide sufficient copies of approved data, with the engineer's approved stamp, for inclusion in the operations and maintenance manuals.
- D. Provide detailed coordination drawings showing how mechanical system components will be installed in coordination with work by others. Engineer's drawing files will be made available to Contractor for producing coordination and as-built drawings upon request.

1.8 SCHEDULE OF VALUES -Special Requirements

- A. Mechanical Contractor shall submit a Schedule of Values reflecting the total value of Mechanical Work in the Contract, and broken down into the following items as a minimum, with a line-item for Materials/Equipment and another for Labor:

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SECTION 230010 – SUMMARY OF MECHANICAL WORK

1. HVAC equipment
2. HVAC materials (ductwork, piping, dampers)
3. HVAC labor
4. Controls equipment
5. Controls labor
6. Controls engineering and programming
7. Controls commissioning and closeout (minimum 10% of total controls cost)
8. Controls training (minimum 5% of total controls cost)
9. TAB
10. Allowances.
11. Miscellaneous
12. Administrative and project management.

- B. Schedule of Values shall be included with bound submittals. Submittals without a Schedule of Values shall not be reviewed.

1.9 EQUIPMENT MANUFACTURERS

- A. Mechanical design is based on equipment and materials scheduled and specified. These are used as the basis for performance characteristics, quality, and physical dimensions/weight.
- B. Equipment and materials by other APPROVED manufacturers may be provided by Contractor. In doing so, Contractor assumes responsibility for the performance, quality, and physical dimensions of the proposed units.
- C. Any costs associated with modifications to the design due to submittal of equipment and/or materials other than those used as the basis of design are the Contractor's responsibility. This includes any design time, production of drawings, and time delays.
- D. Where use of equipment and/or materials other than those used as the basis of design impact other disciplines, Contractor shall assume responsibility for all costs associated with any APPROVED modifications. This may include resizing of electrical circuits, modifying openings in the structure, relocating floor drains, etc.

1.10 OPERATIONS AND MAINTENANCE MANUALS & TRAINING

- A. Submit Operations and Maintenance Manuals two weeks prior to Substantial Completion Inspection. Engineer will not conduct a Substantial Completion Inspection without having reviewed Operations and Maintenance Manuals.
- B. Use Operations and Maintenance Manuals as a guide for conducting training of Owner's personnel.

SECTION 230010 – SUMMARY OF MECHANICAL WORK

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 230010

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque. Unless otherwise noted, windings shall be:
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers:
 - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade: Cast-iron wall sleeves.
 2. Exterior Concrete Walls below Grade: Cast-iron wall sleeves with sleeve-seal system. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade: Cast-iron wall sleeves with sleeve-seal system. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.
 5. Interior Partitions: Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
 - 2. Escutcheons for Existing Piping:
 - a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - f. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
 - g. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Pipe stands.
 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with inturned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 7. Metallic Coating: Hot-dipped galvanized.
 - 8. Paint Coating: Epoxy.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

2.5 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

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- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

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3.2 EQUIPMENT SUPPORTS

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

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 3. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 4. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 5. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 6. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 - 7. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

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2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Housed-restrained-spring isolators.
5. Elastomeric hangers.
6. Spring hangers.
7. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
2. Section 220548.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation device.

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1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

D. Wind-Restraint Details:

1. Basic Wind Speed: Refer to Arch.
2. Building Classification Category: Refer to Arch.
3. Code recommended wind pressure multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
4. Design Analysis: To support selection and arrangement of **wind** restraints. Include calculations of combined tensile and shear loads.
- 5.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Mason Industries.
 7. Vibration Eliminator Co., Inc.

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8. Vibration Isolation.
 9. Vibration Mountings & Controls, Inc.
- B. Elastomeric Isolation Pads:
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 2. Size: Factory or field cut to match requirements of supported equipment.
 3. Pad Material: Oil and water resistant with elastomeric properties.
 4. Surface Pattern: Ribbed or Waffle pattern.
 5. Infused nonwoven cotton or synthetic fibers.
 6. Load-bearing metal plates adhered to pads.
 7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Ribbed or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.
- C. Double-Deflection, Elastomeric Isolation Mounts:
1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
- D. Restrained Elastomeric Isolation Mounts
1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.
- E. Freestanding, Laterally Stable, Open-Spring Isolators:
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

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- a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes elastomeric pad.
 - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.
- H. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- I. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

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- J. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Isolation Technology, Inc.
 - 4. Kinetics Noise Control.
 - 5. Mason Industries.
 - 6. Vibration Eliminator Co., Inc.
 - 7. Vibration Isolation.
 - 8. Vibration Mountings & Controls, Inc.
- B. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

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PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Sections.

3.4 VIBRATION-CONTROL AND WIND-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Install cables so they do not bend across edges of adjacent equipment or building structure.
- C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

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3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust active height of spring isolators.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

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2. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 5. Fasteners: Stainless-steel rivets or self-tapping screws.
 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- E. Fasteners: Stainless-steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- E. Fasteners: Stainless-steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.5 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety-yellow background with black lettering.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Division 09 Sections.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

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7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule: Coordinate with Owner.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes: Coordinate with Owner.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 PAINTING

- A. Clarification: In exposed areas (with no acoustic ceiling tiles), piping and piping insulation shall be painted. Although Division 9 may not specifically call for painting of MEP items, it states paint type and requirements for different materials. To extent possible coordinate painting with Division 9 and with Architect. Where adequate specifications are not available, use the following general guidelines:
 1. Ferrous Metal: Semi-Gloss, Alkyd-Enamel Finish: 2 finish coats over an enamel undercoat and primer.
 - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils. S-W: Kem Kromik Universal Metal Primer B50NZ6/B50WZ1.
 - b. Undercoat: Alkyd, interior enamel undercoat or semi-gloss, interior, alkyd-enamel finish coat, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils. S-W: Pro-mar 200 Interior Alkyd Enamel B34W200 Series.
 - c. Finish Coat: Same as undercoat. Semi-gloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 2. ASJ Jacket: Semi-Gloss, Acrylic-Enamel Finish: 2 finish coats.
 - a. Undercoat: Semi-gloss acrylic latex enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 2.0 mils. S-W: Pro-Mar Interior Latex Egg-Shell Enamel B20W200.

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- b. Finish Coat: Same as undercoat. Semi-gloss, acrylic latex enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils

B. Final colors shall be coordinated with Owner and Architect during construction.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. TAB work shall not be contracted under Division 23 Contractor. Third party TAB Contractor shall be contracted by the Prime Contractor. Coordinate activities and assist TAB Contractor as needed.
- B. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
 - c. Heat-transfer coils.
 - 3. Testing, adjusting, and balancing existing systems and equipment.
 - 4. Duct leakage tests.
 - 5. Control system verification.
 - 6. Other tests as specified.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

1.4 PREINSTALLATION MEETING

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB reports.
- C. Sample report forms.
- D. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

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- A. The Owner will occupy portions of existing buildings Owner will occupy the site and existing building during entire TAB period. Reference SECTION 011000 - SUMMARY for more precise dates and stipulations.
- B. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

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- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. At least 15 calendar days prior to any on-site TAB measurements taking place, prepare and submit to Engineer a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

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- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 SENSOR ACCURACY TESTING

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- A. Measure accuracy of all sensors (temperature, humidity, dewpoint, pressure, carbon dioxide (CO₂), etc.) associated with air conditioning systems and the Building Automation System (BAS).
- B. Provide a written report, separate from and prior to the final TAB report, to include the following:
 1. List of each different type of sensor, manufacturer and model, and its accuracy as stated by manufacturer.
 2. List of every sensor in the project, identified by room number and associated HVAC unit name.
 3. Reading of sensor as measured by TAB, and as simultaneously reported by the BAS and/or other HVAC system, and difference between. (Example format for temperature sensor below.)

Temperature Sensors

ID	BAS read- ing deg F	TAB read- ing deg F	Difference
Room 100 / VAV-100	72.4	72.5	-0.1
Room 124 / VAV-124	72.1	71.7	0.4
Room 124 / VAV-124	73.5	71.6	1.9

4. List observations regarding sensors installation which may impact satisfactory operation of HVAC systems, such as improper location of sensors.
- C. At direction of Engineer, BAS and/or HVAC systems providers will be required to replace or calibrate sensors based upon this TAB sensors accuracy report. Subsequent to such replacement and calibration, re-measure accuracy of those sensors which were calibrated or replaced and submit report per directions above.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.

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- b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.

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3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

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- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.10 PROCEDURES FOR REFRIGERANT HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data **for each refrigerant coil**:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.

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3. Airflow.
4. Air pressure drop.
 - a. Units 6 tons and less: Overall readings (upstream of filters, fan suction, fan discharge) are to be taken for all units. A full test of air pressure drops across every single component of the system (i.e. filters, coils) need be taken only for a representative sample of units as follows:

Qty of units	Full
<u>Installed</u>	<u>Testing</u>
1-10	1
10-20	2
20-30	3
31+	4

- b. Units larger than 6 tons: Readings across **all system components** are to be taken for all units larger than 6 tons.
 - B. Where a unit has multiple coils (e.g. main cooling coil and a reheat coil), take and record data for each coil under conditions as close as possible to intended design operation (e.g., with cooling coil producing control-system sub-cooling setpoint, reheat coil producing control-system supply temperature setpoint).

3.11 TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.
- D. Data may be trended using Building Automation System. However, calibration of DDC sensors must be verified prior to trending data.

3.12 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
- C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

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1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 3. Test room pressurization first, then zones, and finish with building pressurization.
- D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
 3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.13 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

- A. After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.
- B. Observe and record the following conditions for each HVAC system:
1. The distance between the outside-air intake and the closest exhaust fan discharge, flue termination, or vent termination.
 2. Specified filters are installed. Check for leakage around filters.
 3. Cooling coil drain pans have a positive slope to drain.
 4. Cooling coil condensate drain trap maintains an air seal.
 5. Evidence of water damage.
 6. Insulation in contact with the supply, return, and outside air is dry and clean.

3.14 DUCT LEAKAGE TESTS

- A. Duct leakage testing will be performed by mechanical installation contractor.
- B. Witness the duct pressure testing and provide written report on results immediately thereafter.

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1. Verify that proper test methods are used and that leakage rates are within specified tolerances.
2. Report results of all testing and any deficiencies observed. Provide floor plans in report indicating sections of duct tested, and test criterion.

3.15 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
1. Verify temperature control system is operating within the design limitations.
 2. Verify the operation of lockout or interlock systems.
 3. Verify the operation of valve and damper actuators.
 4. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 5. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
 6. Verify damper leakage is in accordance with submitted performance and not so excessive that it prevents system operation in accordance with design intent.
 7. Confirm that the sequences of operation are in compliance with Contract Documents.

3.16 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

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3.18 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Report shall be in pdf format where all data in the entire report is searchable. Reports containing PDF scans of paper copies are not acceptable and will be rejected without review.
- B. Report Format:
1. Title page.
 - a. Project name and location.
 - b. Name and address of:
 - 1) TAB specialist.
 - 2) General Contractor.
 - 3) Architect's name and address.
 - 4) Engineer's name and address.
 - 5) General Contractor's name and address.
 - c. Date of report submission.
 2. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 3. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer, certifying validity and accuracy of field data. Include signature of TAB supervisor who certifies the report.
 4. **Include a page summarizing equipment, devices, and systems which cannot be balanced to specified conditions, reasons why they cannot be so balanced, and recommendations for resolving these issues.**
 5. **Provide a summary list of every air handler and fan, with a column for its design and actual CFM, and % deviation from design CFM.**
 6. Include a list of instruments used for procedures, along with proof of calibration.
 7. Certified field-report data.
 8. List of abbreviations used in report.
 9. Nomenclature and data sheets for each item of equipment, including manufacturer's name, type, size. Include, at minimum:
 - a. Fan curves.
 - b. Pump curves.
 - c. Manufacturers' test data.
 - d. Field test reports prepared by system and equipment installers.
 - e. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. Final Report Contents: In addition to items listed above, include:
1. Original test report of sensor accuracy testing.
 2. Duct leakage test report.

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3. Summary of observations on proper drainage of condensate drain pans for every item of equipment having a condensate drainage system.
 - a. Proper pan slope and pan condensate evacuation.
 - b. Adequate condensate trap depth versus static requirement.
 - c. Adequate slope and lack of ‘bellies’ in condensate pipe drainage system.
 - d. Proper pumped condensate operation.
4. Field observations list of conditions of filters (verify construction filters are removed and final filters are clean) and filter racks.
5. Field measurements and observations regarding leakage of outdoor air and control air dampers.
6. Certified field-report data for each balanced system, including specified versus final performance, notable characteristics of systems, description of system operation sequence if it varies from the Contract Documents
7. Layouts of air distribution systems from construction as-built drawings.
 - a. Number all air devices and systems referenced in report body.
 - b. Scans of paper drawings are not acceptable. Hand-written notes for numbering devices, duct runs, etc., are permissible, but the basic floor plans and duct / piping layouts, equipment and devices locations, etc., must be from original pdf files.
 - c. Indicate duct, outlet, and inlet sizes, pipe and valve sizes and locations, locations of major equipment items such as air handlers, fans, air terminal units, pumps, etc., balancing stations.
8. Summary Of Critical Measurements and Setpoints:
 - a. **Provide a table which summarizes critical measurements and settings for all HVAC equipment 1HP and larger.** Sample tables provided below for pumps and air-side systems showing minimum required information:

Unit Name	Design CFM	Measured CFM	Design ESP	Measured ESP	Tap or VFD Speed Setting	Req'd Static Stpt
AHU-123	1,000	990	1.50"	1.10"	55%	NA

- * Individual system/unit.
- a. Nameplate, design, and measured performance as described in this specification.
 - 1) The intent of TAB measurements is to prove unit performs in accordance with manufacturer’s specified and submitted data. Change setpoints as required to achieve this result. (For example in a dedicated outside air unit with hot gas reheat, set the cooling coil leaving air temperature setpoint and the unit leaving air temperature setpoint to achieve cooling coil design.) Clearly indicate in report the setpoints in effect when measurements were taken.
 - b. Include fan and pump curves for units 1.5HP and larger.
 - c. For units with VFD speed control: Indicate required VFD speed and whether VFD was speed-limited in its controller settings.
10. Floor plans (as-built) showing HVAC unit locations, duct layouts, air terminal devices numbered to match measured data points.
 - a. Show location of air-side pressure sensors, differential or straight pressure, where such sensors are used in control

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12. List of Abbreviations.
13. Checklist of DX HVAC unit inspections: **Sample checklists below.** Include comments as required to explain anomalies or deficiencies. (Engineer will provide sample file in Excel format upon request.)

Unit Inspection Checklist

DX Units	RTU-1	RTU-2	RTU-2
Condensate drain pan is clean			
Condensate pan fully draining, no ponding in pan			
No excessive damper air leakage			
No air leakage @ cabinet, doors, duct connections			
Final air filters installed and clean			
Final filters of type/MERV rating specified			
Coil fins undamaged and/or combed straight			
Fan free of vibration, rotating in correct direction			
Unit interior cleaned and vacuumed			
Access doors open fully & freely			

D. RTU/Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.

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- d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outdoor-air damper position.
 - k. Return-air damper position.
 - l. Settings for outdoor-, return-, and exhaust-air dampers.
 - 1) Air handling units / RTU's *may* be designed to operate with fan varying from high to low speed depending upon compressor operation.
 - 2) For such units, TAB must measure required outside air damper (& return, where applicable) position for intake of design ventilation air not only at full fan speed, but at low fan speed as well. Report results in final TAB report.
 - 3) Convey required damper positions to BAS contractor as soon as they are known, prior to submission of final TAB report.
- E. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):

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- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- F. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- G. VFD-served equipment:
1. A pump or fan served by a VFD must be balanced for maximum energy efficiency by limiting maximum speed via the VFD (“Maximum Allowed Speed”). It is not acceptable to operate VFD at 60hz (or higher) and then balance system by throttling valves or dampers.
 2. VFD Maximum Allowed Speed is to be determined such that design flow is met in the most critical (highest pressure drop) flow path with no throttling in that path. Other flow paths may then be balanced by throttling as needed with VFD at Maximum Allowed Speed.
 3. VFD Maximum Allowed Speed shall be programmed at the VFD controller or AHU/RTU.
- H. Indoor-Air Quality Measurement Reports for Each HVAC System:
1. HVAC system designation.
 2. Date and time of test.
 3. Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
 4. Room number or similar description for each location.
 5. Measurements at each location.
 6. Observed deficiencies.
- I. Instrument Calibration Reports:
1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.

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- d. Dates of use.
- e. Dates of calibration.

3.19 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer conditions, perform additional TAB during near-peak summer conditions.

3.20 SUMMARY OF SYSTEMS SCOPE WORK FOR TESTING AND BALANCING

- A. The following systems are to be included in scope of TAB work for this project:
 - 1. Air distribution systems (ducts, dampers, outlets, etc.)
 - 2. Split System DX units.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, concealed return located in unconditioned space.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."
 - 2. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

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1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, and are limited to, the following:
 1. Mineral-Fiber Insulation:
 - a. CertainTeed
 - b. Manson.
 - c. Knauf FiberGlass GmbH.
 - d. Owens-Corning Fiberglas Corp.
 - e. Schuller International, Inc.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

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- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.9 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 4 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.

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6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

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- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

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- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

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3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

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3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

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B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Service: Round & rectangular, supply-air ducts concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 3 inches (R-8 min).
3. Number of Layers: One.
4. Field-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

B. Service: Round & rectangular, return, outside-air and fume hood exhaust ducts concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 2 inches (R-6 min).
3. Number of Layers: One.
4. Field-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

C. Service: Round supply, make-up, and outside-air ducts, exposed in conditioned space.

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1. Double wall, with 2" insulation thickness, and painted.
- D. Service: Return air duct, exposed in conditioned space: No insulation. Paint duct.
- E. Service: Ten feet of supply and return air ducts closest to AHU or FCU.
1. Material: In addition to exterior wrap, provide internal liner for sound attenuation purposes.
 2. Thickness: 1 inches.
- F. Service: Ten feet of exhaust air duct closest to where duct penetrates the exterior envelope.
1. Material: Exterior wrap.
 2. Thickness: 2 inches.
- G. Where ductwork is not completely concealed, paint all ductwork and insulation. Coordinate color and finish with Architect.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors.
 - 2. Refrigerant piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Flexible Elastomeric Thermal Insulation:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2.2 INSULATION MATERIALS

- A. Mineral-fiber insulation will NOT be allowed for use on any cold piping systems.
- B. Mineral-fiber wrap is NOT approved for use on piping insulation.
- C. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

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- D. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- E. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- F. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- G. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 3. Service Temperature Range: 0 to plus 180 deg F.
 - 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

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- D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

- A. Bands:
 - 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

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1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range. **NO EXCEPTION: PIPES SHALL BE PAINTED.**
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.

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2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

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2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

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- each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe

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insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

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3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of fittings, two locations of strainers, three locations of valves, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

SECTION 230719 - HVAC PIPING INSULATION

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Vapor Retarder Required: Yes.
 - c. Finish: Painted (Coordinate with Architect).
- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be:
 - a. Flexible Elastomeric: **1 inch** thick minimum, with two coats of protective coating recommended by the insulation manufacturer.
 - b. Vapor Retarder Required: Yes.
 - c. Finish: Painted (Coordinate with Architect).

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

3.14 OUTDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be:
 - a. Flexible Elastomeric: **1 inch** thick minimum, with two coats of protective coating recommended by the insulation manufacturer.
 - b. Vapor Retarder Required: Yes.
 - c. Field-Applied Jacket: Aluminum jacket.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

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1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.020 inch thick.

3.16 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for the following MEP systems, assemblies, and equipment:
 - 1. HVAC equipment.
 - 2. Controls and instrumentation, including BAS energy monitoring and control system.
- B. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

1.3 DEFINITIONS

- A. Refer to Section 019113 "General Commissioning Requirements" for additional definitions and assignment of responsibilities.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Refer to Section 019113 "General Commissioning Requirements".
- B. Perform commissioning tests at the direction of the CxA.**
- C. Attend construction phase controls coordination meeting.
- D. Attend testing, adjusting, and balancing review and coordination meeting.
- E. Participate in mechanical systems, assemblies, equipment, and component maintenance orientation and inspection.
- F. Provide information requested by the CxA for final commissioning documentation.
- G. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for required test period.
- H. Provide Project-specific construction checklists and commissioning process test procedures for actual mechanical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- I. Direct and coordinate commissioning testing among subcontractors, suppliers, and vendors.

SECTION 230800 - COMMISSIONING OF HVAC

- J. Verify testing, adjusting, and balancing of Work are complete.
- K. Provide test data, inspection reports, and certificates in Systems Manual.

1.5 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's pre-start and startup checklists for mechanical systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, pre-start checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that mechanical systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

1.6 INFORMATIONAL SUBMITTALS

- A. Construction Checklists: See related Sections for technical requirements, and generate construction checklists for the following:
 - 1. Instrumentation and control for MEP systems.
 - 2. Split Systems.
- B. Certificates of readiness.
- C. Certificates of completion of installation, pre-start, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Refer to Section 019113 "General Commissioning Requirements".

3.2 SYSTEMS READINESS CHECKLISTS

- A. Construction Checklists: Assist CxA in the preparation of detailed Systems Readiness checklists for systems, subsystems, equipment, and components.
 - 1. Contributors to the development of checklists shall include, but are not limited to:
 - a. Systems and equipment installers.

SECTION 230800 - COMMISSIONING OF HVAC

- b. TAB technicians.
 - c. Instrumentation and controls installers.
- B. Contractor shall conduct Systems Readiness Testing to document compliance with installation and Systems Readiness checklists prepared by Commissioning Authority for Division-23 items.
- C. Refer to Section 019113 "General Commissioning Requirements" for issues relating to Systems Readiness checklists and testing, description of process, details on non-conformance issues relating to pre-functional checklists and test.

3.3 SYSTEM START-UP

- A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies.

3.4 TESTING PREPARATION

- A. Certify that systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
- C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.5 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Provide technicians, instrumentation, and tools to verify testing and balancing of mechanical systems at the direction of the CxA.
- 1. The CxA will notify Contractor 4 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 - 4. Remedy deficiency and notify CxA so verification of failed portions can be performed.

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3.6 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of mechanical testing shall include entire HVAC installation, from equipment through distribution systems to each space served. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the Contracting Officer and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the mechanical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 GENERAL TESTING PROCEDURES FOR HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT

- A. HVAC Instrumentation and Control System Testing: Contractor shall fully test operation of controls system prior to requesting Functional Testing with CxA. Point-to-point check out sheets and as-built control diagrams shall be provided to CxA so he may develop testing procedures.
- B. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.

3.8 FUNCTIONAL TEST PROCEDURES FOR SYSTEMS TO BE COMMISSIONED

- A. General
 - 1. The following paragraphs outline the functional test procedures for the various Div. 23 items to be commissioned. Functional testing will take place only after System Readiness

SECTION 230800 - COMMISSIONING OF HVAC

checklists have been completed, equipment has been started-up, TAB has been verified, and Contractor has certified that systems are ready for functional testing.

2. All systems controlled via the Building Automation System shall have all control points and sequences tested by Controls Contractor prior to requesting testing by CX Authority.
3. Functional testing of HVAC systems shall include testing of the BAS.

B. All Equipment:

1. Verify nameplate information (serial numbers, model numbers, etc.); verify that equipment capacity is in accordance with requirements of construction documents.
2. Verify unit runs smoothly and quietly.
3. Verify operation of safeties.
4. Verify electrical wiring and grounding is correct.
5. Verify maintenance and NEC clearances are maintained.
6. Verify Systems Readiness Checklists have been completed.

3.9 COMMISSIONING TESTS

A. Functional testing will be performed on all HVAC equipment, including but limited to the following:

1. Split systems
2. Air distribution system
3. Building automation system

B. Sample requirements are as follows:

1. Record temperatures, pressures.
2. Record programmed setpoints (unocc/occ temperature, RH, CO2, runtime, safeties, alarms).
3. Record programmed schedules and interlocks.
4. Verify equipment installation
5. Verify equipment operation.
6. Verify electrical voltage and amperages are within tolerance.
7. Verify unit data in TAB report.
8. Verify alarms and safeties.
9. Verify all sequences.
10. Verify setpoint resets, adaptive controls for energy conservation.

C. Customized system readiness checklists and function testing requirements will be released after the submittal review phase.

3.10 TRAINING AND O&M MANUALS

A. Refer to Div. 23 specifications.

END OF SECTION 230800

SECTION 230900 – INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Design Intent is to get Full-DDC controls for work under this phase. Coordinate with equipment manufacturer, and integrate controls as needed to ensure that all safeties and warranties are retained. BACnet interface will be used to monitor all alarms and parameters from the unitary controllers.
- 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

- B. Related Requirements:

- 1. Section 230993 "Sequence of Operations for HVAC Controls" for control sequences in DDC systems.

1.3 CODE REQUIREMENTS

- A. All equipment and material and its installation shall conform to the current requirements of the following authorities, and local amendments:

- 1. Occupational Safety and Health Act (OSHA)
- 2. International Electric Code (IEC)
- 3. International Fire Code
- 4. International Building Code
- 5. International Mechanical Code
- 6. International Plumbing Code
- 7. International Energy Conservation Code
- 8. UL 916

- B. Where two or more codes conflict, the most restrictive shall apply. Nothing in these specifications shall be construed to permit work not conforming to applicable codes.

1.4 ACTION SUBMITTALS

- A. **All submittals must be in native PDF format, wherein all text is searchable. Submittals which contain scanned documents which are not 'searchable' will be rejected without being reviewed.**

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

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

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2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
5. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
6. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
3. Schematic drawings for each controlled HVAC system indicating the following:
 - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to HVAC system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Narrative sequence of operation.
 - 1) Contractor is expected to review all specified sequences and submit questions concerning any ambiguities, potential errors or omissions, prior to turning in submittals. Submittals which simply restate control sequences as written in specifications are not acceptable. Submittals must include a restatement of sequences as they will actually be programmed.
4. DDC system network riser diagram; indicate each device connected to network with unique identification for each, communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable, network port(s) for connection of an operator workstation or other type of operator interface, etc.

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5. Color graphics.
 - a. Submit samples and an itemized list of ALL the various graphics pages being proposed for control system. Show layout of pictures, graphics and data displayed, navigation icons, etc.
 - b. Graphics for equipment must be schematically correct versus equipment as actually installed (e.g., all sensors, coils, devices, shown in correct locations & sequential order).
 - c. Engineer's approval of submitted sample graphics pages represents preliminary approval and does not preclude the possibility that graphics' deficiencies may be found in subsequent testing and inspections.

D. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

1.5 INFORMATIONAL SUBMITTALS

- A. All submittals must be in native PDF format, wherein all text is searchable. Submittals which contain scanned documents which are not 'searchable' will be rejected without being reviewed.
- B. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.
- C. Systems Provider Qualification Data: Resume of project manager, installation and programming technician, and service technicians assigned to Project, including name, phone number, and e-mail address.
- D. Product Certificates: Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

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1.6 CLOSEOUT SUBMITTALS

- A. As-built record documentation per section 017700 – Closeout Procedures.
- B. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - b. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
 - c. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - d. Engineering, installation, and maintenance manuals.
 - e. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - f. Backup copy of graphic files, programs, and database in electronic media form.
 - g. List of recommended spare parts with part numbers and suppliers.
 - h. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - i. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - j. Licenses, guarantees, and warranty documents.
 - k. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - l. Owner training materials.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over five-year period following warranty period. Parts list shall be indicated for each year.

1.8 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical circuits for control units.
- C. Coordinate equipment with Division 16 Section "Panelboards".

1.9 PAYMENTS

SECTION 230900 – INSTRUMENTATION AND CONTROLS

- A. 20% of controls cost will be withheld until documentation is provided that the Commissioning and Acceptance Test was carried out, and that it was verified by Engineer.
- B. 5% of controls cost will be withheld until documentation is provided that the Training was carried out, and that it was acceptable by the Owner.

1.10 CONTRACTOR RESPONSIBILITY

- A. All control items, services, and work shown in specifications and drawings shall be provided by Controls Contractor either directly or by subcontract. These shall include, but are not necessarily limited to, the following:
 - 1. Install control equipment incorporating DDC for energy management, equipment monitoring and control, software, programming, including color graphic workstations.
 - 2. Provide control relays and devices, air flow monitoring devices, pressure and temperature sensing devices, dampers and actuators, etc.
 - 3. Provide electrical work associated with control system and as called for on Drawings. Perform all wiring in accordance with all local and national codes. Provide all line voltage wiring, concealed or exposed, in accordance with Div. 26. All low voltage electrical control wiring throughout the building when exposed shall be run in conduit in accordance with Division 26. All low voltage wiring run in concealed accessible areas shall be run using plenum rated wire only.
 - 4. Provide 120V power for direct digital control systems PCU's, and LCU's, as defined later in these specifications, and make final panel hook-up and all final electrical connections to each controller. Provide power for all damper-actuators including VAV boxes.
 - a. Power circuit to PCU/LCU shall serve PCU/LCU and no other equipment.
 - b. Use spares or provide new circuit breaker.
 - 5. Use spare circuit breakers or provide new where no spares exist.
 - 6. Provide all wiring and conduit for all DDC temperature controls, monitoring devices including DDC signal wiring.
 - 7. Provide all control relays. Where motor starters are not called for or do not exist for 1-phase equipment, provide relays and contactors as required for start/stop control by BAS.
 - 8. Provide surge transient protection shall be incorporated in design of system to protect electrical components in all primary control units.
 - 9. Provide all warranty related work, products, materials, and labor.
 - 10. Provide all software programming.
 - 11. Provide consulting and programming services to Owner and Installing Contractor as required to resolve operating problems after system installation.
 - 12. Provide shop drawings indicating equipment locations, points allocation, and schematic wiring. Submittals shall indicate all information pertinent to PCU locations, PCU capacity and spare points, input/output module configuration within PCUs, communication trunks, sensors, valves, pneumatic interface, wiring, and other pertinent equipment information requiring approval prior to field installation. Provide a DDC system riser diagram showing buildings, controller or device within each building, and listing equipment controlled or monitored by each.
 - 13. Provide graphics programming, showing floor plans of all buildings, equipment locations, and operating parameters.
 - 14. Provide commissioning of system.
 - 15. Provide reference manuals.
 - 16. Provide Owner training.
 - 17. Warranty work.
 - 18. Other services, materials, and products as called for in construction documents.

SECTION 230900 – INSTRUMENTATION AND CONTROLS

- B. The following equipment and services shall be coordinated with the Owner:
 - 1. Network connections.

- C. Coordinate with Mechanical Contractor. Mechanical Contractor provides:
 - 1. Installation of control dampers, actuators and all manual dampers.
 - 2. Temporary 24V thermostat for new equipment, if required.
 - 3. Fan coil units with factory-installed dampers (where indicated).
 - 4. Rooftop / AH units with factory-installed outside air damper actuator and controls.

1.11 QUALITY ASSURANCE

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

- B. DDC System Provider / Installer Qualifications:
 - 1. A direct factory owned office of the manufacturer, for the brand or make of control equipment to be supplied, with engineers capable of providing instructions, routine maintenance, design services, programming, and emergency system service on staff.
 - 2. Project supervisor and programmers shall be DDC system manufacturer employees. Only construction services not directly related to DDC system operation (such as provision of electrical power, conduit installation and wire-pulling, etc.) may be subcontracted to non-manufacturer workers.
 - 3. A manufacturer's employee working on this project shall be officed within 40 miles of Project and assigned to support Project during warranty period.
 - 4. Each manufacturer employee assigned to Project shall be a competent and experienced full-time employee with demonstrated past experience on at least 5 projects of similar complexity, scope and value.

1.12 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
 - 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

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- a. Install updates only after receiving Owner's written authorization.
3. Warranty service shall occur during normal business hours and commence **no later than 8 hours following Owner's warranty service request.**
4. Warranty Period: **Two years from date of final system acceptance.**
 - a. Final Acceptance of system is not related to nor dependent upon Substantial Completion. Final system acceptance will be granted only after system is operating without any substantive problems for a minimum of 30 consecutive days, and all issues on Commissioning Issues Log and Engineer's punch lists have been resolved. Obtain formal written approval from Engineer and Owner contractual date of system Final Acceptance.

B. Warranty Inspections

1. At approximately 12 months and 24 months after Final Acceptance of control system, provide a minimum 5 hour on-site inspection of system.
2. Inspection will include an evaluation of performance of the system, including an accuracy of all sensors (re-calibration or replacement is required for sensors obviously inaccurate), solicitation of operator's input of system problems and inadequacies, review of operating sequences and alarm logs to discover potential recurring problems or nuisances, discovery of any failed points, and general system reliability.
3. Provide a written report of each site visit summarizing activities and findings, and recommendations for improving system performance.
4. Failure to provide the on-site inspections at a time near that specified, or by the end of Warranty, does not relieve contractor of obligation to provide such inspections.

1.13 EXTRA MATERIALS

- A. Furnish quantity indicated of matching product(s) in Project inventory **for each unique size and type** of following:
 1. Room Relative Humidity Sensor and Transmitter: One.
 2. Adjustable Range Room Temperature Sensors: One.
 3. CO2 sensor: One.
 4. Current-Sensing Relay: One.

1.14 EQUIPMENT AND SOFTWARE UPDATES / UPGRADES / REVISIONS

- A. Equipment: All equipment, components, parts, materials, etc. provided shall be fully compatible with all other equipment provided at any other time throughout the warranty period. Should updated versions be provided that are not fully compatible with earlier equipment provided (e.g.: a requirement to add hardware or software "interfacing" between an earlier and later generation results in the system not being fully compatible), Controls contractor shall replace earlier equipment with the later version at no cost to Owner.
- B. Software: **If acceptable to the Owner**, all software upgrades applicable to the system and offered by the manufacturer / contractor for this system shall be provided at no cost to the Owner throughout the warranty period. This no cost upgrade shall include installation, programming, modification to field equipment, data base revisions, etc. all as appropriate.

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- C. Revisions: Hardware / software revisions made related to refining sequences of control, adding/monitoring control points, or other similar operations shall be made with all "burn-in" performed at the contractor's expense, throughout the warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Following Manufacturer's are allowed to bid on this project:
 1. Johnson Controls
 2. ALC
 3. Trane – Design Basis

2.2 DDC SYSTEM DESCRIPTION

- A. Modular, microprocessor-based, high-speed, peer-to-peer network of distributed DDC controllers, operator interfaces, and software monitoring and control, including analog/digital conversion and program logic, utilizing stand-alone controllers operating over a local area network allowing peer-to-peer communication among all system controllers, and communications interface to Owner's Central Operator's Station.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

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

2.4 PERFORMANCE REQUIREMENTS

- A. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- B. System Response Time:
 1. Graphic display refresh shall update within eight seconds.
 2. AI point value shall update within 5 seconds, BI point values within 10 seconds.
 3. AO and BO points shall begin to respond to controller output commands within three second(s).

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4. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
 5. Global commands shall also comply with this requirement.
- C. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least four times total I/O points indicated.
 2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
 3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- D. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products, instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3.
 - b. Outdoors, Unprotected: Type 4X.
 - c. Indoors, Heated with Ventilation: Type 2.
 - d. Indoors, Heated and Air Conditioned: Type 1.
 - e. Unconditioned Chiller and Boiler Rooms: Type 4X.
 - f. Conditioned Mechanical Equipment Rooms: Type 1.
 - g. Air-Moving Equipment Rooms: Type 1.
 - h. Localized Areas Exposed to Washdown: Type 4X.
- E. Electric Power Quality:
1. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41. Do not use fuses for surge protection.
 2. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.
- F. UPS: Provide UPS power protection for Servers, and DDC controllers (except application-specific controllers), and Gateways.
- G. Continuity of Operation after Electric Power Interruption: Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated

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controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Dampers:

1. Include panel-mounted, two-position, selector switch for each automatic control damper being controlled by DDC controller. Label each switch with damper designation served by switch, and switch positions to indicate either "Manual" or "Auto" control signal to damper. With switch in "Auto" position signal to control damper actuator shall be control loop output signal from DDC controller.
 - a. For Binary Control Dampers: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, damper shall close. With switch in "Open" position, damper shall open.
 - b. For Analog Control Dampers: A gradual switch shall have "Close" and "Open" switch limits indicated. Operator shall be able to rotate switch knob to adjust damper to any position from close to open.
2. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that damper is under manual, not automatic, control.

2.6 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than two levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level two LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 19,200 bps.

C. DDC system shall consist of dedicated LANs that are not shared with other building systems and tenant data and communication networks.

D. System architecture shall be modular and have inherent ability to expand to not less than three times system size indicated with no impact to performance indicated.

E. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

F. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

G. Special Network Architecture Requirements:

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1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s).

2.7 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
 1. Desktop and portable operator workstation with hardwired connection through LAN port.
 2. Portable operator terminal with hardwired connection through LAN port.
 3. Portable operator workstation with wireless connection through LAN router.
 4. PDA with wireless connection through LAN router.
 5. Remote connection using outside-of-system computer or PDA through Web access.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be easily accessible, properly protected, and clearly labeled.
- D. Desktop and Portable Workstations:
 1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 2. Able to communicate with any device located on any DDC system LAN.
 3. Able to communicate remotely with any device connected to any DDC system LAN.
 4. Connect to DDC system sub-LANs through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 5. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
- E. Personal Digital Assistant:
 1. Connect to system through a wireless router connected to LAN.
 2. Able to communicate with any DDC controller connected to DDC system.
- F. Critical Alarm Reporting:
 1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention. System shall send alarm notification to multiple recipients that are assigned for each alarm.
 2. Alarms must be set to observe proper time delays and other logic to avoid nuisance tripping.
 3. **Coordinate with Owner's representatives to set up Owner's desired alarm notification procedures and methodologies by means including e-mail, text message and pre-recorded phone message to mobile and landline phone numbers.**
- G. Simultaneous Operator Use: Capable of accommodating simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.8 NETWORK COMMUNICATION PROTOCOL

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- A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.
- B. ASHRAE 135 Protocol:
 - 1. ASHRAE 135 communication protocol shall be a required protocol used throughout entire DDC system. The Web Server shall support the BACnet Interoperable Building Blocks (BIBBS) for Read (Initiate) and Write (Execute) Services.
 - 2. System shall not require use of gateways except to integrate HVAC equipment and other systems and equipment not required to use ASHRAE 135 communication protocol.
 - a. Review manufacturer's communications protocols for all systems with which BAS will integrate, and provide gateways as required to allow full communication, such as, for examples, Modbus Application Protocol Specification V1.1b, LonWorks technology using CEA-709.1-C.

2.9 DESKTOP OPERATOR WORKSTATIONS

- A. Not Applicable. Use Owner's existing.

2.10 PORTABLE OPERATOR WORKSTATIONS

- A. Not Applicable. Use Owner's existing.

2.11 PRINTERS

- A. Not Applicable. Use Owner's existing.

2.12 SERVERS

- A. Furnish a Web Server to allow daily operations functions, using real-time system data, to be accomplished from any network connected web browser, from within the facility or in remote locations throughout the world.
- B. Servers shall include software license(s), and CAT-5e or CAT-6 cable installation between server(s) and network.
- C. Operators shall be able to utilize any commercially available browser such as Microsoft Internet Explorer or Netscape Navigator. No additional software shall have to be installed on the client PC for normal operation of the system.
- D. All communications between the web browser and web server shall be encrypted using 128 bit SSL encryption.
- E. Web server shall be able to be located on the Owner's Intranet or on the Internet.
- F. Web server shall have the ability to automatically obtain an IP (Internet Protocol) address using DHCP. Use of static IP addressing shall also be supported.
- G. Web server will have adequate capacity to store and serve 500 user defined graphics, and to archive not less than 12 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.

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- H. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE). The Web browser client shall support Sun Microsystems Java 2 (JRE 1.4.0 or higher) plug-in.
- I. Functionality:
 - 1. A minimum of 30 users shall be able to utilize the system device at the same time. Operators with proper security shall be able to:
 - a. View graphical information about a facility, change setpoints, perform overrides.
 - b. View and change schedules.
 - c. View and acknowledge alarms.
 - d. View historical information.
 - 2. Operators must enter in a valid unique user name and password to access the system.
 - 3. Operator security: The Web server shall include industry standard security protocols to prohibit access by unauthorized users over the World Wide Web. Provide firewalls between server Web and networks with password protection for access to server from Web server.
 - 4. The web server shall display the same graphics that have been created for the Operators Workstation.
 - 5. Operators with proper access shall be able to configure the web server using their web browser.
- J. Web Server Hardware.
 - 1. Provide a solid-state web server. This device may not contain any moving parts including but not limited to cooling fans, disk drives, CD Rom drives etc.
 - 2. All user entered information (web pages, security, etc.) shall be stored in non-volatile memory. System operational information and clock functions shall be backed up by battery or other device for a minimum of 72 hours.

2.13 SYSTEM SOFTWARE

- A. System Software Minimum Requirements:
 - 1. Provide all software required for efficient operation of all the automatic system functions required by this specification. Software shall be modular in design for flexibility in expansion or revision of the system. It is the intent of this specification to require provisions of a system which can be fully utilized by individuals with no, or limited, previous exposure to PC's and programming techniques and languages.
 - 2. The software in the system shall consist of both "firmware" resident in the PCU's and "software" resident in the operator work stations. The architecture of the system, and the application software/firmware shall be distributed with no single system component responsible for a control function for the entire Controller LAN. Each PCU shall contain the necessary firmware and I/O capability to function independently in case of a network failure. No active energy management or environmental control sequences shall be resident in the PC work stations. All PC work stations shall be removable from the system without loss of control function - only alarm monitoring, long term history collection, and operator monitor/command/edit functions would be lost.
 - 3. Software: **All software upgrades applicable to the system and offered by the manufacturer / contractor for this system shall be provided at no cost to the Owner**

- throughout the warranty period.** This no-cost upgrade shall include installation, programming, modification to field equipment, data base revisions, etc. all as appropriate.
4. Real-time multitasking and multiuser 32- or 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
 5. Operating system shall be capable of operating DOS and Microsoft Windows applications.
 6. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
 7. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
 8. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
 9. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
 - a. Graphical viewing and control of environment
2. Scheduling and override of building operations
3. Collection and analysis of historical data
4. Definition and construction of dynamic color graphic displays
5. Editing, programming, storage and downloading of controller databases
6. Provide a graphical user interface which shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.
 - a. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device.
 - b. Provide additional capability that allows at least 10 special function keys to perform often used operations.
7. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft Windows or similar industry standard software that supports concurrent viewing and controlling of systems operations.
 - a. Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows:
 - a. Dynamic color graphics and graphic control
 - b. Alarm management coordinated with section 2.04.E.
 - c. Time-of-day scheduling
 - d. Trend data definition and presentation
 - e. Graphic definition

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- f. Graphic construction
- 8. If the software is unable to display several different types of displays at the same time, the EMS contractor shall provide at least two operator workstations.
- 9. Multiple-level password access protection (minimum of five levels of access) shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - a. Level 1 = View all applications, but perform no database modifications
 - b. Level 2 = Custodial privileges plus the ability to acknowledge alarms
 - c. Level 3 = All privileges except system configuration
 - d. Level 4 = All configuration privileges except passwords
 - e. Level 5 = All privileges
- 10. A minimum of 50 unique passwords, including user initials, shall be supported.
- 11. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
 - a. The system shall automatically generate a report of log-on/log-off time and system activity for each user.
 - b. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
- 12. Software shall allow the operator to perform commands including, but not limited to, the following:
 - a. Start-up or shutdown selected equipment
 - b. Adjust setpoints
 - c. Add/modify/delete time programming
 - d. Enable/disable process execution
 - e. Lock/unlock alarm reporting for points
 - f. Enable/disable totalization for points
 - g. Enable/disable trending for points
 - h. Override PID loop setpoints
 - i. Enter temporary override schedules
 - j. Define holiday schedules
 - k. Change time/date
 - l. Automatic daylight savings time adjustments
 - m. Enter/modify analog alarm limits
 - n. Enter/modify analog warning limits
 - o. View limits
 - p. Enable/disable demand limiting for each meter
 - q. Enable/disable duty cycle for each load

C. Reports and Logs:

- 1. Reports shall be generated and directed to either CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - a. A general listing of all points in the network
 - b. List of all points currently in alarm
 - c. List of all points currently in override status

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- d. List of all disabled points
 - e. List of all points currently locked out
 - f. DDC Controller trend overflow warning
 - g. List all weekly schedules
 - h. List of holiday programming
 - i. List of limits and deadbands.
 - j. Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the building automation system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain system information.
2. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
 3. Each report shall be definable as to data content, format, interval and date.
 4. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server for historical reporting.
 5. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
 6. Reports and logs shall be stored on [workstation] [and] [server] hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
 7. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- D. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
 2. Alarm: All current alarms, except those in alarm lockout.
 3. Disabled I/O: All I/O points that are disabled.
 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 6. Alarm history.
- E. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report.
- F. Scheduling:
1. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance.
 2. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule.
 3. Zone schedules shall be provided for each building zone. Each commandable point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone.
 4. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation.
 5. Collection and Analysis of Historical Data
 - a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may

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be trended automatically at time-based intervals or changes of value, both of which shall be user definable. Trend data may be stored on hard disk for future diagnostics and reporting.

- b. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Lotus 1-2-3a. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

2.14 GRAPHICS

- A. Provide Central Operator's Station with software and hardware as needed to meet requirements specified herein. Graphics are to be online programmable and under password control.
- B. System shall be provided with complete color graphics software package, such that graphics can be created by user from time of software installation, without need for additional hardware or software. Each operator work station shall support not less than 1,000 separate graphic pages. Contractor shall include developed graphics as approved by the Owner's representative for this project.
- C. Graphics program shall be fully user interactive, full color, incorporating the following capabilities:
 - 1. Up to 50 dynamic points of data per graphic page
 - 2. Animated objects for discrete points to illustrate point status
 - 3. On-line 'draw' utility
 - 4. Ability to import .PCX or .DXF file format graphics developed in third party programs
 - 5. "Page Linking" such that it is possible to "zoom" into a specific AHU or any other page through a sequence of graphics without using anything but the system mouse.
 - 6. Generate, store, and retrieve library symbols for use in generating graphic pages.
 - 7. Fifty (50) dynamic points of data per graphic page.
 - 8. Pixel level resolution. Graphics will be displayed on EGA monitors with a 640 X 350 resolution, and on VGA monitors with a 640 X 480 resolution, minimum. Color selections will be made from a color bar consisting of 16 colors, with adjacent text description.
 - 9. Animated objects for discrete points (i.e., when a pump starts, the pipe fills with water or when a damper shuts it goes closed on the screen).
 - 10. Analog bar graphs for analog points. The operator shall be able to locate up to 60 bar graphs per graphic page, with options as to bar graph color, dimensions, horizontal/vertical orientation, and limit values.
- D. Provide for import of .PCX file format graphics developed in third party programs such as Paintbrush. Such imported graphics shall be used as a "backdrop", so that all other dynamic and animated system features may be superimposed on this graphic. Similarly, it shall be possible to import CAD type drawings, by first converting the CAD drawing from .DXF format to .PCX format.
- E. The EMS contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols, so that Owner may develop graphics.

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- F. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
1. Define symbols
 2. Position and size symbols
 3. Define background screens
 4. Define connecting lines and curves
 5. Locate, orient and size descriptive text
 6. Define and display colors for all elements
 7. Establish correlation between symbols or text and associated system points or other displays
- G. System shall allow graphical displays to be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DCU Controllers including Terminal Equipment Controllers used or DDC equipment.
- H. System Configuration and Definition
1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
 2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
 - a. Add/delete/modify stand-alone DDC Controller panels
 - b. Add/delete/modify operator workstations
 - c. Add/delete/modify application specific controllers
 - d. Add/delete/modify points of any type and all associated point parameters and tuning constants
 - e. Add/delete/modify alarm reporting definition for points
 - f. Add/delete/modify control loops
 - g. Add/delete/modify energy management applications
 - h. Add/delete/modify time and calendar-based programming
 - i. Add/delete/modify totalization for points
 - j. Add/delete/modify historical data trending for points
 - k. Add/delete/modify custom control processes
 - l. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
 - m. Add/delete/modify dial-up telecommunication definition
 - n. Add/delete/modify all operator passwords. Add/delete/modify alarm messages
 3. Definition of operator device characteristics, DCU Controllers individual points, applications and control sequences shall be performed using instructive prompting software. a. Libraries of standard application modules such as temperature, humidity and static pressure control may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.

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4. Inputs and outputs for any process shall not be restricted to a single DCU Controller, but shall be able to include data from any and all other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).
5. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DCU Controller. Similarly, changes made at the DCU Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
6. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

I. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways, and other network devices.
2. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
3. Alarms display shall include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
4. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
5. Send e-mail, page, text and voice messages to designated operators for critical alarms.
6. Alarms shall be categorized and processed by class.
 - a. Class 1:
 - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.

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c. Class 3:

- 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
- 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
- 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
- 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.

d. Class 4:

- 1) Routine maintenance or other types of warning alarms.
- 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

7. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
8. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

J. Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Trends shall be associated into groups, and a trend report shall be set up for each group.
3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75% of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Set trend intervals for each I/O point after review with Owner and CxA.
5. When drive storage memory is full, most recent data shall overwrite oldest data.
6. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.

2.15 GRAPHICS PAGES LAYOUT AND QUALITY

- A. All proposed graphics pages are to be submitted to engineer for approval prior to uploading to system.
 1. After uploading graphics pages to system, cooperate with Engineer and Owner to fine tune graphics pages with respect to layout, formatting, points displayed, etc.
- B. Schematic representation of all equipment and system graphics must be accurate and representative of the actual installed field conditions, such as respective locations of indicated devices, air flow patterns, etc. Changes in the field installation, variances in equipment installed versus equipment specified, etc., will require controls subcontractor to revise graphics.
- C. Control and monitored points for any system may be presented solely in tabular form, without graphic representation, only with prior approval of Engineer. Otherwise, a graphical page showing system schematic must be provided for each system.

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- D. Where Modbus or Bacnet interface with equipment controllers is provided, all readable / writeable points available must be accessible via BAS. Of these total number of points, a limited, select number of critical points must be displayed on a dedicated graphics page, accessible by clicking on the schematic of the equipment/system with which associated.
1. Provide Engineer with latest updated list of Bacnet or Modbus points, names and addresses from equipment manufacturer.
 - a. Where selected Bacnet points to display are not designated in drawings or these specifications, budget for displaying up to 24 such points to be selected by Engineer and/or Owner from the latest updated list of Bacnet or Modbus points for equipment being monitored.
 2. Equipment manufacturer's point names are often unclear or ambiguous as to what they actually reference. Contractor will modify any point text descriptor per Engineer and/or Owner direction so than the meaning is absolutely clear.
- E. Building floor plans
1. Building floor plans are to indicate clearly separate HVAC zones. Distinction between HVAC zones may be illustrated by a variety of means acceptable to Engineer, including darker lines surrounding the zone, color variations, superimposed duct layouts, etc. A clear indication of the extent of floor plan served by each unit must be given. Depending upon temperature-dependent color-coding
 2. Engineer endeavors to provide current floor layouts in contract drawings. However, Owner may modify buildings by adding doors or walls, etc. If necessary due to changes in building floor plans, revise graphics to show accurate wall and door locations.
 3. All building floor plans must indicate final room numbers (exceptions to include only very small rooms which have no thermostat, such as janitor's closets, etc.). Prior to producing floor plan graphics, confirm in writing from Owner and/or Architect what final room numbers are. Graphics display for special purpose rooms, such as Gyms, Cafeterias, Band Halls, etc., must show this generic name of room in addition to room number (if it is indicated on drawings).
 4. Locations of all major equipment (VAV boxes, air handlers, exhaust fans, chillers, boilers, pumps, etc.) are to be indicated on floor plans, along with a clear indication of the area each serves.
 5. Floor plan graphic of each zone is to be color-coded, displaying different colors to show space conditions are within or out of specified temperature range.
 6. All temperature, relative humidity, and CO2 sensors locations are to be indicated on floor plans in actual position where installed. A clear indication of which unit(s) is controlled by that sensor must be given (such as by a dashed or curved line connecting the two).
 7. Actual readings of temperature, relative humidity, and CO2 sensors are to be indicated on floor plans.
- F. Graphics text
1. All text displayed on graphic must be large enough to be clearly and easily readable. Font colors must be chosen for good contrast against background so that they are clearly and easily readable. Super-position of separate text lines overlapping one another or overlapping other iconography is not acceptable.
 2. Text wording for labeled points must be clear and easily understood to any person with moderate experience with HVAC systems.

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3. Not all text must have identical font and style on each individual graphic page. Use of varying size and style is required and helpful in identifying and distinguishing important values. However, use consistent font size and style for displaying parameters of similar nature or importance.
4. Text for all parameters must be so positioned on graphics screens that it is unquestionably obvious to what symbols, equipment, or values it applies. This is typically done by placing the text very close to the item to which it applies. Where graphics prevent this (e.g. where it would be too crowded and therefore unclear), use arrows or lines connecting value to the item.
5. Equipment indicated in graphics must be identified with the precise name as indicated in drawings in order to facilitate cross-referencing between graphics and drawings. Where equipment name has changed or Owner desires it be changed, make such modification on final graphics pages.
6. Symbols for devices such as smoke detectors, cut-out safety switches, filter dP sensors, heating or cooling coils, etc., must be labeled so that it is unambiguously clear what the symbol represents.
7. Spelling on graphics pages must be correct.

G. Specified Points

1. *At a minimum*, every input and output listed as a point in bid documents must be displayed graphically.

H. Units

1. Units for all parameters are to be listed on graphics screens or other screens. Use the following nomenclature, or other only as approved by Engineer.
 - a. Commanded state: On/Off or Off/Enable, as appropriate
 - b. Variable speed motor (e.g. fan or pump) commanded speed: % of full speed
 - 1) It is unacceptable to display BAS output signal to VFD when such signal does not correspond to the actual VFD/fan speed. Coordinate closely with VFD programming such that speed indication on BAS screen exactly matches actual VFD speed.
 - c. Variable speed motor (e.g. fan or pump) speed feedback: % of full speed feedback
 - d. Duct static pressure and duct static pressure setpoint: in. WC, or "wc, following by 'setpoint' when value displayed is the setpoint
 - e. Temperature: °F, or deg F, or simply 'F'
 - 1) Outside air temperature: OAT
 - 2) Discharge or supply air temperature: use either DAT or SAT
 - 3) Return air temperature: RAT
 - f. Relative humidity: % RH
 - g. Valve or damper analog output commanded position: % open
 - 1) For cooling tower bypass valves, add descriptive text such as "% open to bypass")
 - h. Valve or damper analog output feedback position: % open / position feedback
 - i. CO2 reading and CO2 setpoint: ppm
 - j. Hydronic system pressure: psi
 - k. Hydronic system differential pressure: psi dP, or psi ΔP

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- l. Chiller cooling load: Tons
 - m. Refrigerant system pressure: psi
 - n. Alarm state of any point: Alarm / Normal
 - o. Air flow: CFM
 - p. Water flow: GPM
 - q. Light level: fc (footcandles)
 - r. Filter status: Dirty / Clean for digital, in. WC, or "wc for analog
 - s. Power and energy: kWh, kW, KVA.
2. For any additional parameters not specifically listed above, use similarly descriptive, standardly accepted units designations, approved by Engineer.
 3. Consistent nomenclature for points must be used throughout all graphics pages.
 4. Graphics text **MUST** distinguish between On/Off and Off/Enable digital output points. Typical Off/Enable items include chillers, boilers, DX units, etc. Typical On/Off items include fan motors, pumps, etc. Do not indicate a status or command value of “ON” for equipment that is actually controlled as Off/Enable.
 5. **Numerical values for all units are to be displayed to decimal point values truncated to a level commensurate with the accuracy of the sensor.** Unless otherwise noted, display values to the following decimal accuracy:
 - a. List to 0 decimal points accuracy: Variable speed drive speed, relative humidity, % valve and damper position, CO2 concentration, water flow, air flow, gallons, kWh, KVA, kW, amps.
 - b. List to 1 decimal point accuracy: Temperature sensor inputs, temperature setpoints, duct static pressure, and voltage.
 - c. List to 2 decimal point accuracy: Building static pressure.
- I. Reset schedules
1. ALL reset schedules specified in operating sequences must be clearly indicated on the screen of the equipment to which it applies. (For example, a chilled water supply temperature reset schedule versus outside air temperature must be listed on the chiller graphic page.) All values in this reset schedule are to be operator adjustable by clicking on the value within the reset schedule.
- J. Forced parameters
1. Provide a clear indication on graphic screen when automatic control or readout of any point (command or status, input or output, analog or digital) has been overridden (usually referred to as being placed in Operator or Forced or Manual mode). This may be done in a variety of ways acceptable to engineer (such as placing a large, bold M next to the point, having the point value flash red, placing a dashed rectangle around it, etc.)
 2. The indication of a point being in Forced mode must be placed on the main graphic screen of the equipment such that Operator is not required to access other backup screens to see which points are Forced.
- K. Provide navigation icons or “linkages” for major systems pages or major equipment items to allow the operator to switch quickly from one major system or building area screen to another.
- L. Indication of equipment Status
1. Graphics must make clear with no ambiguity the meaning of the term “Status” (often as applied to equipment such as boilers and chillers, the meaning is not intuitively clear).

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- a. When Status indicates presence or absence of an alarm, it must be labeled “Alarm Status”.
- b. When Status indicates an actual on/off or operating state of equipment, specifically indicate what status is being provided. For example, if the Status point reads whether the burner is firing or not, it must be labeled “Burner Status”; if the Status point reads whether a chiller compressor is On or not, it must be labeled “Compressor Status”; if the Status point simply indicates whether a piece of equipment has received an Enable command or not, it must be labeled “Status: Equipment Enabled”.

2.16 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network. The digital system controllers shall perform full control automation functions regardless of the condition of communications with the Central Operator's Station.
- E. Environment Requirements:
 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
 3. Controllers located outdoors shall be rated for operation at 32 to 150 deg F.
- F. Power and Noise Immunity:
 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches (900 mm) of enclosure.
- G. DDC Controller Spare Processing Capacity:
 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 50 percent.
 - c. Application-Specific Controllers: Not less than 50 percent.
 2. Memory shall support DDC controller's operating system and database and shall include the following:
 - a. Monitoring and control.

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- b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.
- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
- 1. Network Controllers:
 - a. 20 percent of each AI, AO, BI, and BO points connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: Two.
 - 2) AOs: Two.
 - 3) BIs: Two.
 - 4) BOs: Two.
 - 2. Programmable Application Controllers:
 - a. Minimum Spare I/O Points per Controller:
 - 1) AIs: Two.
 - 2) AOs: Two.
 - 3) BIs: Two.
 - 4) BOs: Two.
 - 3. Application-Specific Controllers:
 - a. Minimum Spare I/O Points per Controller:
 - 1) AIs: Two.
 - 2) AOs: Two.
 - 3) BIs: Two.
 - 4) BOs: Two.
- I. It is not acceptable to name a controller using simply names and numbers that do not identify the school.
- J. Each controller must be given a name such that the campus / school being served is clearly and unambiguously evident in the name. For example, for Harlingen campus, use letters such as 'HRL' in the name of the controller so that it is clearly associated with Harlingen.

2.17 NETWORK CONTROLLERS

- A. General Network Controller Requirements:
- 1. Include adequate number of controllers to achieve performance indicated.
 - 2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
 - 3. Controller shall have enough memory to support its operating system, database, and programming requirements.

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

B. Serviceability:

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

2.18 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations. Controllers shall be configured to use stored default values to ensure fail-safe operation.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.
9. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
10. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.19 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

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- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

2.20 SENSORS & FIELD DEVICES

- A. All sensors and field devices shall be of commercial grade quality and shall be installed according to the manufacturer's recommendations. Outdoor damper actuators shall be rated for exterior service and provided in weatherproof UV-inhibited housing.

- B. Temperature Sensors (General)

1. All temperature inputs for the automation system shall be derived directly from analog inputs from electronic temperature sensors. Transducing of pneumatic sensor signals shall not be acceptable.
2. Temperature sensing elements shall be RTD type, thermistor type, or solid state sensors, as specified in drawings or points list. All sensors of a particular type shall be from the same manufacturer.
3. Characteristics for temperature sensors:
 - a. Interchangeability of +/- 0.2% at the reference temperature.
 - b. Time constant response to temperature change shall be less than three seconds per degree F.
 - c. Sensors shall be linear, drift free, and require only a one time calibration. Sensing elements shall be factory calibrated.
 - d. The sensing elements shall be hermetically sealed.
 - e. Additional linearizing, ranging, and lead length compensation may be accomplished in software if required to meet the accuracies specified within.
4. Expected temperature sensor operating range and end to end accuracy, including errors associated with sensor, transmitter (if applicable), leadwire and A/D conversion shall be as follows:

Sensed Element	Expected Oper. Range	Sensor Accuracy
a. Return air	40 to 100°F	0.5°F
b. Indoor space temperature	40 to 100°F	0.5°F
c. Outside air	0 to 125°F	0.5°F

- C. Adjustable Limited Range Wall Temperature Sensors (Thermostats)

1. **General: All wall sensors installed as part of this project shall have adjustable limited range setpoint adjustment function.**
 - a. 10K-2-R-SOD (10K, DA, Cool / Warm, OVR). Override option shall be provided.
 - b. Setpoint limits shall be adjustable via the COS and password protected.
 - c. Unit shall have a built in processor and shall communicate with local controller.
 - d. Unit shall have an LCD display for space temperature and on / off state
 - e. Unit shall have a password protection function to restrict access to service mode.
 - f. Provide extra thermostats: 5 of each type.
2. **Following areas shall have sensors with override option in addition to adjustable setpoint range function: all sensors in Administration, Gym.**

- D. Humidity Sensors: Bulk polymer sensor element.

1. Bulk polymer sensor element. Install humidity sensors in the space and not in ductwork unless specifically noted. Coordinate locations of duct mounted sensors with Engineer.
 - a. Accuracy: 5 percent full range with linear output.

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- b. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
 - c. Duct and Outside-Air Sensors: With element guard and mounting plate.
- E. Carbon Dioxide (CO₂) sensors:
- 1. CO₂ sensor shall monitor indoor carbon dioxide (CO₂) levels in accordance with ASHRAE standard 62-2004. Complete kit shall include optional aspiration box for mounting sensor inside return air duct.
 - 2. Sensor shall have a 4 - 20 mA linear output over a range of 0 - 5000 ppm of CO₂. A SPDT shall be provided for local control or alarm output.
 - 3. **Provide sensor with LCD readout.**
 - 4. Power: 24VAC or DC at 400mA max.
 - 5. Measuring range: 0-2000 ppm
 - 6. Accuracy: 40 ppm + 2% of reading
 - 7. Analog output: 4-20 mA
 - 8. Control relay: N.O. SPST, 0.75 amp at 24VAC/VDC
 - 9. Operating temperature: 32° - 122°F
 - 10. Operating humidity: 5-95% non-condensing
 - 11. Calibration adjustment: zero to span
 - 12. Min. req. calibration: One year
 - 13. Unit enclosure: UL fire rated
 - 14. Aspiration box: High impact styrene
- F. Equipment operation sensors as follows:
- 1. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
 - 2. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- G. Equipment on/off control shall use either momentary pulsed relays or magnetically latched relays, as appropriate for the equipment's control starter. Interfacing controls shall be configured such that in its last commanded state. All equipment safeties and interlocks shall remain active, and will not be bypassed by new EMS controls. For motors with VFDs provide On/Off Control as appropriate VFD terminals.
- H. Watthour Transducers: Shall have an accuracy of +/- 2.5% at 0.5 power factor to 2.0% at 1 power factor for KW and KWH outputs. Output signals for KW and KWH shall be internally selectable without requiring the changing of current or potential transformers. Current and potential transformers shall be in accordance with ANSI C57.13.
- I. Voltage Outputs: Variable voltage outputs shall provide a voltage signal from 0 to 20 volts. All voltage outputs shall be fuse protected against shorts to 120 volts AC and capable of withstanding a short ground indefinitely. All voltage outputs shall be protected against + or - 1500 volts, 50 microseconds transients. Voltage outputs shall have a resolution of 0.1 volts.
- J. Current Outputs: Variable current outputs shall be a sinking type and shall provide 0 to 20 milliamps with a resolution of 0.1 mA and a compliance of 20 volts minimum. All current outputs shall be fuse protected to 120 volts AC and protected against + or - 1500 volts, 50 microsecond transients.
- K. Pressure Sensors: Pressure sensors and differential pressure sensors shall be piezo-resistive strain-gauge with temperature compensation. Sensors shall be selected to provide linear

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indication with an adequate span for the application. Sensor shall be 0 - 10 V or 4 - 20 mA. Insure sensors are rated to operate at temperature of sensed media. Sensors shall have an accuracy of 1% of full scale. Sensors shall accept overpressures of at least 120 psig, at any port, without damaging the sensor.

- L. Motor On/Off Status: Unless otherwise specified, status shall be proven using current sensing relays connected at VFDs and calibrated for minimal operating speed.
- M. Hardware Overrides: A three position manual override switch shall allow selection of the ON, OFF, or AUTO outputs state for each output point. In addition, all analog output points shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.
- N. Damper Actuators
 1. Electronic direct-coupled actuation shall be provided.
 2. The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable.
 3. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 4. For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
 5. All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
 6. Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
 7. All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
 8. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
 9. All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
 10. Actuators shall be provided with a conduit fitting and a minimum 3ft electrical cable and shall be pre wired to eliminate the necessity of opening the actuator housing to make electrical connections.
 11. Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
 12. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

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- O. Field Testing and Programming Equipment: A portable laptop or notebook computer shall interface via standard push-in connection at an asynchronous serial port located at the Control modules and at selected enhanced zone temperature sensors as indicated on project plans. This portable unit shall be capable of full global communications with all Control modules connected within the respective network and shall provide functionally identical user interface to the Workstation, in non-graphic format. Units shall be able to interrogate all points and alter all programming.

2.21 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in an enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers. Do not house more than one controller in a single enclosure.
2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
3. Enclosures shall be NRTL listed according to UL 508A.
4. Enclosures constructed of steel, finished inside and out with polyester powder coating electrostatically applied and then baked to bond to substrate.
5. Hinged door full size of front face of enclosure and supported using:
 - a. Enclosures sizes less than 36 in. (900 mm) tall: Multiple butt hinges.
 - b. Enclosures sizes 36 in. (900 mm) tall and larger: Continuous piano hinges.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spade lugs for stranded cable and wire.
7. Install a maximum of two wires on each side of a terminal.
8. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
9. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
10. Mount products within enclosure on removable internal panel(s).
11. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- (6-mm-) high lettering.
12. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.

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2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

2.22 RELAYS

A. All:

1. Heavy duty, rated for at least 10 A at 250-V ac and 60 Hz.
2. Construct the contacts of either silver cadmium oxide or gold.
3. Relay enclosed in a dust-tight cover.
4. Coil transient suppression to limit transients to non-damaging levels.
5. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
6. Mechanical Life: At least 10 million cycles.
7. Electrical Life: At least 100,000 cycles at rated load.
8. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
9. Timing Ranges, where applicable: Multiple ranges from 0.1 seconds to 100 minutes.
10. Repeatability: Within 2 percent.
11. Recycle Time: 45 ms.
12. Minimum Pulse Width Control: 50 ms.
13. Power Consumption: 5 VA or less at 120-V ac.
14. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).
15. General-Purpose Relays: With LED indication and a manual reset and push-to-test button.
16. Multifunction Time-Delay Relays: With knob and dial scale for setting delay time.

B. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current. Choose relay size to be able to read smallest current from motor at lowest speed.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

2.23 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

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A. 250 through 1000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
3. UPS shall provide up to 15 minutes of battery power.
4. Performance:
 - a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
 - b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
 - d. On Battery Output Voltage: Sine wave.
 - e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
 - f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
 - g. Transfer Time: 6 ms.
 - h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
5. UPS shall be automatic during fault or overload conditions.
6. Include front panel with power switch and visual indication of power, battery, fault and temperature.

2.24 SURGE PROTECTION

A. Zener diodes, silicone avalanche diode, optical isolation, varistors, or combination thereof.

B. Transient protection

1. Communications LAN:
 - a. Provide surge protection equipment sized specifically for expected operating current of LAN.
 - b. Exceeds severity level 4 of IEC 801-4.
 - c. Operating voltage: 12 volts.
 - d. Maximum operating current: 200 mA
 - e. Clamping action turn-on: 14.3 volts
 - f. Maximum clamping at 2 kW (8 x 20 microsecond wave): 22 volts
 - g. Maximum surge voltage: 20 kV
 - h. Maximum surge current (8 x 20 microsecond wave): 2.5 kA
 - i. Current leakage at perating voltage: 5 microamps
 - j. As manufactured by Surge Control Limited, SPR series, or approved equal.
2. Power supply:
 - a. Provide surge protection equipment sized specifically for expected operating current of DDC controller.
 - b. Exceed recommendations for ANSI / IEEE C62.41-1991 Categories A3 and B3 and UL1449.
 - c. Design such that suppressor does not "wear out" with repeated surges.
 - d. CSA certified and UL recognized.
 - e. EMI / RFI filtering.
 - f. Differential and common mode suppression and filtering.

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- g. Less than 5 nanosecond response time.
- h. Maximum transient voltage 6 kV.
- i. Maximum transient current 3 kA.
- j. Minimum clamping turn-on, 210 volts.
- k. Maximum clamping voltage, (I-test):
 - 1) line to neutral — 245 volts.
 - 2) line to ground — 245 volts.
 - 3) neutral to ground — 245 volts.
- l. Maximum clamping voltage @ 3 kA:
 - 1) line to neutral — 325 volts.
 - 2) line to ground — 430 volts.
 - 3) neutral to ground — 430 volts.
- m. As manufactured by Surge Control Limited, SPP-1200 series, or approved equal.

C. Protective devices shall be continuous duty, automatic and self restoring.

2.25 CONTROL WIRE AND CABLE

- A. 7/24 soft annealed copper strand with a 2- to 2.5-inch (50- to 65-mm) lay.
- B. Plenum rated LAN and Communication Cable complying with NFPA 70 and DDC system manufacturer requirements for network being installed.

2.26 CONTROL POWER WIRING AND RACEWAYS

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.
- B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.

2.27 IDENTIFICATION

- A. Provide engraved phenolic tag, fastened with drive pins with min. 0.5" high white lettering on black background, bearing unique identification nomenclature for control equipment and devices.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETINGS

- A. **Pre-installation Conference:** Schedule and attend conference at location of owner's choosing. Mandatory attendees include representatives from BAS contractor, Owner, Engineer, and Commissioning Authority.

3.2 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify compatibility with and suitability of substrates. Examine roughing-in for products to verify actual locations of

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connections before installation. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

- B. Prepare written report listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Coordinate with Owner for provision of required communication infrastructure that is Owner's responsibility, including data drops, IP addresses, etc.
- B. Communication Interface to Equipment with Integral Controls: DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control. [Reference drawings for equipment to be connected.](#)

3.4 GENERAL INSTALLATION REQUIREMENTS

- A. The I/O Summary on the drawings is provided as a list of the minimum points required. Provide all controls points, temperature sensors, relays, actuators, and devices necessary to achieve operational sequences at no additional cost to the Owner, whether explicitly called for or not in this specification. Coordinate with all sub-contractors to ensure all items are provided and installed.
- B. Install in accordance with manufacturer's instructions.
- C. Controls Contractor is responsible for complete operational installation of system, including, but not limited to the following:
 - 1. Electrical power supply to all control system components, including but not limited to; controllers, actuators, sensors, from dedicated circuits in electrical panels.
 - 2. Complete installation of duct-mounted components, including but not limited to: temperature, relative humidity, pressure, and CO2 sensors, and dampers/actuators.
 - 3. Complete installation of pipe-mounted components, including but not limited to: control valves and actuators, temperature sensors, pressure sensors.
- D. All electrical material and installation shall be in accordance with local applicable codes and requirements of Division 26. All automation system equipment supplied shall be provided with adequate grounding in accordance with the manufacturer's specifications and suggested engineering applications procedures. These requirements shall include, but not be limited to:
 - 1. A "clean earth ground" for all FCUs and central operator's station.
 - 2. No "ground mixing" between equipment components.
 - 3. Insulation of all panels from metal conduits.
 - 4. Equal-potential grounding for equipment where required.
- E. Identification:
 - 1. Provide a permanent, stick-on tape marker [on the inside cover](#) of the space sensor (e.g. temperature, RH) to identify the name of the HVAC unit associated with the sensor.
 - 2. Provide within each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature for that particular controller.
 - 3. Label each end of cable, wire and tubing in enclosures following an approved identification system that extends from field I/O connection and all intermediate

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connections throughout length to controller connection. **Use printed labels, not handwritten.**

4. Identify all controller enclosures with **1/8 inch** thick plastic labels not less than **3 x 1.25 inches**. Fasten with stainless-steel rivets or self-tapping screws or contact-type permanent adhesive, compatible with label and with substrate
- F. Install products to satisfy more stringent of all requirements indicated.
- G. Install products level, plumb, parallel, and perpendicular with building construction. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- H. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- I. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- J. Seal penetrations made in fire-rated assemblies and in acoustically rated assemblies in accordance with applicable fire codes.
- K. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- L. Install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- M. Corrosive Environments:
1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
 - a. Laboratory exhaust-air streams.
 - b. Process exhaust-air streams.
 2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
 3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.5 CONTROLLER INSTALLATION

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- A. Quantity and location of network and programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
- B. Install controllers in enclosures to comply with indicated requirements in a protected location that is easily accessible by operators.
- C. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 DDC SYSTEM I/O CHECKOUT, ADJUSTMENT, CALIBRATION AND TESTING

- A. Prepare and submit a report to Engineer and Commissioning Authority documenting results for checking, adjustment, calibration, testing. Include a description of corrective measures and adjustments made to achieve desired results for each I/O point, control sequence, and system.
- B. **Sensor Check and Calibration:**
 - 1. Calibrate every sensing device, including temperature, relative humidity, pressure, etc. by comparing field-installed sensors to a high accuracy instrument that has been calibrated within the previous 12 months. Calibrate each instrument according to instrument instruction manual supplied by manufacturer. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. (E.g., an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent).
 - 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 - 3. All field sensors must read to within accuracy range listed in these specifications. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
 - 4. Programmed offsets may be used to a certain degree to adjust sensor readings. Replace all sensors requiring an offset of more than 2F, or 10% RH, or 0.2" air static pressure or 1.5 psig water static, or 50 ppm CO₂.
 - 5. Submit a report certifying that every sensor has been calibrated and is reading accurately as a prerequisite for testing by the commissioning authority. List results of each sensor (field-reading versus calibrated instrument reading).
- C. **Control Damper Checkout:**
 - 1. Verify that control dampers are installed correctly for flow direction.
 - 2. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 3. Verify that damper frame attachment is properly secured and sealed.
 - 4. Verify that actuator wiring is complete, enclosed and connected to correct power source.

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5. Stroke and adjust control dampers following manufacturer's recommendation, from 100 percent open to 100 percent closed and back to 100 percent open. Verify that damper blade travel is unobstructed and that damper actuator and linkage attachment is secure.
6. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
7. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

D. Control Valve Checkout:

1. Verify that control valves are installed correctly for flow direction.
2. Verify that valve body attachment is properly secured and sealed.
3. Verify that valve actuator and linkage attachment is secure.
4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
5. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
6. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open. Verify that valve ball, disc or plug travel is unobstructed.
7. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

E. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

F. Switches: Calibrate switches to make or break contact at set points indicated.

G. Controllers:

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
7. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
8. Verify that spare I/O capacity is provided.
9. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance. Test every I/O point throughout its full operating range.
10. Test every control loop to verify operation is stable and accurate.
11. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
12. Test and adjust every control loop for proper operation according to sequence of operation.
13. Test software and hardware interlocks for proper operation. Correct deficiencies.
14. Operate each analog point at upper, mid, and lower portions of range
15. Exercise each binary point.

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16. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.

3.8 DDC SYSTEM COMMISSIONING TESTS

- A. Provide written request to Commissioning Authority (CxA) for initiation of on-site Functional Testing. Functional Testing will not take place until:
 1. System has been thoroughly tested as described in this section under “DDC System I/O Checkout, Adjustment, Calibration, And Testing”, and report has been submitted.
 2. Certificate of Readiness has been submitted to CxA.
 - a. At his discretion, if entire control system has not been completed, CxA may test portions of system which have been completed.
 3. Prefunctional Checklists, if required by contract documents, have been submitted to CxA.
- B. Contractor shall set up trend logs as requested by the CxA, Engineer, or Owner, without any limits on the number of trends, to assist in testing and verification of system operation.
 1. Prior to start of functional testing, set up the following initial trend logs:
 - a. VAV air handler (or RTU):
 - 1) Room temperature: 15 minute readings.
 - 2) Discharge air temperature: 15 minute readings.
 - 3) Commanded fan speed: 15 minute readings.
 - 4) Commanded cooling/heating stages: 15 minute readings.
 - 5) OA damper position: Each 5% change of value.
 - 6) Return air CO2 (where point is specified): 30 minute readings.
- C. Contractor shall set up trends and logs as requested by the Engineer or Owner, without any limits on the number of trends.
- D. CxA will perform on-site and remote Functional testing as specified in Construction Documents and in accordance with generally accepted commissioning procedures. DDC system shall demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated. Reference section 019113 “General Commissioning Requirements” for more information.
 1. Contractor is to provide a qualified representative, intimately familiar with the project installation and issues, to carry out Functional Testing procedures as directed by CxA, for the duration of Functional Testing.
- E. CxA will issue reports to Contractor, in such forms as Commissioning Issues Logs, emails, written reports, detailing items which appear not to be in conformance with construction documents requirements. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- F. Due to the complexity of control systems and potential for latent defects to go undiscovered during Functional Testing, DDC system or tested portions thereof must operate essentially

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trouble-free for a period of 30 consecutive days following Functional Testing before Final Acceptance of system will be granted.

3.9 WARRANTY SERVICE

- A. System deficiencies discovered subsequent to Final Acceptance of system will be treated as Warranty items. Under Warranty requirements, address all operating problems, repair or replace worn or defective components, adjust control parameters as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
- B. Provide system inspections and reports annually during warranty period; reference paragraph “Warranty Inspections” in this specifications section.

3.10 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning **at Final Acceptance of system**, service agreement shall include software support for two year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of **Final Acceptance of system**. Upgrading software shall include operating system and new or revised licenses for using software.

3.11 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system. Owner may send up to **10** persons to attend training. Training shall occur within normal business hours at a mutually agreed on time.
- B. Provide not less than **seven** hours of training total, **broken up into two 3.5 hour sessions**. Provide staggered training schedule as requested by Owner to accommodate Owner personnel schedules.
- C. Schedule training with Owner at least four business days before expected Substantial Completion. All training shall occur before Final Acceptance of control system.
- D. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate daily operators, advanced operators, and system managers and administrators.
- E. Maintain a training attendee list and sign-in sheet. Sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
 - 1. For each session, submit a scanned copy (PDF) of circulated sign-in sheet to Owner, Engineer, and Commissioning Authority with 48 hours of end of training session.
- F. Provide each attendee with a color hard copy of all training materials and visual presentations. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter.

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G. Instructor Requirements:

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

H. On-Site Training:

1. Provide as much of training located on-site as deemed feasible and practical by Owner. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. On-site training shall include regular walk-through tours to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
4. Operator workstation shall be used in training, whether Owner's or contractor-provided & via remote web access.

I. Training Content:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals, and control drawings.
11. Accessing data from DDC controllers.
12. Operating portable operator workstations.
13. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
14. Running each specified report and log, setting up Trend Logs.
15. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
16. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
17. Executing digital and analog commands in graphic mode.
18. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
19. Demonstrating DDC system performance through trend logs and command tracing.
20. Demonstrating scan, update, and alarm responsiveness.
21. Demonstrating spreadsheet and curve plot software, and its integration with database.
22. Demonstrating on-line user guide, and help function and mail facility.
23. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.

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24. Demonstrating operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
25. Demonstrating integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.
 - 2. Division 23 Sections for DX Split Systems and VFDs.

1.2 ABBREVIATIONS

- A. Abbreviations used in this specifications section:
 - 1. BAS: Building Automation System
 - 2. CO2: Carbon Dioxide
 - 3. DAT: Discharge Air Temperature
 - 4. DCV: Demand Control Ventilation
 - 5. DDC: Direct Digital Control
 - 6. dP: differential Pressure
 - 7. dT: differential Temperature
 - 8. DX: Direct Expansion
 - 9. EF: Exhaust fan
 - 10. OA: Outside Air
 - 11. RH: Relative Humidity
 - 12. RTU: Rooftop Unit
 - 13. TAB: Testing, Adjusting and Balancing

1.3 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Provide controls and operating sequences for the following HVAC systems at [Cameron County Santa Rosa Phase-2](#):
 - 1. DX Single-Zone, VAV, Split Systems.
 - a. Coordinate equipment safeties, compressor delay timers, etc., with equipment manufacturer such that warranties are retained.
 - 2. DX Single zone, constant volume split system.
 - 3. While design intent is for BAS to control all equipment, additional BACnet card interface to unitary controllers will be necessary for monitoring of parameters and specialized alarms with alarm codes available from integral unit controller. Coordinate with equipment manufacturer. As needed, obtain clarification from engineer and supplier, prior to bidding.

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- B. **Prior to bidding**, Controls contractor shall notify general, mechanical and electrical contractor of any work required for operational installation of controls devices that will not be conducted by Controls Contractor. This includes, but is not limited to: installation of controls devices and sensors, as well as any needs for power wiring and/or conduit.
- C. A list of the minimum number and type of control points required is given. Provide any additional points, sensors, gateways, interface cards, etc. as required to achieve sequences, whether specifically called for in Points List or not.
- D. Provide all hardware, software, and labor required to achieve specified sequences.
- E. Units or systems that are grouped together for purposes of sequence description are not meant to be controlled together. Each system shall have its own set of adjustable parameters and will respond only to values (space temperatures for example) associated with it. This means that one unit may be in heating mode while another with similar sequence may be in cooling mode.

1.4 EQUIPMENT TIME SCHEDULES

- A. Contractor is responsible for programming schedules for all equipment and systems prior to turning system over to Owner at final system acceptance.
- B. **Request Owner's input for on/off and optimum start/stop (OSS) programming for all equipment and systems, including both Normal and upcoming Holiday schedules, and Program holiday time schedules as per Owner's direction.**
 - 1. Obtain owner's desired schedule as soon as practically possible. Prior to then, HVAC systems are never to be programmed to operate in normal Occupied mode on weekends, nor for more than 12 hours on any day Mon-Fri, unless expressly directed to do so by general contractor or Owner, and only for special purposes such as wall dry-out, removing fumes generated during construction, etc. **Inform the commissioning agent of such special such scheduling directions, and of the target date the special schedule will be lifted.**
- C. Note that outside air dampers, exhaust fans, or various other specified equipment devices may have independent dedicated time schedule different from the equipment which they serve or are associated with. For example, distinct time schedules may be required for actual Occupied time (for instance, 8AM to 5:30PM) requiring ventilation versus required equipment start/stop times for comfort.
- D. Equipment items having the same Off/Enable or Start/Stop times are not to be software interlinked such that one cannot be changed without changing the other. Each individual equipment item is to have its own individual programmable Off/Enable or Start/Stop scheduling capability.
- E. Stagger AHU start times by a minimum of 20 seconds between starts.
- F. Unoccupied hours, Off / Enable:
 - 1. Enable cooling if space air temperature rises above 90°F (adj.). Disable unit once temperature has fallen to 85°F (adj.) or below.
 - 2. Enable heating if space air temperature drops below 45°F (adj.). Disable unit once temperature has risen to 55°F (adj.).

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3. Enable cooling if relative humidity rises above 60% (adj.). Disable unit once relative humidity has fallen to 55% (adj.).
4. Unit shall run for a minimum of 30 min. (adj.) or until specified conditions are satisfied.
5. Issue Alarm if the unit has been in unoccupied mode for 4 hours (adj) and relative humidity rises above 60% (adj.). This time delay should allow false alarms immediately after units are disabled.
6. Manual Override: Control may be manually overridden at the zone Thermostat, controller and the COS.
7. Hardware Interlocks: Controls shall not bypass any safeties or interlocks associated with fire protection shutdown.

1.5 SPACE TEMPERATURE SETPOINTS

- A. Temperature and humidity setpoints and operating schedules listed in sequences of operations are initial values, based upon input from Owner's representatives and common industry practice, and are not to be considered as final. Final setpoint and schedules must be programmed as per Owner's direction, and in consultation with and with approval of Owner and/or Engineer and Testing and Balancing firm, regardless of schedules listed in this specification.
- B. In consultation with Owner and/or Engineer, and Testing and Balancing firm, make minor revisions to operating sequences which will result in improved operation of systems.
- C. All adjustable setpoint temperature sensors / thermostats are to be set and software limited as to the range heating and cooling setpoint which building occupants may reset. Initial values are listed in control sequences. Determine final limits in consultation with Owner and Engineer.
- D. Whether in Occupied or Unoccupied mode, the active heating setpoint must always be lower than the active cooling setpoint by a minimum of 5F, or higher if called for in sequences. This differential is referred to as the "deadband".
 1. With exception of that required for dehumidification, no heating operation is to take place when room temperature is within deadband. Operation of hot water coil or electric reheat is to begin only when room temperature has fallen 1°F below the heating setpoint.
 2. Cooling operation within the deadband must be at an absolute minimum, ie. specified minimum air flow to provide necessary ventilation.
- E. Room Temperature Setpoints
 1. Allowable range for space temperature setpoints will be limited via control system.
 - a. Program temperature setpoints to be set only at the central operator station, and not be adjustable at the zone thermostat.
 2. System is expected to maintain room temperature no more than 0.75F above cooling setpoint / below heating setpoint during 'normal' steady-state operating conditions.
 3. Unless otherwise noted in drawings or operating sequences described below, program the following room temperature setpoints for all heating and cooling equipment.
 - a. Occupied Hours

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- 1) Cooling setpoint = 74F
- 2) Heating setpoint = 69F

b. Unoccupied Hours

- 1) Cooling setpoint = 86F
- 2) Heating setpoint = 59F
- 3) Run unit for a minimum 20 minutes. Disable unit once temperature has fallen 3F below Cooling or 3F above heating setpoint.

F. Room Relative Humidity (RH) Setpoints

1. System is expected to begin dehumidification sequence at 1% RH above setpoint.
2. Unless otherwise noted in drawings or operating sequences described below, program the following room RH setpoints for all cooling equipment.

a. Occupied Hours

- 1) Cooling RH setpoint = 59%
- 2) Run unit for a minimum 20 minutes. Disable dehumidification mode once RH has fallen 3% below setpoint.

b. Unoccupied Hours

- 1) Cooling setpoint = 59%

G. Room CO2 Setpoints

1. Unless otherwise noted in drawings or operating sequences described below, program the following room CO2 setpoints for all HVAC equipment with CO2 control capability serving individual rooms where DCV is specified:

a. Occupied Hours

- 1) Minimum setpoint = 700ppm, corresponding to minimum OA intake.
- 2) Maximum setpoint = 1100ppm, corresponding to maximum OA intake (equal to design OA CFM).
- 3) Program system so that min and max setpoints may be adjusted by system operator via Global Command.

b. Unoccupied Hours

- 1) Not applicable.

1.6 BACNET CONNECTIONS

A. Bacnet interface will be used for monitoring of parameters, specialized alarms with alarm codes that are sensed by the unitary controller:

1. All points readable within equipment Bacnet register are to be communicated to and readable by BAS.
2. Provide a dedicated graphic page to display selected Bacnet points. Navigate to this dedicated graphic by clicking on the equipment icon.

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3. The point descriptor text for all Bacnet points displayed on the dedicated Bacnet page are to have clear, unambiguous meaning; simply copying manufacturer's text descriptor may not be acceptable. Supply manufacturer's points text descriptors to Engineer for pre-approval. Revise descriptors if directed by Engineer.
4. Display all values with proper units (deg F, psig, etc.), truncated to decimal point accuracy commensurate with accuracy of sensor.

1.7 OUTDOOR AIR CONDITIONS

- A. Outdoor air temperature and relative humidity are to be read from an Engineer-approved web-based weather service such as Accuweather.com. Update conditions at no longer than the minimum update time provided by national weather service.
- B. Display OA temperature and RH conditions on all graphics screens. Display values rounded to nearest whole number.

1.8 GENERAL

- A. Individual sequence descriptions may list units to which sequence applies. Contractor must verify equipment quantities and unit types through drawings review and on-site inspections.
- B. All setpoints used in controls sequences shall be user adjustable with a minimum of keystrokes.
- C. Points lists have been provided as a general guideline, and are not all inclusive. Provide all points required for achievement of operating sequences.
- D. All delays shall be operator adjustable. Program for a minimum delay between on/off commands for HVAC equipment to prevent short cycling.
- E. Unless noted otherwise, program for minimum VFD speed of 30% of full 60hz speed.
- F. Unless noted otherwise, close HVAC unit outside air dampers during all Unoccupied periods.
- G. Optimum Start/Stop (OSS):
 1. When this feature is Enabled, control system shall automatically calculate the optimal start time for each HVAC system or unit so that comfort conditions will be achieved by the scheduled Occupied time. Control system shall determine the optimal time for equipment shutdown so that comfort conditions may be maintained until scheduled off time with minimal energy use.
 2. Coordinate with Owner for information on desired times for comfort conditions and whether OSS is to be Enabled.
- H. Interlocks:
 1. Hardware: Controls shall not bypass any safeties or interlocks associated with fire protection shutdown.

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2. Provide all hardware necessary to achieve software interlocks required for proper system operation, including but not limited to control of dampers and exhaust fans. Coordinate with mechanical and electrical contractors.
- I. Damper Actuators:
 1. Do not provide physical linkage between OA and return air dampers. Do not control OA and return dampers in complementary fashion (i.e., where sum of % open values of each always add to 100%) unless specifically directed in operating sequence.
 - J. Operator Station Display: Indicate the following on operator workstation display terminal, as applicable per points list:
 1. Building floor plan, indicating individual rooms, thermostat locations, and areas served by each air handler, fan coil unit and rooftop unit.
 2. Conditioned space air temperature, all zones.
 3. Conditioned space air Base temperature setpoint, all zones.
 4. Conditioned space air Actual temperature setpoint, all zones.
 5. Distinguish different area(s) served by individual HVAC equipment items by use of color variation or heavy lines on floor plans graphics page.
 6. When a control point is in "Test" mode, graphic shall indicate the status such as "test" or "manual".

1.9 SUMMARY TABLES

- A. Provide a dedicated graphic page for a summary table for each type of HVAC equipment for which there are two or more types (e.g. rooftop units, fan-coil units, etc.).
- B. [Provide a master navigation button on main dashboard graphic page to take one to these tables.](#)
- C. Provide tables using format and headers as in the following Sample tables:

	1	2	3	4	5	6	7
DX AHU w/ Reheat Summary table							
	Space	Compr	Unit	Space	Dehum	Ret Air	OA Dmpr
RTU	Temp	Stages On	DAT	RH	Status	CO2	% open
RTU-126	74	1	54	54%	Off	750 (1)	44%

	1	2	3	4	5	6	7
FCU Summary table							
	Space	Temp	Compr	Unit	Heat		
FCU	Temp	Setpoint	Status	DAT	Status		
FCU-1	72	70	Off	54	Off (3)		

Exhaust Fans				
Equipment	Space(s)	Command	Status	Fan Speed
	Served			
EF-1	Art Rm 123	On (4)	On	Low (5)

Notes

(1) If no CO2 sensor exists, put "NA" in column.

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- (2) If SCR type, list %. If staged, list On or Off.
- (3) If unit has no heat, put "NA" in column. If NO units in project have heat, column may be omitted.
- (4) List as On or Off, or as Enable or Disable, as appropriate.
- (5) For all single speed fans, list "NA", list High or Low for 2-speed fans.

1.10 ALARMS

- A. Alarms shall be read and displayed on graphics screens for conditions described in this section.
 1. The graphic screen for each piece of HVAC equipment must have a dedicated line for Alarm condition, and all alarms must be enunciated on the graphic screen when they occur.
 2. For CRITICAL alarms listed below, designated representatives of owner must be sent alarm messages **via text and email**. The alarm message must clearly indicate the campus, the particular piece of HVAC equipment for which alarm occurred, the date and time it occurred, and the nature of the alarm.
 3. All alarm setpoints are to be easily adjustable via operator interface. Controls provider will change all such setpoints, at Engineer's direction, should actual conditions warrant different settings.
 4. All alarms are to be predicated on the equipment or system being ON and having been operational sufficient time to have stabilized. (E.g. when a chiller first starts in the morning, it may take 30 minutes to achieve chilled supply water temperature setpoint; no alarms are to be initiated during that time.)
- B. General Alarm requirements:
 1. Alarms described below are for multiple types of HVAC and other systems. Program as applicable for equipment which exists on this project.
 2. Except as otherwise noted below, no alarms are to be generated for equipment or sensors during Unoccupied hours.
 3. All alarm setpoints are to be easily adjustable by Operator via global commands.
 4. A delay (suggested 20 minutes) is to be incorporated before alarms are generated immediately following HVAC equipment startup in order to give equipment time to obtain desired conditions. If the programmed delay time proves inadequate to prevent nuisance alarms at equipment startup, Controls contractor must verify what delay time is appropriate, and whether such alarms are caused by mechanical issues.
 5. Alarms are to be set up scrupulously to avoid generation of nuisance alarms, e.g. alarms read from HVAC units which repeatedly fail to start, generating a new alarm each time
 6. ALARM DESCRIPTIONS MUST BE CLEARLY GIVEN IN HISTORICAL ALARMS REGISTER TO INDICATE THE NAME OF THE ITEM CAUSING THE ALARM. This description must be plainly displayed without the requirement of having to 'hover' the cursor over the alarm line in the alarm history register.
 7. Where control system connects via Bacnet to a controller of an HVAC unit, in addition to simple on/off status of alarm, alarm codes are to be read and displayed by the BAS. Provide a dedicated graphic page to list description of alarm codes.
- C. Critical HVAC Alarms:
 1. Control system will send alarm notifications via text message and email to designated Owner personnel for Critical HVAC alarms for the following:
 2. When dedicated outside air coil leaving air temperature deviates from setpoint by 1.5F for 15 consecutive minutes.

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3. Any additional Critical HVAC alarms designated by engineer or owner's facility manager (FM).
- D. CO2 alarms:
1. Register alarm any time, during occupied or unoccupied hours, that a sensor reads outside of the following Minimum / Maximum expected values indicating sensor is likely malfunctioning: 370 ppm / 2000 ppm.
 2. Register alarm when any CO2 sensor (for examples, space or return duct) reads above 1300ppm for 15 consecutive minutes.
 - a. Program system to all alarm setpoint to be adjustable via a Global Command.
- E. Space temperature alarms:
1. Register alarm any time, during occupied or unoccupied hours, that a sensor reads outside of the following Minimum / Maximum expected values indicating sensor is likely malfunctioning: 45F / 100F.
 2. Register alarm when sensor remains 1.5F above cooling setpoint or 1.5F below heating setpoint for 15 consecutive minutes. **Base alarms only on active temperature setpoint, e.g. use Unoccupied setpoints for alarming when system is in Unoccupied mode.**
- F. Relative Humidity (RH) alarms:
1. Register alarm any time, during occupied or unoccupied hours, that a sensor reads outside of the following Minimum / Maximum expected values indicating sensor is likely malfunctioning: 10% / 100%.
 2. RH remains above setpoint for more than 20 consecutive minutes.
- G. For all HVAC units (including exhaust or ventilation fans), register alarms under the following conditions (where applicable to particular unit):
1. Discrepancy between commanded state of operation and actual state of operation, as indicated by status feedback.
 2. Discharge air temperature of any hydronic cooling coil remains 1.5F above or 2F below setpoint for more than 15 consecutive minutes.
 3. Discharge air temperature of any DX cooling coil remains below 40F for more than 2 consecutive minutes.
 4. Discharge air temperature from an electric heating coil fails to rise by 5F within 15 minutes after heater is enabled.
 5. Outside air coil leaving air temperature remains below 35F for 5 consecutive minutes.
 6. Mixed air temperature remains below 35F for 5 consecutive minutes.
 7. Unit has tripped on any safety (e.g., high static pressure, freezestat).
 8. Duct static remains above 2.5" for 15 consecutive seconds; shut down air handler.
 9. Duct static pressure deviates above or below setpoint by 20% of setpoint for more than 15 minutes.
- H. **Smoke Control: Smoke detector, where existing on HVAC units, stops fan when products of combustion are detected in air stream.**
1. **Fan will be stopped directly via fire alarm system.**
 2. **BAS is not required to monitor smoke detector status.**
 3. **Stopping of fan by fire alarm system automatically signals alarm due to Command-Status mismatch at BAS.**
- I. **ALL HVAC equipment items:**

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1. Command/status mismatch for any component (e.g. fan, motor, heater, etc.)
2. Safety alarms:
 - a. Low mixed air temperature: < 35F for 2 minutes.
 - b. High leaving air temperature: > 120F for 10 consecutive minutes.
 - c. High duct static pressure, when measured analog:
 - 1) > 3.5" wc for 5 consecutive minutes.
 - 2) > 4.5" wc for 30 consecutive seconds.
 - d. High duct static pressure, when via binary mechanical switch monitored by BAS: On/Off alarm status, set to trip at 3.5" wc.
 - e. Safety alarms are to be programmed to shut down equipment.
- J. ALL analog sensors (CO2, temperature, humidity, pressure, etc.):
 1. Sensor gives a reading outside of its normally expected range of:
 - a. Space temperature, indoor conditions: 45F to 100F.
 - b. Outdoor air conditions: 15F to 120F, 10% to 100%.
 - c. Relative Humidity, indoor conditions: 15% to 80%.
 - d. CO2, indoor conditions: 375 to 2500 ppm. [sensors reading < 400ppm but within the submitted and specified accuracy (as an example, 40ppm ±2% of reading) must have an offset programmed such that they bottom out at no less than 400ppm]
 - e. Duct static pressure: -0.05" to 4.0".
 - f. Hydronic static or differential pressure: -1 to 100 psig.
 2. Controlling air temperature sensors (e.g. can be space temperature, return air temperature, etc.):
 - a. Measured temperature rises above or falls below setpoint by 2 deg F and remains so for 20 consecutive minutes. [Base alarms only on active temperature setpoint, e.g. use Unoccupied setpoints for alarming when system is in Unoccupied mode.](#)
 - b. CRITICAL ALARM: Measured temperature rises above or falls below setpoint by 2 deg F and remains so for 1 hour.
 3. HVAC unit air temperature sensors:
 - a. Hydronic system water coil: after unit and chiller/boiler plant have been in operation at least 30 minutes, leaving air temperature rises above or falls below setpoint by 2 deg F and remains so for 20 consecutive minutes.
 - b. DX cooling coil: leaving air temperature fails to fall to less than 58 deg F if compressor has been on for 15 consecutive minutes.
 - c. DX heating coil: leaving air temperature fails to rise at least 10 deg F when heater has been on for 10 consecutive minutes.
 - d. Heating coils (in AHU, VAV box, or elsewhere): leaving air temperature fails to rise at least 10 deg F when heater has been on for 10 consecutive minutes.
 4. Relative humidity sensors:
 - a. RH rises 10 percentage points above setpoint for 30 consecutive minutes.
 5. Pump differential pressure:
 - a. Measured dP differs from setpoint by 20% for 20 consecutive minutes (e.g. with 20psig setpoint, differing by 4psig).
 6. Carbon Dioxide sensors:
 - a. CO2 concentration rises above setpoint by 250ppm and remains so for 20 consecutive minutes.
 7. Duct static sensor:
 - a. Pressure deviates from setpoint (by 0.20") for more than 15 consecutive minutes.
 8. Dirty filter dP sensor (when specified as a point):
 - a. Coordinate with mechanical and TAB contractors to determine optimum dP setpoint. Alarm when dP surpasses setpoint for more than 3 consecutive hours.

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- K. ALL digital sensors (differential pressure, etc.):
 - 1. Dirty filter dP sensor (when specified as a point):
 - a. Coordinate with mechanical and TAB contractors to determine optimum dP setpoint for cut-out device. Alarm when dP switch closes.
- L. Any equipment with BAS-Bacnet communication specified (chiller, boiler, DX, VFD's, etc.):
 - 1. Where equipment is provided with code numbers corresponding to alarm conditions, read and display the alarm code in the alarm indication line. Provide a dedicated page or table which explains the meaning of each code number.
 - 2. Where equipment does not offer coded alarms, monitor general alarm contacts along with any other alarm conditions described herein and display alarm condition on graphic.

1.11 CONTROL SEQUENCES FOR DX SPLIT SYSTEMS

- A. Applicable to all Single Zone Variable Volume Split Systems:
- B. Coordinate with Div. 23, Sections. Units shall be configured as follows:
 - 1. With APR valves for staging cooling during cooling and dehumidification modes
 - 2. With CO2 based demand-controlled ventilation (DCV) using modulating, motorized, ultra-low leakage type, OA damper, and space CO2 sensors.
- C. Fan Control: System starts fan to run continuously during occupied periods.
 - 1. Cycle fan during unoccupied periods as required to maintain space temperature setpoints.
 - 2. During occupied mode, VFD shall modulate fan speed between minimum speed and 100% to maintain space temperature and relative humidity setpoints, and heating, setpoint (adjustable).
- D. Unoccupied Mode Enable/Disable: During unoccupied hours, enable unit operation and control to meet unoccupied mode setpoints. Unit shall run until space conditions are satisfied, but never for more than 20 minutes in any hour.
- E. Start-Up Operation: In the order of priority, start-up operation shall be commanded as follows:
 - 1. System shall initiate unit and command to Cooling Mode if space temperature is above cooling setpoint.
 - 2. System shall initiate unit and command to Heating Mode, if space temperature is below heating setpoint.
 - 3. If temperature setpoint is satisfied at start-up, but humidity setpoint is not, System shall initiate unit in Dehumidification Mode.
- F. Cooling Mode:
 - 1. Modulate cooling stages to control discharge air temperature setpoint (54°F, adj.). Includes compressor staging, unloading of compressors, and via APR valve compressor capacity control.
 - 2. Provide time delays as recommended by manufacturer to prevent short cycling of supply fans and compressors. System shall alternate compressors (as applicable).
 - 3. Disable cooling if space is below cooling setpoint and/or OAT is below 50F (adj).
 - 4. Should space RH as measured by system surpass RH setpoint, activate dehumidification mode.
- G. Dehumidification Mode:

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1. If space T is satisfied but space RH is above setpoint, reset cold coil discharge air temperature setpoint to 50F (adj). Enable heater to maintain heating space T setpoint. When RH drops below setpoint, resume normal operation.
 2. Close outside air damper and disable cooling if space temperature drops 1.5F (adjustable) below space temperature heating set point.
 3. System shall terminate Mode when space humidity drops below setpoint by amount specified in SPACE SETPOINTS section above, or if system is commanded to Cooling Mode.
- H. Heating Mode (Electric):
1. When space temperature drops below heating setpoint, **system** modulates fan speed to 50% and modulates SCR heater to satisfy space temperature setpoint.
 2. System disables heating, when temperature rises above setpoint for more than 5 minutes.
- I. Economizer Mode: Not applicable.
- J. Ventilation (OA) Sequence:
1. Interlock OA dampers with compressors such that when system is in cooling mode, OA dampers will close when compressors cycle off.
 2. Provide dedicated time schedule for OA dampers that *can be* set independently of AHU time schedule. Obtain actual Occupancy schedule from Owner and open / close outside air damper per Owner's actual Occupancy schedule (and **not per AHU schedule**).
 3. Provide space CO2 sensors, and motorized OA dampers for DCV. Provide controls sequences to modulate OA dampers to maintain CO2 setpoint. Damper position, OA CFM and CO2 setpoint shall be operator adjustable.
 4. Coordinate required minimum and maximum OA damper positions with TAB. Modulate OA dampers such that unit brings in desired OA intake at all fan speeds, i.e. OA damper will open more at low fan speed than at high fan speed.
 5. TAB to document CFM and both minimum and maximum damper positions at minimum and maximum fan speed.
 6. Unoccupied Periods:
 - a. OA Damper Position: Closed.
 7. Normal Operation:
 - a. When CO2 Level is between minimum and maximum setpoints, modulate OA damper as follows:
 - 1) Minimum open position at minimum CO2 setpoint or less.
 - 2) Maximum open position at maximum CO2 setpoint (OA not to exceed scheduled CFM).
 - 3) Vary OA damper position linearly between minimum and maximum positions as CO2 varies between minimum and maximum values.
 - b. When CO2 Level is below minimum setpoint, position OA damper to minimum open position, as determined by TAB for given fan speed (initially set at 25%).
 - c. If after 30 minutes of operation CO2 concentration has not fallen below setpoint, modulate return air damper 20% closed.
 - d. If after an additional 30 minutes of operation CO2 concentration has not fallen below setpoint, modulate return air damper 40% closed, and continue operation at that position until CO2 concentration has fallen below setpoint.
 - e. Modulate outside air dampers to minimum position when CO2 concentration falls below setpoint; re-position return air dampers to fully open.
 - f. Close OA Damper if OA T drops below 35F or rises above 105F (adj. Setpoints.), or if space humidity rises more than 10% above set point (adjustable).

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K. Graphics Display: Indicate the following on display terminal for every unit as applicable:

1. System graphic.
2. System occupied/unoccupied mode.
3. System on-off indication.
4. Fan status.
5. Fan speed.
6. System Heating / Cooling mode indication.
7. System Dehumidification mode indication, and APR valve status.
8. Cooling Stage 1 Compressor on-off indication and command.
9. Cooling Stage 2 Compressor on-off indication and command.
10. Electric heater SCR, % load.
11. Discharge air temperature setpoint and indication (downstream of cooling coils)
12. Unit discharge air temperature (downstream of heating coils).
13. Space-temperature.
14. Space-temperature setpoint.
15. Space relative humidity.
16. Space relative humidity setpoint.
17. CO2 concentration.
18. CO2 min and max setpoints.
19. OA damper commanded position.
20. OA damper position feedback.
21. RA damper commanded position.
22. RA damper position feedback.
23. Global outside air temperature and RH.
24. Outside air enthalpy.
25. BACnet pages for points, alarms, and alarm codes.

L. Safeties:

1. Smoke Control: Smoke detector, located in return air, stops fan when products of combustion are detected in air stream. Stopping of fan automatically signals alarm.
2. High temperature safety.
3. Freeze-stat safety.

1.12 MINI SPLIT SCHEDULED CONTROL SEQUENCES (DX WAC and ACCU)

A. Applicable to AC systems serving areas such as concession stands.

B. Background: Systems are controlled by programmable thermitats. BAS shall monitor space Temperature with a T sensor to initiate alarms when temperatures exceed setpoints.

C. Unit Default Mode:

1. Acts as independent DX system.
2. Monitor space temperature.

D. Operator Workstation: Display the following data:

1. System graphic.
2. Space Temperature and setpoint.
3. Alarms.

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1.13 OTHER SEQUENCES

- A. Operator Overrides: System shall allow operator to enable / disable unit and / or control / adjust all setpoints from COS.
- B. Alarms: System shall issue alarm at COS upon failure of fan or failure to achieve setpoint within specified time (15 min. adj.)
- C. Graphics pages must have units listed beside parameter values (e.g. °F, ppm, % Open, psi, etc.)
- D. When parameters are in manual or test modes, graphics shall indicate that they are in test mode.
- E. Provide up to 4 hours of programming to account for additional control sequences and fine-tuning above sequences, during the course of the project.
- F. Monitor Alarm status of elevator sump pump control panel. Coordinate with Plumbing Contractor.
- G. Provide controls and graphics for Domestic Water Heaters.
 - 1. Provide time schedules and optimal start/stop function and status for water heaters and related recirculation pumps, and/or heat trace, if applicable.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty.
 - 1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.
 - 4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

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1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 - 1. Suction Lines for Air-Conditioning Applications: 115 psig.
 - 2. Suction Lines for Heat-Pump Applications: 225 psig.
 - 3. Hot-Gas and Liquid Lines: 225 psig.
- B. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 - 2. Suction Lines for Heat-Pump Applications: 380 psig.
 - 3. Hot-Gas and Liquid Lines: 380 psig.
- C. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type L, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.

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- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8/A5.8M.
- E. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze.
 - 2. Packing: Molded stem, back seating, and replaceable under pressure.
 - 3. Operator: Rising stem.
 - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 - 5. Seal Cap: Forged-brass or valox hex cap.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
 - 1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 3. Piston: Removable polytetrafluoroethylene seat.
 - 4. Closing Spring: Stainless steel.
 - 5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 6. End Connections: Socket, union, threaded, or flanged.
 - 7. Maximum Opening Pressure: 0.50 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.

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3. Seat: Polytetrafluoroethylene.
 4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Reverse-flow option (for heat-pump applications).
 7. End Connections: Socket, flare, or threaded union.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24-V ac coil.
 7. End Connections: Socket.
 8. Throttling Range: Maximum 5 psig.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.

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5. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina, charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

L. Receivers: Comply with AHRI 495.

1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

M. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

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

1. Arkema Inc.
2. DuPont Fluorochemicals Div.
3. Genetron Refrigerants; Honeywell International Inc.
4. Mexichem Fluor Inc.

B. ASHRAE 34, R-134a: Tetrafluoroethane.

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- C. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- D. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

2.5 REFRIGERANT PIPING SUPPORT EXTERIOR TO BUILDING

- A. Exterior: Pre-manufactured strut supports; 3/8" stainless steel threaded rods holding 7" long aluminum cross-strut, stainless steel bolts, 3" to 6" adjustable height, molded 33% fiberglass reinforced nylon support base; UV stabilized. MAPA Products, type MS-2 or MS-3.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- D. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.

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- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.

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- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

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- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

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3.5 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

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3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 1. Install core in filter dryers after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Open shutoff valves in condenser water circuit.
 2. Verify that compressor oil level is correct.
 3. Open compressor suction and discharge valves.
 4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections include the following:
 - 1. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.
 - 2. Division 26 Section "Transient Voltage Suppression" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

- A. BAS: Building Automation System.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFD: Variable frequency drive.

1.4 REFERENCES

- A. ANSI/NEMA ICS 6 – Enclosures for industrial control systems.
- B. ANSI/UL 198C – High intensity capacity fuses; current limiting types.
- C. NEMA ICS 2 – Industrial control devices, controllers, and assemblies.
- D. NEMA KS 1 – Enclosed switches.
- E. NEMA PB 1.1 – Instructions for safe installation, operation, and maintenance of panelboards rated 600 volts or less.

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

1.5 SUBMITTALS

- A. Product Data: For each type of VFD, provide dimensions; mounting arrangements; location for conduit entries; shipping and operating weights; and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFD.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current ratings of integrated unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFD. Provide schematic wiring diagram for each type of VFD.
- C. Manufacturer's field service report.
- D. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include routine maintenance requirements for VFDs and all installed components

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated dimensions and clearances.
- D. Comply with NFPA 70.
- E. UL listed drive and UL-508 listed bypass/inverter assembly.

1.7 WARRANTY

- A. Written warranty, signed by manufacturer. Manufacturer's standard form in which manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period. Manufacturer will provide all labor required for replacement of materials, equipment, controls, and any other portion of complete assembly, as required. A factory-trained employee of manufacturer shall perform warranty work.
 - 1. Warranty Period for VFD's: Manufacturer's standard, but not less than three years from date of Substantial Completion.

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

2. Warranty period will commence from the date of manufacturer's startup.
- B. For the duration of the warranty, local manufacturer's representative must provide a response time of no more than 24 hours. Any failed VFD must be put back into automatic operation within this time period. Mere acknowledgement of a problem does not constitute an acceptable response.

1.8 SPARE PARTS

- A. Spare Fuses: Furnish three spare fuses for each type and rating installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Danfoss.
 2. Yaskawa.
 3. Other manufacturers may be accepted only with prior approval of Engineer, and only if they meet all requirements of this specification. Provide request for substitution a minimum of 7 days prior to submission of bid.
- B. Specific models proposed must have a continuous and proven track record of no less than 3 years.

2.2 VARIABLE FREQUENCY DRIVES

- A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, premium-efficiency induction motor by adjusting output voltage and frequency.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
 1. Input ac voltage tolerance of 380 to 480 V, plus or minus 10 percent.
 2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
 3. Capable of driving full load, under the following conditions, without derating:
 - a. Ambient Temperature: 0 to 40 deg C.
 - b. Humidity: Less than 90 percent (non-condensing).
 - c. Altitude: 3300 feet (1000 m).

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 97 percent.
6. Overload Capability: 1.10 times the base load current for 60 seconds at 40°C; 2.0 times the base load current for 3 seconds at 40°C.
7. Starting Torque: 100 percent of rated torque or as indicated.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
10. Continuous output current rating shall be no less than 100% of NEC motor amperage ratings.
11. Overload current capability of power cube at 40°C shall equal or exceed 200% of NEC motor amperage values for instantaneous trip, and 110% of NEC amperage for a minimum of sixty seconds, without damage to power cube.
12. Minimum 5% input impedance line reactor; comply with EN61000-3-2, or minimum 3% DC link reactor (also called inductive choke) connected to the DC bus between the rectifier and the PWM inverter.

E. Power Quality Issues

1. VFD must be capable of operating satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic distortion and commutation notches up to 36,500 volt-microseconds, and when other VFDs are operating from the same bus.
2. VFD shall generate less than 3% total harmonic distortion back to the incoming power line at the point of common connection with sensitive equipment. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (the consumer-utility interface or primary side of the main distribution transformer).
3. The system shall not produce spikes on the incoming line.
4. Any inverter that generates sufficient electrical line noise to interfere with the operation of sensitive building equipment shall be field modified or replaced by the inverter supplier at no additional cost to the Owner.
5. Provide input line noise suppression with MOV's (metal oxide varistors) and snubber circuits to allow for operation on typical industrial or commercial power distribution systems. MOV's shall be provided across incoming line terminals and transistors to protect inverter from voltage surges and spikes.
6. The VFD shall not induce excessive power losses in motors. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS current for pure sine wave operation.
7. VFD must be capable of operating a motor satisfactorily with up to 300 feet of wiring between VFD and motor.

F. Diodes: Bridge rated for 1600 volts.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.

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5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- H. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Snubber networks to protect against malfunction due to system voltage transients.
 3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 4. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance.
 5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 6. Instantaneous line-to-line and line-to-ground overcurrent trips.
 7. Loss-of-phase protection.
 8. Reverse-phase protection.
 9. Short-circuit protection.
 10. Motor overload.
 11. Motor over-temperature fault.
 12. Heat sink over temperature (Max. operating ambient: 104 degrees F)
 13. Protect solid state inverter devices by limiting output current to 110% of inverter rating, automatically prevent over-current trip due to momentary overload conditions.
- I. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- K. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.
- L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.
- M. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- N. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- O. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).

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2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

P. Control Signal Interface: Provide VFD with the following:

1. Provide communications devices as necessary to allow for connectivity to major automation systems.
2. VFD shall be provided with protocol information specific to Owner's BAS control manufacturer and shall be pre-configured at the factory to provide automatic communications, without the need for field programming, via a single twisted pair wire.
 - a. The VFD shall allow the DDC system to control the drive's digital and analog outputs and monitor all drive digital and analog inputs via the serial interface.
 - b. VFD is to support BACNet, LonWorks, and Modbus RTU.
 - c. Serial communications capabilities include, but are not limited to: run/stop control, speed set adjustment, proportional/integral or PID control adjustments, current limit and acceleration/deceleration time adjustments. The drive shall also have the capability of allowing the DDC system to monitor the following feedback signals: process variable, output speed/frequency, current, torque, power (KW), operating hours, kilowatt hours; relay outputs, and diagnostic warning and fault information.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (over-temperature or over-current).
 - d. PID high or low speed limits reached.

Q. Manual Bypass: Arrange magnetic contactor to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

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- R. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
- S. Bypass Controller:
 - 1. NEMA ICS 2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
 - 2. Bypass section is to be located in a metal enclosure separate from the drive section, and shall be constructed in such a manner that the inverter can be removed for repair while still operating the motor in the "bypass" mode without exposing personnel to any electrical voltage. VFD shall have inverter input power disconnect with door interlocked handle (lock out type) arranged to isolate VFD and permit safe troubleshooting & testing of inverter in when energized and/or de-energized, while motor is operating in bypass mode.
 - 3. Manual bypass shall contain:
 - a. A molded case circuit breaker or non-fused disconnect switch with door interlocked handle (lock out type) that interrupts input power to both the bypass circuitry and the drive.
 - b. A thermal overload to provide protection of motor in the bypass mode.
 - c. A safety interlock circuit that disconnects power to the motor (regardless of the mode of operation—"inverter" or "bypass") in response to a signal from the thermal overload and/or external safety circuits.
 - d. Line voltage to 120/1 volt transformers, fused per NEC, to provide power to bypass control circuits. Transformer shall be sized to include additional 20VA capacity for use by EMS contractor. DC and/or solid-state bypass sources are not acceptable.
- T. Non-fused input disconnect switch.
- U. Where indicated, provide accessories for "Contactor Motor Selection with Bypass" that will allow the DDC system to remotely switch lead-lag motors.

2.3 ENCLOSURES

- A. NEMA 4XSS for any VFD located outdoors.
- B. NEMA 12, for all other VFDs located in unconditioned space (indoors).
- C. NEMA 1, for all other VFDs located in conditioned space (indoors).
- D. Metal inverter enclosure. Plastic and/or fiberglass enclosures are not acceptable.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.
- B. Select rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with VFD mounting surface.
- B. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."
- C. Do not install incoming AC lines in same conduit as feeder lines to motor.
- D. Do not install wiring runs between VFD and motor longer than recommended by manufacturer.

3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring according to Division 16 Section "Basic Electrical Materials and Methods"

3.5 CONNECTIONS

- A. Ground equipment.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

SECTION 232923 - VARIABLE FREQUENCY MOTOR CONTROLLERS

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing: Perform the following field quality-control testing:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting VFDs, and perform startup service.
- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.
- C. Complete installation and startup checks according to manufacturer's written instructions.
- D. Upon successful completion of testing, submit written certification that drives are operating in accordance with Contract Documents, and within design operating limits of equipment. Notify Owner; include set points of adjustable devices, amperages recorded, and any other pertinent data. This information is to be included in the operation and maintenance manual.

3.8 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 CLEANING

- A. Clean VFDs internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 DEMONSTRATION

- A. Provide services of manufacturer trained employee(s) for minimum of three hours training. Demonstrate operation of controllers in the automatic, manual, and bypass modes.

END OF SECTION 23 29 23

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall, spiral-seam, round ducts and fittings.
 - 3. Double-wall, round and flat-oval spiral-seam ducts and formed fittings.
 - 4. Sheet metal materials.
 - 5. Duct liner.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

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1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
 - 3. Fire-Stopping Materials.

- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Equipment installation based on equipment being used on Project.
 - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

- C. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

- B. Welding certificates.

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- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. Round, Spiral Lock-Seam Ducts.

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- B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- D. Duct Joints:
1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Manufacturers:
 - 1) Ductmate Industries, Inc.
 - 2) Lindab Inc.
- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Unless elbow construction type is indicated, fabricate elbows as follows:
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 2. Round Mitered Elbows with Aerofoil Vanes: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
 3. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
 4. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
 5. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate

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nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

6. Round Elbows Larger than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
7. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
8. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
9. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

2.3 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Lindab Inc.
 2. McGill AirFlow LLC.
 3. SEMCO Incorporated.
- B. Ducts: Prefabricated double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Inner Duct: Minimum 0.028-inch solid sheet steel.
- F. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
 1. Solid Inner Ducts: Use the following sheet metal thicknesses:

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- a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
- G. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.26 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Terminate insulation where double-wall duct connects to single-wall externally insulated duct, and reduce outer shell diameter to inner duct diameter.
 4. Coat insulation with antimicrobial coating.
 5. Cover insulation with polyester film complying with UL 181, Class 1.
 6. **Supply and Make-Up Air Ducts: 2 inches thick.**
 7. **Painted for indoor application. Coordinate final finish with architect.**

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Manufacturers:
 - a. Owens Corning's Aeroflex Plus Duct Liner or Equal.

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2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Maximum Thermal Conductivity:
 - b. Thickness: 1 inch for sound attenuation, and R8 for thermal insulation.
 - c. Thermal Conductivity (k-Value): 0.26 at 75 deg Fmean temperature.
 - d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.
 - e. Water-Based Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - f. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb-tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
 - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

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

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

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

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- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant, one-part elastomeric sealant, formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Products: Subject to compliance with requirements, products that may be incorporated in the Work are limited to, the following:
 - 1. "Dow Corning Fire Stop Foam"; Dow Corning Corp.
 - 2. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
 - 3. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
- C. Seams and laps arranged on top of duct.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

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- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.

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- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
- G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.
- I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", and as defined below.
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. All Ducts U.N.O: Seal Class A.
 - 3. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 4. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

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- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 Sections.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. **Comply with requirements for Leakage Class A for sealing all ducts.** Refer to SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Supply, Return, Exhaust, Outdoor Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - b. Engineer will randomly designate two supply duct systems for testing in accordance with Section 4 of SMACNA HVAC Air Duct Leakage Test Manual, current edition. If leakage test results exceed SMACNA allowable leakage rates, then additional two systems shall be tested. Supply duct test section shall include main trunk line from the mechanical room to the farthest VAV box. For systems without VAV boxes, main trunk shall be determined on site

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3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

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

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

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6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

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

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
2. Ducts Connected to Constant-Volume Air-Handling Units
 - a. Pressure Class: Positive 3-inch wg
 - b. Minimum SMACNA Seal Class: A
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A

B. Return Ducts:

1. Ducts Connected to Fan Coil Units, and Terminal Units
 - a. Pressure Class: Positive or negative 2-inch wg
 - b. Minimum SMACNA Seal Class: B.
2. Ducts Connected to Air-Handling Units
 - a. Pressure Class: Positive or negative 3-inch wg
 - b. Minimum SMACNA Seal Class: B

SECTION 233113 - METAL DUCTS

- C. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg
 - b. Minimum SMACNA Seal Class: A

- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to AHUs, Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units
 - a. Pressure Class: Positive or negative 2-inch wg
 - b. Minimum SMACNA Seal Class: A

- E. Double-Wall Duct Interstitial Insulation:
 - 1. Supply Air Ducts: 2 inches thick, unless noted otherwise on drawings.

- F. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Double Skin vaned elbows. See drawings.
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

- G. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Backdraft and pressure relief dampers.
 2. Barometric relief dampers.
 3. Manual volume dampers.
 4. Control dampers.
 5. Fire dampers.
 6. Flange connectors.
 7. Turning vanes.
 8. Remote damper operators.
 9. Duct-mounted access doors.
 10. Flexible connectors.
 11. Flexible ducts.
 12. Duct accessory hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

SECTION 233300 - AIR DUCT ACCESSORIES

- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.7 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

SECTION 233300 - AIR DUCT ACCESSORIES

- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Pottorff.
 - 4. Ruskin Company.
- B. Description: Gravity balanced. Blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner, steel ball bearings, and axles.
- C. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners and mounting flange.
- D. Blades: Multiple single-piece blades, 0.050-inch-thick aluminum sheet with sealed edges.
- E. Blade Action: Parallel.
- F. Blade Seals: Neoprene, mechanically locked.
- G. Blade Axles:
 - 1. Material: Galvanized steel.
- H. Tie Bars and Brackets: Galvanized steel.
- I. Return Spring: Adjustable tension.
- J. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators, where noted.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Stainless steel.
 - 8. Screen Type: Bird.
 - 9. 90-degree stops.

SECTION 233300 - AIR DUCT ACCESSORIES

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Flexmaster U.S.A., Inc.](#)
 - b. [McGill AirFlow LLC.](#)
 - c. [Nailor Industries Inc.](#)
 - d. [Pottorff.](#)
 - e. [Ruskin Company.](#)
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [McGill AirFlow LLC.](#)
 - b. [Nailor Industries Inc.](#)
 - c. [Pottorff.](#)
 - d. [Ruskin Company.](#)
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.

SECTION 233300 - AIR DUCT ACCESSORIES

- e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Tie Bars and Brackets: Aluminum.
- C. Low-Leakage, Steel, Manual Volume Dampers:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Pottorff.**
 - b. **Ruskin Company.**
 2. Comply with AMCA 500-D testing for damper rating.
 3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 4. Suitable for horizontal or vertical applications.
 5. Frames:
 - a. Hat shaped.
 - b. 0.094-inch-thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.
 7. Blade Axles: Galvanized steel.
 8. Blade Seals: Neoprene.
 9. Tie Bars and Brackets: Galvanized steel.
 10. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- D. Low-Leakage, Aluminum, Manual Volume Dampers:
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Pottorff.**
 - b. **Ruskin Company.**
 2. Comply with AMCA 500-D testing for damper rating.
 3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 4. Suitable for horizontal or vertical applications.

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5. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 7. Blade Axles: Galvanized steel.
 8. Blade Seals: Neoprene.
 9. Tie Bars and Brackets: Aluminum.
 10. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- E. Jackshaft:
1. Size: 1-inch diameter.
 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.
 3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [Greenheck Fan Corporation](#).
 2. [Pottorff](#).
 3. [Ruskin Company](#).
 4. [Young Regulator Company](#).
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
 2. 0.094-inch-thick, galvanized sheet steel.
 3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 6 inches.

SECTION 233300 - AIR DUCT ACCESSORIES

2. Opposed-blade design.
 3. Galvanized-steel.
 4. 0.064 inch thick single skin.
 5. Blade Edging: Closed-cell neoprene.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Molded synthetic.
 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
 2. Pottorff.
 3. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.138 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

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2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ.
 - 3. Ward Industries, Inc.
- B. Description: Factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. METALAIRE, Inc.
 - 3. SEMCO Incorporated.
 - 4. Ward Industries, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Double wall.

2.9 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff.
 - 2. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.

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- E. Wall-Box Cover-Plate Material: Stainless steel.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Pottorff.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ward Industries, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..

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- 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
- 3. Service Temperature: Minus 50 to plus 250 deg F.

- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd..
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.

- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd..
 - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.

2.12 FLEXIBLE DUCTS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
 - 1. [Flexmaster U.S.A., Inc.](#)
 - 2. Thermaflex

- A. Where acoustical flexible duct is shown on drawings, provide Flexmaster Type 8M (or Thermaflex M-KE) UL 181 Class I Air Duct or equal.

- B. The duct shall be constructed of a CPE fabric supported by helical wound galvanized steel. The fabric shall be mechanically locked to the steel helix without the use of adhesives or chemicals.

- C. The internal working pressure rating shall be at least 6” w.g. positive and 4” w.g. negative through 16” diameter, and 1” w.g. negative for 18” and 20” diameters, with a bursting pressure of at least 2 ½ time the working pressure.

- D. The duct shall be rated for a velocity of at least 4000 feet per minute.

- E. The duct must be suitable for continuous operation at a temperature range of -20° F to +250° F.

- F. Factory insulate the flexible duct with fiberglass insulation. The R-value shall be at least 8 at a mean temperature of 75° F.

- G. Cover the insulation with a fire retardant metalized vapor barrier jacket reinforced with crosshatched scrim having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E96, Procedure.

- H. Sound attenuation Properties: Acoustical performance, when tested by an independent laboratory in accordance with the Air Diffusion Council’s Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties, shall be as follows:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6” diameter	7	31	40	38	40	27
8” diameter	13	29	36	35	38	22
12” diameter	21	28	29	33	26	12

SECTION 233300 - AIR DUCT ACCESSORIES

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

2.13 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers (control dampers for fans 2,000CFM and larger) at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

SECTION 233300 - AIR DUCT ACCESSORIES

6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect terminal units to supply ducts directly, and for fan powered boxes with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- O. Connect flexible ducts to metal ducts with stainless steel draw bands.
- P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.
 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes grilles, registers, diffusers, and other air devices
- B. Related Sections:
 - 1. Section 089116 "Operable Wall Louvers" and Section 089119 "Fixed Louvers" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- B. Source quality-control reports.

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Price Industries.
 - 2. Titus.

2.2 AIR DEVICES

- A. Rectangular and Square Ceiling Grilles, Registers, Diffusers: See schedules for material, finish, size, pattern, damper type, and accessories.
- B. Fire rated air devices: Plans indicate a "fire damper" designation on diffusers that need a fire rated air device. Coordinate with plans.

2.3 INSULATION

- A. All cold surfaces that are susceptible to condensation shall be insulated.
- B. Insulation may be provided by manufacturer or by installing Contractor. Coordinate with installing Contractor.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 236200 – PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, refrigerant compressor and condenser units.

1.3 PERFORMANCE REQUIREMENTS

- A. **Delegated Design:** Design ACCU supports to comply with **wind** performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. **Wind-Restraint Performance** rated for basic Wind Speed: Rated for project location.

1.4 ACTION SUBMITTALS

- A. **Product Data:** For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. **Shop Drawings:** For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. **Wiring Diagrams:** For power, signal, and control wiring.
- C. **Delegated-Design Submittal:** For compressor and condenser units indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. **Design Calculations:** Calculate requirements for selecting **wind restraints**.

1.5 INFORMATIONAL SUBMITTALS

- A. **Coordination Drawings:** Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which compressor and condenser units will be attached.
 - 2. Liquid and vapor pipe sizes.
 - 3. Refrigerant specialties.
 - 4. Piping including connections, oil traps, and double risers.
 - 5. Compressors.
 - 6. Evaporators.

SECTION 236200 – PACKAGED COMPRESSOR AND CONDENSER UNITS

- B. **Manufacturer Wind Loading Qualification Certification:** Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article, Division 7 and in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."
 - 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of wind force and locate and describe mounting and anchorage provisions.
 - 3. **Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.**
- C. **Wind Storm Certification, International Building Code and TDI Compliance Statement and shop drawings from a licensed PE for IBC and TDI.**
 - 1. **Licensed Professional Engineer shall certify that the listed items are designed for and will withstand wind speed for the location of the project, per the relevant edition of International Building Code, ASCE Std 7, Texas Department of Insurance requirements:**
 - 2. **Sealed shop drawings showing installation instructions and attachment of equipment. Include quantity and type of restraining brackets/clips, screws, spacing, etc.**
 - a. **Equipment curb/attachment for exterior and roof mounted equipment such as RTUs, ACCU, fans.**
 - b. **Attachment of equipment to curb/pad.**
 - c. **Attachment of curb/pad to building structure.**
- D. **Field quality-control reports.**
- E. **Warranty: Sample of special warranty.**

1.6 CLOSEOUT SUBMITTALS

- A. **Operation and Maintenance Data:** For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. **Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."**
- C. **ASHRAE/IESNA 90.1 Compliance:** Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
- D. **ASME Compliance:** Fabricate and label water-cooled compressor and condenser units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

SECTION 236200 – PACKAGED COMPRESSOR AND CONDENSER UNITS

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."
- B. Coordinate location of piping and electrical rough-ins.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Compressor failure.
 - b. Condenser coil leak.
 - 2. Warranty Period (Compressor Only): Ten years from date of Installation.
 - 3. Warranty Period (Components Other Than Compressor): Ten years from date of Installation.
 - 4. Contractor is responsible for scheduling delivery of equipment to the jobsite less than 6 months prior to startup. Startup of equipment shall not occur more than 6 months prior to substantial completion. Any extensions in warranty required due to early deliveries, scheduling equipment without adequate time to obtain substantial completion within the 6-month schedule or due to construction time extensions shall be paid for by the contractor.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin Applied
 - 2. Carrier Corporation; a unit of United Technologies Corp.
 - 3. YORK; a Johnson Controls company.
 - 4. Trane
- B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
- C. Compressor: Hermetic Scroll compressor designed with crankcase heater, and back seating service access valves on suction and discharge lines.
 - 1. See construction schedules for type of compressor and staging required.
 - 2. Multiple stages (min. 2) scroll compressors and refrigeration capacity control via APR valve on the lead refrigerant circuit. Modulation shall be from 25-100% of the unit capacity.
 - 3. Motor: Constant speed and includes thermal- and current-sensitive overload devices.

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- 4.
 5. Unit shall have a sound rating no higher than 70 dB(A). Provide sound attenuation blankets to meet specified sound.
- D. Refrigerant: R-410A.
- E. Preferred Condenser Coil: Seamless copper-tube, aluminum-fin coil; including electronic expansion valves, solenoid valves, 4-way valve, shut of valves, filters, oil separators, service ports and refrigerant accumulator.
- F. Coils may be fabricated from aluminum microchannel tubes with equalizing-type vertical distributor.
1. Provide an independent expansion device for each refrigeration circuit. Factory pressure tested at 450 psig and leak tested at 200 psig.
- G. Condenser coil shall be supplied with hail guards.
- H. Coil and Condenser Cabinet Coating: Coil and condenser cabinet/casing shall have a UV-resistant corrosion coating with minimum 10,000-hour salt spray rating when tested in accordance with ASTM B117. Coating shall carry a 5-year warranty, from the date of original equipment shipment from the factory.
- I. Condenser Fans: Propeller-type vertical discharge; directly driven. Include the following:
1. Permanently lubricated ball-bearing motors.
 2. Separate motor for each fan.
 3. Motors with thermal-overload cutouts.
 4. Dynamically and statically balanced fan assemblies.
- J. Operating and safety controls include the following:
1. Manual reset, high-pressure sensor and cutout switches.
 2. Low oil pressure cutout switch.
 3. Control transformer.
 4. Control circuit fuses
 5. Crankcase heaters
 6. Fusible fan motors
 7. anti-recycling timers
 8. overload relay
- K. Accessories:
1. Coordinate with specified building automation system.
 2. Low Ambient Controller: Modulates or stages condenser fan to permit operation down to 0 deg F with low-pressure switch.
 3. Package with refrigerant circuit pressure sensors, and service valves.
 4. Expansion valve to match with Evaporator Coil.
 5. Evaporator defrost controller.
 6. Liquid line solenoid valves, multiple compressors.
 7. filter-dryer.
 8. See drawing schedules.

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- L. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
 - 1. Steel, galvanized or zinc coated, for exposed casing surfaces, treated and finished with manufacturer's standard paint coating.
 - 2. Lifting lugs to facilitate rigging of units.
 - 3. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
 - 4. Condenser coil hail guard to protect coil from physical damage.
 - 5. Compressor sound blankets
 - 6. E-coat for condenser coil.
 - 7. **Wind Restraints: Metal brackets compatible with the unit casing, painted to match unit, used to anchor unit to the pad, and designed for loads at Project site.**

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110, ARI 306/110.
- B. Energy Efficiency: Equal to or greater than the higher of the scheduled efficiency or that prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."
- C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

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- C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated.
- B. Equipment Mounting:
 - 1. Install compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete.", Section 033053 "Miscellaneous Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
 - 3. Provide anchoring devices to meet windstorm certification.
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.
- E. Installing contractor must be a certified installer of the brand provided.

3.3 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- B. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."
- C. Arrange for insulation of entire evaporator body, all suction lines, and all other surfaces where condensation might occur, both internal and external to unit cabinet, whether such items are factory-insulated or not, and whether provided by manufacturer or installing contractor. Non-insulated cold surfaces will not be accepted.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

SECTION 236200 – PACKAGED COMPRESSOR AND CONDENSER UNITS

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
 - 2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service for split system.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Inspect for physical damage to unit casing.
 - b. Verify that access doors move freely and are weathertight.
 - c. Clean units and inspect for construction debris.
 - d. Verify that all bolts and screws are tight.
 - e. Adjust vibration isolation and flexible connections.
 - f. Verify that controls are connected and operational.
- B. Lubricate bearings on fan motors.
- C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
- D. Adjust fan belts to proper alignment and tension.
- E. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
- F. Measure and record airflow and air temperature rise over coils.

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- G. Verify proper operation of condenser capacity control device.
- H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- I. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 236200

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes full 2" double wall, modular air-handling units with direct expansion cooling coils, in horizontal and vertical configurations, for indoor installations on concrete pads.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

1.4 SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. AMCA 210 certified fan-performance curves with system operating conditions indicated.
 - b. AMCA 301 certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Filters with performance characteristics.
- B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- C. Source quality-control reports.
- D. Field quality-control reports.

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

- E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by AHRI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Equipment shall be UL certified and listed and classified by ETL.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate base size with condensate drain connection opening and requirements for condensate drain trap size.
- C. Coordinate side of coil connections and access doors. Coordinate exact dimensions of custom openings for supply, return and fresh air. Coordinate dimensional limitations.
- D. Since spatial constraints are an important consideration, coordinate site conditions, space availability for equipment, maintenance and NEC clearances, etc., prior to submitting bids.
- E. Electric duct heater location (if applicable) shall be coordinated with existing ductwork configuration on site. Ensure that adequate clearances and straight sections are maintained for proper performance and maintenance.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by Contractor and signed by manufacturer, agreeing to replace components that fail in materials and workmanship within the specified

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period: One year parts and labor from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set for each air-handling unit.
 2. Fan Belts: One set for each air-handling unit fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Daikin Applied
 2. Carrier; Div. of United Technologies Corp.
 3. York International Corporation.
 4. Trane

2.2 GENERAL REQUIREMENTS

- A. Manufacturer shall clearly define any exceptions made to plans and specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made.
- B. Carefully coordinate with Electrical, Mechanical, and Controls Contractors for items of work that required close integration.
- C. Units shall be delivered prewired, bearing an approved label with all of the necessary identification marks, electrical data, and any necessary cautions as required by the National Electrical Code.
- D. The entire unit shall be covered with a protective covering from time of shipment at factory until installed with structure protecting indoor air handling units. If at any time the protective covering is removed before installation, the equipment shall be thoroughly cleaned, internally and externally.
- E. Unit shall be factory assembled central station air handler with a fan, motor and drive assembly, direct expansion refrigerant coils, access section, combination filter-mixing box section, control dampers and accessories, as indicated on schedules and details.
- F. All unit sections shall be supplied with longitudinal 14-gage or higher G90 galvanized steel formed channel perimeter base rails to serve as housekeeping rails when unit is installed. The manufacturer at the factory shall install base rails. Perimeter lifting brackets shall be provided on each section. Slings of units in place of lifting brackets is not acceptable.

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

- G. Units shall ship in the fewest number of sections to meet project requirements. All section shall be individually flanged and gasketed to allow easy assembly and disassembly.

2.3 UNIT CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components. Panels can be removed without affecting the structural integrity of the unit. Units shall be weatherproofed and equipped for installation indoors or outdoors as scheduled.
1. Unit shall be constructed not to deflect more than $L/200$ at any point on the exterior liner at 1.25 times design station pressure up to $\pm 6''$ W.G. static pressure subject to factory or field testing.
 2. Outside Casing: G90 galvanized steel, **thickness as required to meet deflection limits.**
 3. Inside Casing: G90 galvanized steel, except **coil casing and coil liner: Type 304 stainless steel.**
 4. Joints: All walls, roofs, and joints shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
 5. Base Rail: Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Base rail shall be continuous, with flanged connections at shipping splits. Mounting feet are not acceptable. Integral lifting lugs shall be provided for hoisting.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- B. Casing Insulation and Adhesive:
1. Materials: 2" thick nominal 3 lb/cu.ft. density acoustic insulation; Thermal Conductivity (k-Value): **0.26 at 75 deg F** mean temperature. R-13 or higher.
 2. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
 3. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
 4. Location and Application: Encased between outside and inside casing.
- C. Inspection and Access Panels and Access Doors: Access doors large enough for easy access to accommodate periodic maintenance and inspection. Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Provide access panels and doors in the following locations:
1. Location: Access doors to fans and motors, filters, dampers and operators, coil section inspection and access section, electrical control panels, and as specified on unit drawings
 2. Construction: Same construction as unit casing.
 3. Thermal Resistance: Doors shall be designed to reduce thru metal for improved performance.
 4. Gaskets: Design press fitted into the frame slots for easy field replacement.
 5. Hardware: Each door is complete with a minimum of two stainless steel hinges and two lever lock handles.
 6. Access Panels: Lift out access panels either bolted or secured with two or more cam-lock fasteners must be provided in locations where non-regular access is required.

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- D. Condensate Drain Pans: Formed sections of **stainless-steel** sheet complying with requirements in ASHRAE 62. Fabricate IAQ drain pans with slopes in three planes to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil. To prevent moisture carryover, extend drain pan a minimum of 6" (preferably 12") past the leaving face of the cooling coil. Unit drain pan shall be a minimum of 3" deep to permit cleaning and inspection.
1. Double-Wall Construction (full 2" thick): Fill space between walls with NFPA 90A compliant insulation and seal moisture tight.
 2. Drain Connections: One end of pan. Coordinate with drawing.
 3. Units with stacked coils shall have a stainless steel intermediate drain pan with copper drop tubes to main pan to collect condensate from top coil.
- E. Base Rail: Unit shall have a minimum 6" tall continuous base rail bolted or welded to the unit frame. Mounting feet are not acceptable.

2.4 FAN SECTION

- A. Fan-Section Construction: Plenum, airfoil, or forward curve type fan, wheel, fan shaft, bearings, motor, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with spring vibration isolation, a minimum of 2" deflection. Direct-driven centrifugal fans consisting of housing where specifically shown. Motor, fan bearings, and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Horizontal-Flanged, Split Housing: Bolted construction.
 3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector or rubber vibration absorbent discharge seal.
 4. Flexible Connector: Factory fabricated with a fabric strip **5-3/4 inches** wide attached to 2 strips of **2-3/4-inch-** wide, **0.028-inch-** thick, galvanized-steel sheet or **0.032-inch-** thick aluminum sheets; select metal compatible with casing.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: **26 oz./sq. yd.**
 - 2) Fabric Tensile Strength: **480 lbf/inch** in the warp and **360 lbf/inch** in the filling.
 - 3) Fabric Service Temperature: **Minus 40 to plus 200 deg F.**
- C. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

- a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- D. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
1. Ball-Bearing Rating Life: ABMA 9, L_{10} of 120,000 hours.
 2. Roller-Bearing Rating Life: ABMA 11, L_{10} of 120,000 hours.
- F. Belt Drives (where specified): Factory mounted, with final alignment and belt adjustment made after installation and with 1.5 service factor based on fan motor.
1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 3. Belts: Oil resistant, nonsparking, and nonstatic; matched for multiple belt drives.
 4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; **0.1046-inch-** thick, **3/4-inch** diamond-mesh wire screen, welded to steel angle frame; prime coated.
 5. Motor Mount: Adjustable for belt tensioning.
- G. Vibration Control: Vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 2 inch static deflection and side snubbers designed to achieve high isolation efficiency. Fans (other than plug fans) shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
- H. Fan-Section Source Quality Control:
1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.5 MOTORS

- A. General: Refer to Division 23 Section for general requirements for motors.
- B. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
- C. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range.

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- D. Totally Enclosed Fan Cooled (TEFC), premium efficiency (E+3) type, NEMA Design B, inverter rated for Variable Speed Drive application, of size and electrical characteristics as shown on equipment schedule.
- E. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
- F. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- G. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B mounted on adjustable base.
- H. Bearings: The following features are required:
 - 1. Ball or roller bearings with inner and outer shaft seals.
 - 2. Grease lubricated. Provide grease lines for motor and shaft lubrication, extended to the to a common mounting on access side of fan.
 - 3. Designed to resist thrust loading where belt or other drives produce lateral or axial thrust in motor.
- I. Overload Protection: Built-in, automatically resetting, thermal-overload protection.
- J. Noise Rating: Quiet.
- K. Efficiency: Premium efficiency.
- L. Suitable for use with variable speed drives.
- M. Nameplate: Indicate ratings, characteristics, construction, special features, and full identification of manufacturer.
- N. Starters, Electrical Devices, and Wiring: VFDs where indicated. Electrical devices and connections are specified in Division 26 Sections.

2.6 COIL SECTION

- A. Coil Sections: Common or individual, insulated, stainless-steel casings for cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with electronic-expansion valve.
 - 1. Coils shall be burst tested to 450 psig and proof tested to 300-psig air pressure, under water. After testing, insides of coils are to be dried; all connections are to be sealed and coil shall be shipped with a charge of dry nitrogen.
 - 2. Suction headers shall be constructed of copper tubing. Suction connections shall penetrate unit casings to allow for sweat connections to refrigerant lines. Coils shall have equalizing vertical distributors sized according to the capacities of the coils. Coil casing shall be Type 304 stainless steel.
 - 3. For coils units served by multiple compressor/condensing units, provided intertwined coils with full faced activation at part load conditions.

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4. Suction and liquid line connections shall be clearly labeled on the outside of the unit.
- C. Coil casing shall be **Type 304** stainless steel.
- D. Auxiliary Drain: Return bends and headers of coils shall be fully concealed within the air-handling unit. Provide auxiliary drain pan complete with drain connection at headered end of cooling coils. Exterior header covers will not be acceptable.
- E. Coil Removal: Coils shall be removable from the unit at the header end, unless shown otherwise on drawings.

2.7 ELECTRICAL HEATING COILS

- A. Electric Coil (where indicated in schedule): Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and integral fused disconnect (one-time fuses) interlocked with door of heater coil.
- B. Electrical Heating Coils, Controls, and Accessories: Comply with UL 1995.
 1. Electric heat of capacity, voltage and control specified provided at unit discharge, or as indicated on drawings.
 2. Casing Assembly: **Galvanized-steel** frame.
 3. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 4. Coils shall be machine crimped into stainless steel terminals, which are insulated with high temperature ceramic insulators.
 5. Provide internal wiring of controls, contactors, etc. including 120 volt, 60 hertz control circuit transformer, automatic reset thermal cutout and fuses per NEC and UL (on heaters exceeding 48 amps).
 6. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
 - a. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
 7. Control Panel: **Unit** mounted with disconnecting means and overcurrent protection. Include the following controls:
 - a. Magnetic contactor.
 - b. Proportional electronic airflow sensor for proof of flow, independent of duct static pressure. Shall adjust heater capacity per available airflow
 - c. Solid-state stepless pulse controller (SCR where noted).
 - d. Time-delay relay.
 - e. Pilot lights.
 - f. Integral door interlock type disconnect switch.
 - g. Line terminal block.

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2.8 AIR FILTRATION

- A. General Requirements for Air Filtration Section: Shall be a part of the combination filter mixing box section. See sections below.
 - 1. Comply with NFPA 90A.
 - 2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 3. Provide dual filter holding frames constructed of extruded aluminum for increased rigidity arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - 4. Pre-Filter: Galvanized steel with metal grid on outlet side for use with MERV 8 filter media, steel rod grid on inlet side, hinged access, and with pull and retaining handles.
 - 5. Filter: 4" thick, MERV 13.

2.9 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating,".
- B. All Dampers: Ultra-low leak (ULL), double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 3.7 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.
- C. Mixing boxes and filter-mixing boxes shall have parallel blades. All mixing boxes and filter mixing boxes shall have access doors as specified on both sides.
- D. Coordinate damper actuators on damper shafts with controls.
- E. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."
- F. Combination Filter and Mixing Section:
 - 1. See filter details above.

2.10 ACCESSORIES

- A. See schedules.

2.11 CONTROLS

- A. Air handler controls shall be achieved through dedicated DDC programmable control modules as specified in Section 230900. Each AHU shall have a dedicated controller capable of achieving control sequences in stand-alone mode.
- B. AHU manufacturer shall coordinate with work of Section 230900 to ensure DDC system can fully interact with the AHU without compromising any of the system safeties or warranties.

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2.12 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic or refrigerant, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of air handling units.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Contractors providing units other than those used as the basis of design will assume all responsibility for changes required to accommodate units proposed.

3.2 INSTALLATION

- A. Equipment Mounting: Install air-handling units on concrete bases **using elastomeric pads**. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03 Sections.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using line size, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Insulate condensate lines.
- E. **Refrigerant Piping:** Conform to applicable requirements of Division 23 Section "Refrigerant Piping." Unless otherwise indicated, connect piping with unions and shutoff valves to allow units to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.
- F. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories." Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- J. **Electrical and controls conduit connections at the AHUs:** Seal the annulus of the conduit with fire-proof, air and water tight sealant to prevent air and condensate flow into or out of the AHU and FCU.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 1. Inspect field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
 - 2. Prepare a written report on findings and recommended corrective actions.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- D. Prepare test and inspection reports.

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3.5 STARTUP SERVICE

- A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 7. Comb coil fins for parallel orientation.
 8. Verify that proper thermal-overload protection is installed for electric coils.
 9. Install new, clean filters.
 10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
 11. Inspect field assembly of components and installation of central-station air-handling units including [refrigerant piping sizing and arrangement](#), ductwork, and electrical connections.
 12. Prepare a written report on findings and recommended corrective actions
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for modular indoor air-handling system testing, adjusting, and balancing.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

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- B. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning **units** consisting of separate evaporator-fan and compressor-condenser components.

1.3 PERFORMANCE REQUIREMENTS

- A. **Delegated Design:** Design ACCU supports to comply with **wind** performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. **Wind-Restraint Performance** rated for basic Wind Speed: Rated for Brownsville, Texas.

1.4 SUBMITTALS

- A. **Product Data:** Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. **Shop Drawings:** Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. **Wiring Diagrams:** For power, signal, and control wiring.
- C. **Manufacturer Wind Loading Qualification Certification:** Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article, Division 7 and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of wind force and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. **Field quality-control reports.**

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- E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- F. Warranty: Sample of special warranty.
- G. Certified Compliance Statement and shop drawings from a licensed PE for IBC and TDI.
 - 1. Sealed shop drawings showing installation instructions and attachment of equipment to curb, and curb to structure. Include quantity and type of restraining brackets/clips, screws, spacing, etc.
 - 2. As a separate attachment provide sealed IBC and TDI compliant calculations for curbs and attachment.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-Up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
- D. International Building Code and TDI Compliance: Licensed Professional Engineer shall certify that the listed items are designed for and will withstand wind speed for the location of the project, per the relevant edition of International Building Code, ASCE Std 7, Texas Department of Insurance requirements.
 - 1. Equipment curb/attachment for exterior and roof mounted equipment such as RTUs, ACCU, fans.
 - 2. Attachment of equipment to curb/pad.
 - 3. Attachment of curb/pad to building structure.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period. Warranty period to commence from the date of equipment start-up.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

1. Warranty Period:
 - a. For Compressor: **Five** year(s) from date of Substantial Completion.
 - b. For Parts and Labor: **One** year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: **One** set for each air-handling unit.
 2. Fan Belts: **One** set for each air-handling unit fan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Trane.
 2. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
 3. Lennox International Inc.
 4. YORK; a Johnson Controls company.

2.2 INDOOR UNITS **5 TONS** OR LESS

- A. Vertical, Evaporator-Fan Components: An assembly including cabinet, filter, chassis, coil, drain pan, fan, and motor in blow-through configuration with direct-expansion cooling coil, and electric heating coil, where scheduled.
- B. Cabinet: Covers and access panels shall be manufactured of 20 gauge pre-painted, galvanized sheet metal. Cabinet walls shall have insulated panels, fabricated to allow removal for access to internal parts and components. Units shall be designed and equipped for installation indoors.
- C. Chassis: Unit structural members shall be manufactured of 16 gauge pre-painted, galvanized sheet metal. Removable panels for servicing, and insulation on back of panel.
 1. Insulation: Standard insulation or minimum 1", whichever is greater.
- D. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- E. Reheat Coil: **If scheduled**, unit shall include a hot gas reheat coil with a modulating reheat control valve and an electronic controller. The valve position shall be controlled to provide a specific supply air temperature setpoint that is set on the control board or sent to the control board by a remote 0-10 Vdc signal.
- F. Electric Coil: **If scheduled**, helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for over-current protection.

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- G. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Special Motor Features: Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
 - 2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 3. Enclosure Type: Totally enclosed, fan cooled.
 - 4. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
 - 6. Mount unit-mounted disconnect switches on unit.

- H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

- I. Condensate Drain Pans:
 - 1. Fabricated with slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.
 - b. Depth: A minimum of 1 inch deep.
 - c. Stainless-steel sheet or non-corrosive plastic, insulated.
 - d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 2. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: **2 inches**.
 - 3) Merv according to ASHRAE 52.2: 8.
 - 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
 - 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 - 1. Casing: Corrosion free pre-painted steel cabinet, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

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2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll, mounted on rubber mounts for vibration isolation.
 - b. Two-stage (where scheduled) compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: **R-407C** or **R-410A**.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
 - e. Internal excessive current and temperature protection.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.

2.4 ACCESSORIES

- A. Programmable Thermostat with the following features:
 1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature and RH, set-point temperature and RH, time setting, operating mode, and fan speed.
- B. Other:
 1. Direct driven ECM fan motor, and with built in dehumidification sequence option for indoor units.
 2. Low Ambient Controller: Cycles condenser fan to permit operation down to 35 deg F with time-delay relay to bypass low-pressure switch.
 3. Package with refrigerant circuit suction and discharge gauges, and service valves.
 4. Automatic-reset timer to prevent rapid cycling of compressor.
 5. Site glass, filter-dryer.
 6. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
 7. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
 8. Thermostatic expansion valve to match with existing Evaporator Coil, if existing is incompatible.
 9. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.
 10. Evaporator defrost controller.
 11. Liquid line solenoid valves, electric unloaders, factory/field installed accumulators to accomplish stages of unloading.
 12. See drawing schedules.
- C. Unit Casing: Galvanized steel, finished with paint finish capable of withstanding at least 1000 hours when tested in salt spray atmosphere (ASTM B 117- 95 test procedure); with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.
 1. Condenser coil louvered hail guard to protect coil from physical damage.
 2. Condenser coil coating: epoxy coat or Energy Guard
 3. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on **4-inch-** thick, reinforced concrete base that is **4 inches** larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install and connect refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- E. Provide auxiliary drain pans with float switches to disable fans. Provide drain piping with stop valves from pans to floor drains.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Division 15 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 15 Section "Duct Accessories."
- D. Ground equipment according to Division 16 Section "Grounding and Bonding."
- E. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Verify that air-conditioning units are installed and connected according to manufacturer's written instructions and the Contract Documents.
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 3. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 4. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 5. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 6. Comb coil fins for parallel orientation.
 7. Verify that proper thermal-overload protection is installed for electric coils.
 8. Install new, clean filters.
 9. Verify that manual and automatic volume control and fire and smoke dampers in connected
 10. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 11. Measure and record motor electrical values for voltage and amperage.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- D. Complete installation and startup checks according to manufacturer's written instructions.
- E. After startup service and performance test, change filters.
- F. Manually operate dampers from fully closed to fully open position and record fan performance.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

DEMOLITION GENERAL NOTES:

- ALL DEMOLITION WORK SHALL BE DONE IN ACCORDANCE WITH ALL APPLICABLE CODES INCLUDING THOSE PUBLISHED BY OSHA.
- PROVIDE ALL DEMOLITION WORK REQUIRED FOR THE REMOVAL OF MECHANICAL EQUIPMENT AND ASSOCIATED DEVICES. PROVIDE A COMPLETE AND OPERABLE SYSTEM UPON COMPLETION OF THE PROJECT.
- ALL EXISTING EQUIPMENT REMOVED DURING CONSTRUCTION, THAT IS NOT TO BE REUSED, SHALL BE REMOVED FROM THE JOB SITE AND PROPERLY RETURNED TO THE OWNER, IF DESIRED BY OWNER.
- CONTRACTOR SHALL NOT DAMAGE STRUCTURAL INTEGRITY OF BUILDING ELEMENTS WITHOUT THE EXPRESSED WRITTEN CONSENT OF THE ENGINEER. CONTRACTOR SHALL GAIN CONSENT OF ENGINEER PRIOR TO COMPROMISING INTEGRITY OF STRUCTURAL BEAMS, IN WORK ASSOCIATED WITH BOTH DEMOLITION AND INSTALLATION.
- OWNER MAY WISH TO KEEP DEMOLISHED EQUIPMENT AND MATERIALS. COORDINATE OWNER, AND DISPOSE OF EQUIPMENT AND MATERIALS THAT OWNER DOES NOT RETAIN.
- COORDINATE CUTTING AND PATCHING OF ARCHITECTURAL ELEMENTS LIKE WALLS, FLOORS, ROOFS WITH OWNER/ENGINEER. PATCH UNUSED ROOF AND WALL PENETRATIONS, AND FINISH TO MATCH EXISTING ARCHITECTURAL ELEMENTS.

INSULATION:

- FIBERGLASS INSULATION MAY NOT BE USED ON ANY COLD PIPING SURFACES; ONLY CLOSED CELL INSULATION IS ACCEPTABLE.
- PROVIDE INSULATION ON ALL SURFACES CAPABLE OF CREATING CONDENSATION.

EQUIPMENT:

- EQUIPMENT INSPECTION:
 - FIELD VERIFY ALL CONDITIONS AND MEASURE DIMENSIONS WITHIN THE BUILDING PRIOR TO ORDERING EQUIPMENT AND/OR PROCEEDING WITH INSTALLATION.
 - ALL EQUIPMENT SHALL BE FACTORY TESTED, AND CONTRACTOR SHALL VERIFY EQUIPMENT CONDITION PRIOR TO INSTALLATION. CONTRACTOR IS RESPONSIBLE FOR EQUIPMENT DAMAGED DURING MOVING AND INSTALLATION.
 - EQUIPMENT FOUND DEFECTIVE PRIOR TO FINAL ACCEPTANCE SHALL BE REPLACED AT NO COST TO OWNER.
- EQUIPMENT ACCESS:
 - INSTALL ALL VALVES, CONTROLS, DAMPERS, FANS, ETC. IN ACCESSIBLE LOCATIONS. PROVIDE ADEQUATELY SIZED ACCESS DOORS WHERE REQUIRED.
- EQUIPMENT INSTALLATION:
 - PROVIDE SPRING HANGER TYPE VIBRATION ISOLATORS TO SUPPORT SUSPENDED AHUS, FANS AND OTHER POWERED VIBRATING EQUIPMENT. PROVIDE FLEXIBLE DUCT CONNECTORS.
 - COMPLETELY WEATHERPROOF ALL EQUIPMENT, DUCTS, PIPES AND OTHER DEVICES AND MATERIALS INSTALLED OUTSIDE THE BUILDING, IN PARKING AREA, OR OTHERWISE EXPOSED TO WEATHER. AS A MINIMUM, WEATHERPROOFING SHALL INCLUDE, BUT IS NOT LIMITED TO THE FOLLOWING: JACKETING FOR ALL PIPING INSULATION, VALVES AND ACCESSORIES RATED FOR OUTDOOR SERVICE. ELECTRICAL ENCLOSURES NEMA 4X-SS. PROVIDE ELECTRICAL HEAT TRACING FOR UTILITIES SUSCEPTIBLE TO FREEZING.
 - AFFIX ID TAGS TO ALL MECHANICAL EQUIPMENT PER SPECIFICATIONS.
- EQUIPMENT INSULATION:
 - INSULATE ALL SURFACES THAT ARE CAPABLE OF BECOMING COLD AND COLLECTING CONDENSATE. THIS INCLUDES SUPPLY DIFFUSERS AND CONNECTING DUCTWORK / TRANSITION PIECES.
- PLUMBING:
 - PROVIDE CODE RECOMMENDED CLEARANCE OR MINIMUM 10' BETWEEN EXHAUST FANS DISCHARGES, PLUMBING VENTS AND AIR INTAKES. COORDINATE LOCATIONS WITH PLUMBING CONTRACTOR.
 - PROVIDE INSULATED AND TRAPPED CONDENSATE DRAIN LINES FROM ALL AIR CONDITIONING EQUIPMENT AND TERMINATE TO NEAREST FLOOR DRAIN OR OTHER APPROVED RECEPTACLES. COORDINATE DRAINS WITH PLUMBING.
- ELECTRICAL:
 - CONTRACTOR IS RESPONSIBLE FOR COORDINATION WITH ELECTRICAL CONTRACTOR REGARDING EQUIPMENT SIZES AND TYPES OF ELECTRICAL INTERFACE EQUIPMENT REQUIRED.
 - DUE TO VARIATIONS IN EQUIPMENT CHARACTERISTICS BY DIFFERENT EQUIPMENT SUPPLIERS, MECHANICAL EQUIPMENT ULTIMATELY PROVIDED MAY DIFFER IN HORSEPOWER OR AMPERAGE REQUIREMENTS FROM THAT SPECIFIED IN THESE DRAWINGS. COORDINATE WITH GENERAL CONTRACTOR PRIOR TO BIDDING, AND PRIOR TO SUBMITTALS AND ORDERING EQUIPMENT, TO ENSURE THAT EQUIPMENT ELECTRICAL REQUIREMENTS ARE CONVEYED TO ELECTRICAL CONTRACTOR. IT IS SOLELY CONTRACTOR'S RESPONSIBILITY TO ENSURE COMPATIBILITY ISSUES ARE COORDINATED.

COORDINATION:

- GENERAL:
 - CONTRACTOR SHALL REVIEW COMPLETE DOCUMENTS PRIOR TO SUBMITTAL OF PROPOSAL TO GAIN COMPLETE UNDERSTANDING OF PROJECT SCOPE, WORK BY OTHERS, AND MECHANICAL WORK ASSOCIATED WITH OTHER DISCIPLINES.
 - TIME OR MONEY ALLOWANCES WILL NOT BE MADE TO ACCOMMODATE UTILITY CONFLICTS THAT CAN BE REASONABLY RESOLVED BY COORDINATION DURING SHOP DRAWING STAGE.
- SITE:
 - TIME OR MONEY ALLOWANCES WILL NOT BE MADE TO ACCOMMODATE UTILITY CONFLICTS THAT CAN BE REASONABLY RESOLVED BY COORDINATION DURING SHOP DRAWING STAGE.
- ARCHITECTURAL AND STRUCTURAL:
 - REFER TO ARCHITECTURAL AND STRUCTURAL PLANS FOR DETAILS OF CONSTRUCTION, INCLUDING BEAMS, FLOOR AND WALL PENETRATIONS, CHASES, AND REFLECTED CEILING PLANS. VERIFY OPENING SIZES WITH EQUIPMENT FURNISHED.
 - SLEEVE ALL EXTERIOR WALL AND GRADE BEAM PENETRATIONS. GRADE BEAM PENETRATIONS SHALL BE MADE WITHIN MIDDLE 1/3 OF VERTICAL SPAN OF BEAM.
 - SEAL AROUND DUCTS AND PIPING AT ALL WALLS, A/C ROOMS AND WALL LOUVER PENETRATIONS WITH FIREPROOF CAULKING. RE: SPECS. PROVIDE ESCUTCHEON PLATES AND FLASHING AROUND PENETRATION, BOTH INSIDE AND OUTSIDE, TO PROVIDE FINISHED LOOK.
- SPATIAL COORDINATION:
 - COORDINATE ALL WORK WITH OTHER TRADES; COORDINATE SCHEDULE OF WORK WITH ALL SUB-CONTRACTORS TO ACHIEVE SMOOTH FLOW OF CONSTRUCTION.
 - SPACES ABOVE CEILING ARE CONGESTED. DESIGN INTENT IS THAT UTILITIES BE INSTALLED TIGHT AGAINST CEILING STRUCTURE TO EXTENT POSSIBLE, WHILE RETAINING ADEQUATE MAINTENANCE ACCESS PER CODES.
 - IN CASE OF CONFLICTS, ITEMS SHALL BE ARRANGED ACCORDING TO THE FOLLOWING PRIORITIES: LIGHTING, FIRE PROTECTION, HVAC. PROVIDE OFFSETS/RISES/DROPS REQUIRED TO RESOLVE CONFLICTS WITH OTHER UTILITIES, AND TO ACCOMMODATE ALL UTILITIES ABOVE CEILINGS.
 - IN GENERAL, REROUTE SMALLER DUCTS/PIPES THROUGH JOISTS TO RESOLVE CONFLICTS WITH LARGER. PERFORM REROUTING IN MOST EFFICIENT MANNER POSSIBLE, AND IN ACCORDANCE WITH INDUSTRY STANDARDS.
 - PROVIDE COORDINATION DRAWINGS OF REFLECTED CEILING PLAN AND SECTION ABOVE CEILING SHOWING WORK OF ALL AFFECTED TRADES. DO NOT PROCEED WITH FABRICATION WORK UNTIL COORDINATION DRAWINGS HAVE BEEN APPROVED BY A/E.
 - SEE ELECTRICAL PLANS FOR EXACT LOCATION OF ELECTRICAL PANELS TO AVOID DUCTWORK AND PIPING RUNNING OVER THESE AREAS. COORDINATE WITH ELECTRICAL CONTRACTOR.
 - LOCATE AIR DEVICES AS SHOWN. COORDINATE WITH OTHER TRADES TO AVOID CONFLICT AND ADJUST LOCATION IF NEEDED WITHOUT COMPROMISING AIR DEVICES PERFORMANCE.
- CONTROLS:
 - REFER TO SPECIFICATIONS FOR CONTROL COMPONENTS AND DEVICES TO BE COORDINATED WITH MECHANICAL WORK.
 - CONTROLS CONTRACTOR SHALL PROVIDE BUILDING AUTOMATION SYSTEM (BAS) THAT CONTROLS EQUIPMENT SHOWN ON DRAWINGS. CONTROLS CONTRACTOR IS RESPONSIBLE FOR INSTALLING LOW VOLTAGE POWER AND COMMUNICATIONS. REFERENCE SPECIFICATIONS FOR CONTROL COMPONENTS AND SEQUENCING TO BE COORDINATED W/ MECH. WORK.
 - DRAWINGS SHOW GENERAL LOCATION OF DDC SENSORS (T, RH, AND CO2). UNLESS NOTED OTHERWISE, INSTALL SENSORS AT 48" ABOVE FINISHED FLOOR. WIRING SHALL BE IN CONCEALED WALLS. IN CASE OF CONFLICTS WITH FURNITURE, WINDOWS, ETC., COORDINATE EXACT LOCATION WITH ARCHITECT AND ENGINEER.

DUCTWORK:

- DUCTWORK GENERAL:
 - DRAWINGS ARE DIAGRAMMATIC IN NATURE. FOR CLARITY SAKE, MOST DUCT OFFSETS/RISES/DROPS ARE NOT SHOWN. WHERE DUCTS PENETRATE WALLS, INSTALL THEM PERPENDICULAR TO WALL.
 - RECTANGULAR AND ROUND DUCTWORK SHALL BE GALVANIZED STEEL. SIZES SHOWN ARE INSIDE CLEAR DIMENSION, UNLESS NOTED OTHERWISE.
 - VERIFY BOTTOM OF DUCT ELEVATION AND COORDINATE WITH OTHER TRADES.
 - CONSTRUCT AND LEAKAGE TEST ALL DUCTWORK BASED ON SPECIFICATIONS AND SMACNA REQUIREMENTS, WHICHEVER IS MORE STRINGENT. COORDINATE PRESSURE CLASSES WITH EQUIPMENT SCHEDULES.
 - FLEXIBLE DUCTS MAXIMUM LENGTH SHALL NOT EXCEED 6 FEET. USE OF FLEXIBLE DUCTWORK IS LIMITED TO AREAS WITH AN ACCESSIBLE SUSPENDED CEILING. PINCHED DUCT WILL HAVE TO BE REPLACED.
 - IN AREAS WHERE DUCT CONFLICTS CANNOT BE AVOIDED, ROUTE SMALLER DUCTS THROUGH ROOF JOISTS.
 - LOCATE AIR DEVICES AS SHOWN. COORDINATE WITH ELECTRICAL, IF NEEDED. RELOCATE DIFFUSER TO ADJACENT TILE.
- DUCTWORK INSULATION:
 - WRAP ALL OUTSIDE AIR, SUPPLY AND RETURN DUCTWORK UNLESS NOTED OTHERWISE.
 - IN ADDITION, FOR ACOUSTICAL PERFORMANCE INTERNALLY LINE FIRST 10' OF SUPPLY AND LAST 10' OF RETURN DUCTWORK.
 - PROVIDE ACOUSTICAL LINING FOR ALL TRANSFER DUCTS AND RETURN AIR ELBOWS.
 - INSULATION ON DUCT SHOULD TO BE PROPERLY TAPED AND MASTICS MUST BE APPLIED ON SEAMS AND JOINTS AND AT ENDS ADJACENT TO DUCT FLANGES AND FITTINGS. FOR DUCT SIDES WITH DIMENSIONS LARGER THAN 18 INCHES, APPLY ADDITIONAL PINS AND CLIPS TO HOLD INSULATION TIGHTLY AGAINST SURFACE AT CROSS BRACING.
 - INSULATE ALL EXHAUST DUCTWORK 10 FEET FROM EXTERIOR OPENING.
- DUCT FITTINGS:
 - WHERE RECTANGULAR TEE FITTINGS ARE SHOWN, PROVIDE FITTING WITH ADJUSTABLE DIVIDER SHEET AND TURNING VANES.
 - WHERE RECTANGULAR MAIN AND BRANCH CONNECTIONS ARE SHOWN, PROVIDE EXTRACTOR VANES. NOT APPLICABLE TO DUCTWORK DOWNSTREAM OF VAV BOXES.
 - PROVIDE TURNING VANES IN ALL ELBOWS PER SPECS.
- DAMPERS:
 - IN AN ACCESSIBLE LOCATION, PROVIDE MANUAL-TYPE VOLUME BALANCING DUCT DAMPERS IN ALL SUPPLY, RETURN AND EXHAUST DUCT BRANCHES TO INDIVIDUAL GRILLES, REGISTERS AND DIFFUSERS (GRD). TO MINIMIZE NOISE INSTALL DAMPERS CLOSER TO THE BRANCH CONNECTION THAN TO THE GRD. IN DUCTWORK, PROVIDE ACCESS DOORS TO ALL DAMPERS.
 - ABOVE INACCESSIBLE CEILINGS AND IN CASE DUCT CONFIGURATION DOES NOT ALLOW FOR INSTALLATION OF DAMPER IN DUCTWORK, PROVIDE REMOTE MANUAL DAMPER BY YOUNG REGULATOR OR EQUAL. (CABLE OPERATED SYSTEM) WITH ENGINEER'S PERMISSION CONTRACTOR MAY PROVIDE VOLUME DAMPER THAT IS INTEGRAL TO GRD.
 - PROVIDE BALANCING DAMPERS ON ALL EXHAUST GRILLES TO ACHIEVE DESIRED AIRFLOW.
 - PROVIDE DYNAMIC FIRE DAMPERS (RUSKIN DIDB20, TYPE B OR EQUAL) IN ACCORDANCE WITH CODE REQUIREMENT. IN ALL PENETRATIONS OF FIRE RATED WALLS, OCCUPANCY SEPARATION WALLS, BARRIERS AND PARTITIONS, AND EXIT CORRIDORS. REFER TO ARCHITECTURAL PLANS FOR RATED WALLS. PROVIDE ACCESS DOORS AS PER CODE REQUIREMENTS, EQUAL TO RUSKIN ADH-22 FOR RECTANGULAR DUCT, ACUDOR RD FOR ROUND DUCT. WHERE GRILLE ACCESS IS INDICATED, ADDITIONAL DUCT ACCESS DOOR IS NOT REQUIRED. WHERE THE CEILING IS FIRE RATED PROVIDE FIRE RATED AIR DEVICES FOR TRANSFER & RETURN AIR GRILLES AND SUPPLY AIR DIFFUSERS AS PER CODE REQUIREMENTS. REFER TO ARCHITECTURAL PLANS FOR RATED CEILINGS.
 - PROVIDE ACCESS DOORS (NOT SHOWN IN DRAWINGS) FOR INSPECTION OF DUCT MOUNTED EQUIPMENT SUCH AS FIRE/SMOKE DAMPERS, MANUAL BALANCING DAMPERS AND TURNING VANES. IN AREAS WITH HARD CEILING COORDINATE ACCESS DOOR LOCATIONS AND CEILING ACCESS PANELS WITH OTHER TRADES.

CODES & ORDINANCES:

- GENERAL:
 - UNLESS DRAWINGS OR SPECIFICATIONS HAVE MORE STRINGENT REQUIREMENTS, PERFORM ALL WORK PER APPLICABLE VERSION OF INTERNATIONAL BUILDING CODES, AND LOCAL CODES AND ORDINANCES.
 - PRIOR TO SUBMITTING PROPOSAL, NOTIFY ENGINEER OF ANY ASPECTS OF DESIGN WHICH ARE THOUGHT TO BE IN NONCOMPLIANCE WITH APPLICABLE CODES.
- PERMITS:
 - CONTRACTOR IS RESPONSIBLE FOR ALL PERMITS AND FEES ASSOCIATED WITH PROJECT, INCLUDING FEES FOR INSPECTIONS, APPLICATIONS, AND PROVISION OF NEW SERVICES.
 - CONTRACTOR WHO WILL ACTUALLY PERFORM WORK MUST APPLY FOR ALL REQUIRED PERMITS.
- APPROVALS AND INSPECTIONS:
 - OBTAIN APPROVAL FROM CITY FIRE DEPARTMENT AND BUILDING AND SAFETY DEPARTMENT PRIOR TO INSTALLATION OF ANY FIRE RELATED ITEMS.
 - COORDINATE PRESSURE TESTS, INSPECTIONS AND APPROVAL FOR ALL SYSTEMS WITH PERMITTING OFFICER, OWNER AND ENGINEER.

GENERAL NOTES:

- CONTRACT RELATED:
 - COORDINATE WORK AMONG ALL DISCIPLINES. IT IS NOT THE INTENT OF THESE DOCUMENTS TO DICTATE WHO MUST DO THE WORK. ALL WORK SHOWN IS THE RESPONSIBILITY OF THE (PRIME) CONTRACTOR.
 - WORK TO BE DONE UNDER ALLOWANCES BECOMES AN INTEGRAL PART OF THE PROJECT AND RESPONSIBILITY OF CONTRACTOR ONCE ALLOWANCE IS APPROVED.
 - CONTRACTOR SHALL NOT PROCEED WITH ANY WORK INVOLVING A CHANGE IN PROJECT SCOPE OR COST WITHOUT FIRST HAVING OBTAINED ENGINEER'S APPROVAL IN WRITING. UNLESS ENGINEER HAS AGREED TO SUCH CHANGE PRIOR TO IT BEING DONE, AND HAS AGREED THAT AN INCREASE IN COST ASSOCIATED WITH SUCH CHANGE IS WARRANTED; CONTRACTOR WILL NOT BE REIMBURSED FOR SUCH CHANGE.
- TEST & BALANCE:
 - TEST & BALANCE SHALL BE PERFORMED UNDER GENERAL CONTRACTOR, SEPARATE FROM MECHANICAL CONTRACT. DURING BIDDING, CONTRACTOR SHALL SUBMIT A COPY OF EVIDENCE THAT TAB AGENT MEETS THE QUALIFICATIONS SPECIFIED UNDER DIV. 23 SECTION 230593 TO PRIME CONTRACTOR.
 - TEST & BALANCE TO COORDINATE MINIMUM AND MAXIMUM OUTSIDE AIR DAMPER SETTINGS WITH DDC CONTROLS AND ENGINEER. PROVIDE TIME ALLOTMENT FOR MULTIPLE DAMPER SETTINGS AT VARIOUS FAN SPEEDS (MINIMUM 50%, 100%).
 - CONTRACTOR SHALL COORDINATE TAB ACTIVITIES WITH TAB CONTRACTOR.

ABBREVIATIONS

A	AMPS	ENT.	ENTERING	NO	NORMALLY OPEN
ACCU	AIR COOLED CONDENSING UNIT	EXT.	EXTERNAL OR EXTERIOR	NTS	NOT TO SCALE
ACT	ACTUATOR	FCU	FAN COIL UNIT	OA	OUTSIDE AIR
AFF	ABOVE FINISHED FLOOR	FD	FIRE DAMPER	PH	PHASE
AHU	AIR HANDLING UNIT	FM	FLOW METER	P.O.C.	POINT OF CONNECTION
B.	BOTTOM	FS	FLOW SWITCH	RA	RETURN AIR
BAS	BUILDING AUTOMATION SYSTEM	FPI	FINS PER INCH	RAG/RG	RETURN AIR GRILLE
BOP	BOTTOM OF PIPE	G.	GROUND	RD	ROOF DRAIN
BOTT.	BOTTOM	GA.	GAGE	RM.	ROOM
C.	CONDUIT OR COMMON	GALV.	GALVANIZED	RPZ	REDUCED PRESSURE ZONE
CHR	CHILLED WATER RETURN	GPM	GALLONS PER MINUTE	SA	SUPPLY AIR
CHS	CHILLED WATER SUPPLY	GRND.	GROUND	SD	SUPPLY AIR DIFFUSER
CHW	CHILLED WATER	HB	HOSE BIBB	SS	STAINLESS STEEL
CHWP	CHILLED WATER PUMP	HP	HORSEPOWER	SZ	SINGLE ZONE
CR	CONDENSER WATER RETURN	HS	HUMIDITY SENSOR	TAB	TESTING & BALANCING
CS	CONDENSER WATER SUPPLY	HVAC	HEATING, VENTILATION, & AIR CONDITIONING	T.O.L.	TOP OF LOUVER
CLG.	CEILING OR COOLING			TS	TEMPERATURE SENSOR
COMB.	COMBINATION	LVG.	LEAVING	TSTAT	THERMOSTAT
CONC.	CONCRETE	MD	MOTORIZED DAMPER	UG	UNDERGROUND
COND.	CONDUIT	MECH	MECHANICAL	UNO	UNLESS OTHERWISE NOTED
CT	COOLING TOWER	MOT. STRTR.	MOTOR STARTER	V	VOLTS
CU.	COPPER	MS	MOTOR STARTER	VAV	VARIABLE AIR VOLUME
CW	CITY WATER	MVD	MANUAL VOLUME DAMPER	VFD	VARIABLE FREQUENCY DRIVE
DDC	DIRECT DIGITAL CONTROLS	MZ	MULTI-ZONE	W	WIRE
DMPR.	DAMPER	NC	NORMALLY CLOSED		
DISC.	DISCONNECT				
EAG/EG	EXHAUST AIR GRILLE				
EMS	ENERGY MANAGEMENT SYSTEM				

MECHANICAL SYMBOLS LEGEND

12x12	DUCT SIZE: FIRST FIGURE IS SIDE SHOWN		THERMOSTAT
(12x12)	BELOW DUCT SIZE: FIRST FIGURE IS SIDE SHOWN		SPACE HUMIDITY SENSOR
	DIRECTION OF FLOW-RETURN		DUCT HUMIDITY SENSOR
	DIRECTION OF FLOW-SUPPLY		SPACE CARBON DIOXIDE SENSOR
	FIRE DAMPER		STATIC PRESSURE SENSOR
	FLEXIBLE DUCT		DUCT CARBON DIOXIDE SENSOR
	EXHAUST AIR GRILLE		CHILLED WATER RETURN
	RETURN AIR/TRANSFER AIR GRILLE		CONDENSATE PIPING
	SUPPLY AIR DIFFUSER		BUTTERFLY VALVE
	SIDE TAP WITH DAMPER		MANUAL VALVE
	BACKDRAFT DAMPER		AUTOMATIC VALVE
	AUTO-FLOW REGULATOR		CHECK VALVE
	DRAIN VALVE		PRESSURE GAUGE & COCK
	BALL VALVE		TEMPERATURE SENSOR
			THERMOMETER WELL

REVISIONS	BY
ADD	ETHOS



CAMERON COUNTY PARKS SANTA ROSA PARK IMPROVEMENTS PHASE II



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Gomez Mendez Saenz Inc.
Architects-Planners
Interior Designers

Date: FEBRUARY 01, 2022
Scale: As Noted
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CEILING DEMO GENERAL NOTES:

1. PRIOR TO DEMOLITION, IN CEILINGS SCHEDULED TO BE REMOVED PREPARE REFLECTED CEILING PLAN SKETCH SHOWING LOCATIONS OF ALL CEILING COMPONENTS AND DEVICES TO BE RE-USED INCLUDING BUT NOT LIMITED TO: EXISTING LIGHT FIXTURES, SPEAKERS, FIRE ALARM DEVICES, EMERGENCY LIGHTING, ETC. IF ANY OF THE ABOVE ITEMS ARE IN NON-WORKING CONDITION, SUBMIT A WRITTEN REPORT TO OWNER/ENGINEER.
2. CONTRACTOR TO EVALUATE CEILING GRID PRIOR TO DEMOLITION AND DOCUMENT ALL BROKEN, CRACKED, MISSING TILES, ETC. AND PROVIDE REPORT TO OWNER AND ENGINEER.

CEILING DEMO KEYED NOTES:

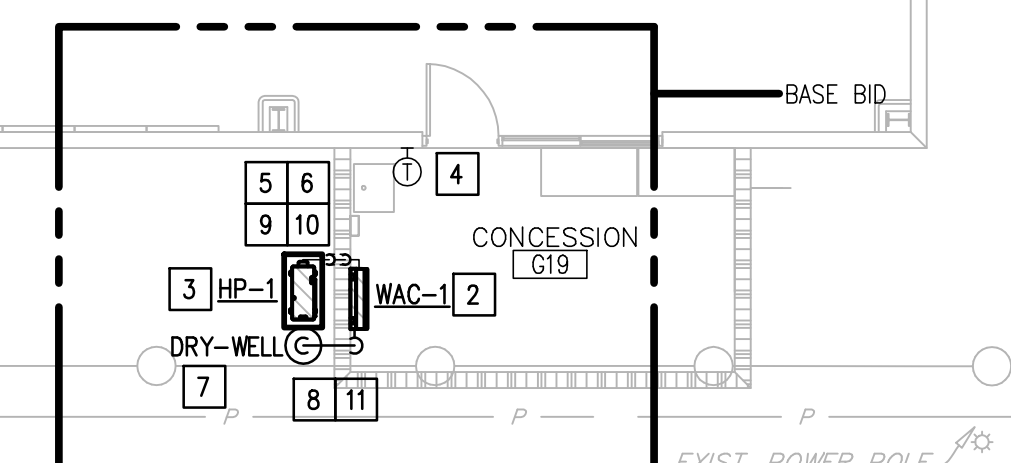
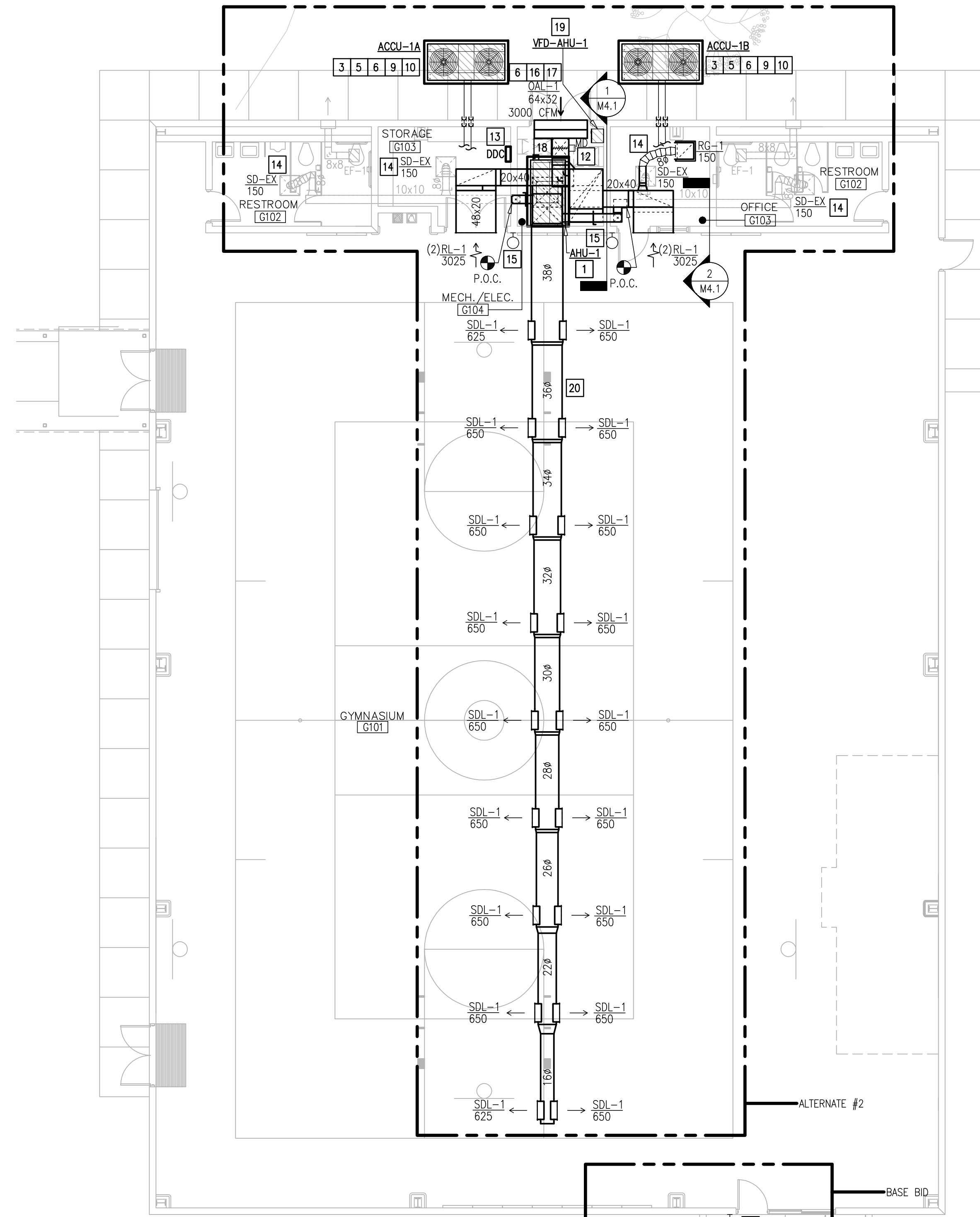
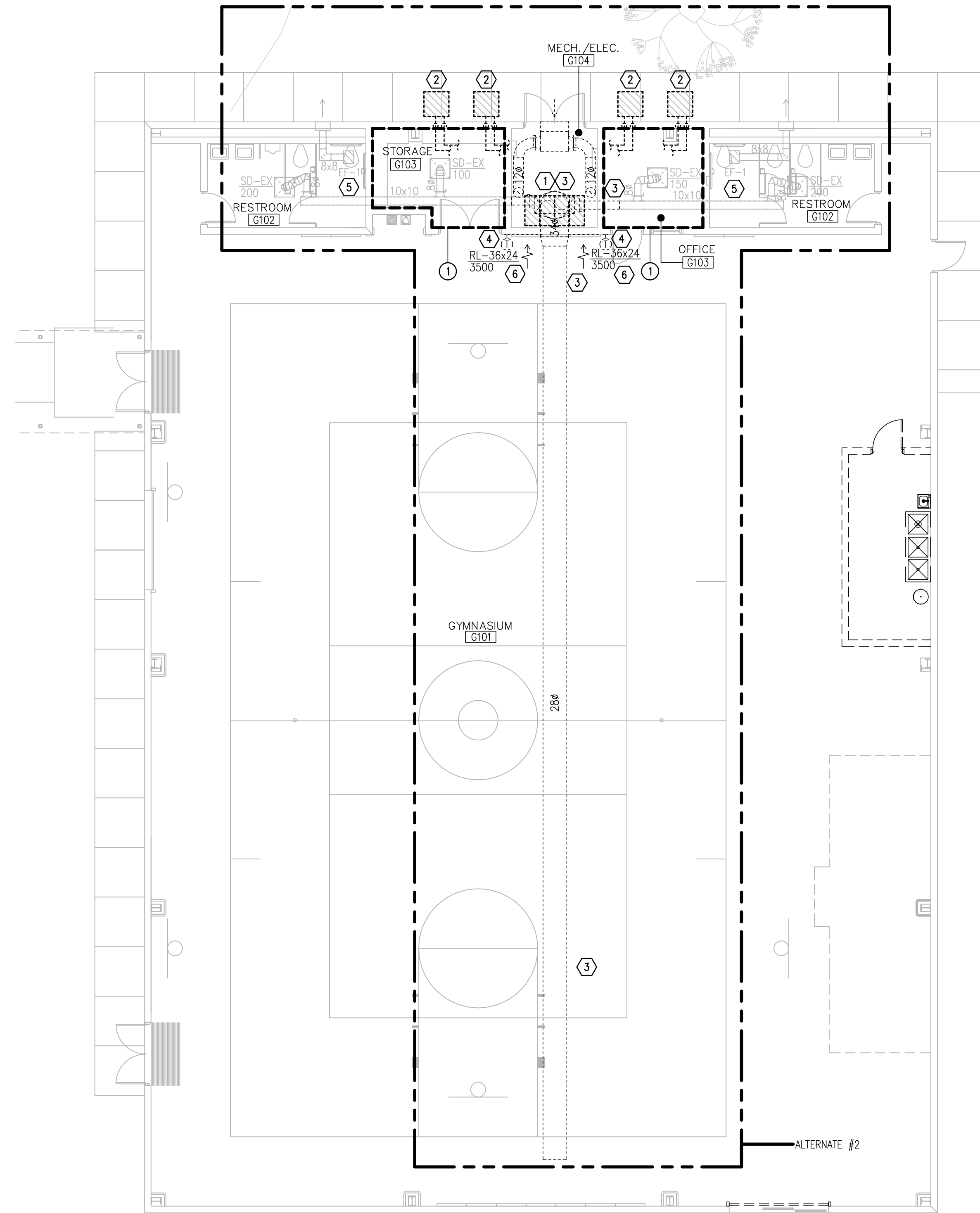
- 1 TEMPORARILY REMOVE EXISTING CEILING TILES/GRID, LIGHT FIXTURES, FIRE ALARM DEVICES, SENSORS, DUCTWORK, PIPING, ETC. AS NECESSARY FOR DEMOLITION AND PROVISION OF MEP SYSTEMS (ELECTRICAL CONDUITS, ETC.) AND RE-INSTALL AFTER WORK ABOVE CEILING HAS BEEN COMPLETED.

DEMOLITION KEYED NOTES:

- 1 DEMOLISH EXISTING FAN COIL UNITS (FCU), FCU PLATFORM, CONDENSATE PIPING, AND CONTROLS WIRING INCLUDING THERMOSTAT. REFER TO ELECTRICAL NOTES FOR WORK RELATED TO DISCONNECTS, CONDUITS, WIRING, ETC. (TYPICAL OF 4)
- 2 DEMOLISH EXISTING CONDENSING UNIT (ACCU) AS SHOWN. DEMOLISH EXISTING REFRIGERANT LINES, DUCTWORK, HANGERS, AND CONNECTIONS.
- 3 DEMOLISH EXISTING DUCTWORK, TRANSITIONS, FITTINGS, FLEX CONNECTORS, AND DAMPERS AS SHOWN.
- 4 DEMOLISH EXISTING TEMPERATURE SENSORS AND THERMOSTATS AS SHOWN. APPROXIMATE LOCATION SHOWN, FIELD VERIFY EXACT LOCATION. (TYPICAL)
- 5 EXISTING HVAC EQUIPMENT TO REMAIN. (TYPICAL)
- 6 DEMOLISH EXISTING WALL MOUNTED RETURN AIR GRILLE. REPAIR WALL AS NECESSARY AND PROVIDE WALL PADDING TO MATCH EXISTING.

MECHANICAL KEYED NOTES:

- 1 PROVIDE AIR HANDLING UNIT AS SCHEDULED. ROUTE COPPER CONDENSATE LINE TO EXISTING FLOOR DRAIN AND INSULATE PER SPECIFICATIONS. DROP REFRIGERANT LINES NEXT TO UNIT TO AVOID INTERFERENCE WITH MAINTENANCE ACCESS. POSITION UNIT TO ALLOW REQUIRED CLEARANCES. INSTALL ON HOUSEKEEPING CONCRETE PAD. REFER TO STRUCTURAL FOR MORE INFORMATION.
- 2 PROVIDE WALL MOUNTED EVAPORATOR UNIT (WAC) PER SCHEDULE. CONTRACTOR SHALL LOCATE UNIT AND INSTALL PER MANUFACTURER'S RECOMMENDATIONS / REQUIREMENTS. FURNISH UNIT WITH ACCESSORIES PER SCHEDULE.
- 3 PROVIDE AIR COOLED CONDENSING UNIT AND INSULATED REFRIGERANT PIPING PER SCHEDULE AND SPECIFICATIONS. MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES. REFRIGERANT PIPING SHOWN IS STRICTLY SCHEMATIC, VERIFY NUMBER OF CIRCUITS AND PIPE SIZES WITH MANUFACTURER'S DATA. INSTALL ACCU ON HOUSEKEEPING CONCRETE PAD. REFER TO STRUCTURAL FOR MORE INFORMATION.
- 4 PROVIDE THERMOSTAT, RH, AND CO2 SENSORS WHERE INDICATED. INSTALL 48" A.F.F. COORDINATE WITH ARCHITECT AND OWNER TO MEET ADA REQUIREMENTS. PROVIDE CLEAR LOCKING COVER FOR ALL SENSORS. (TYPICAL)
- 5 ROUTE REFRIGERANT PIPING TO INDOOR UNIT. COORDINATE ROUTING WITH OTHER TRADES PRIOR TO INSTALLATION. SLEEVE WALL PENETRATION. SEAL AIRTIGHT AROUND PIPE PENETRATION.
- 6 SLEEVE ALL WALL PENETRATIONS PER SPECIFICATIONS. SEAL AROUND DUCTS & PIPING AT ALL WALLS, AC ROOMS AND WALL LOUVER PENETRATIONS WITH FIRE-PROOF CAULKING. PROVIDE ESCUTCHEON PLATES AND FLASHING AROUND PENETRATION, BOTH INSIDE AND OUTSIDE TO PROVIDE A FINISH LOOK. (TYPICAL)
- 7 PROVIDE DRY WELL TO COLLECT CONDENSATION FROM A/C SYSTEM. REFER TO DETAIL SHEET.
- 8 PROVIDE COPPER CONDENSATE PIPING FROM WAC EVAPORATOR TO DRY WELL.
- 9 PROVIDE REFRIGERANT LINE SUPPORTS. SEE ASSOCIATED DETAIL. (TYPICAL)
- 10 PROVIDE 1" INSULATION & PROTECTIVE ALUMINUM JACKETING ON EXPOSED REFRIGERANT LINES. SEE SPECIFICATIONS. (TYPICAL)
- 11 PROVIDE TRAPPED COPPER CONDENSATE PIPING FROM WAC-1 EVAPORATOR TO DRY WELL.
- 12 CODE AND WORKING CLEARANCE FOR ELECTRICAL PANELS. DO NOT ROUTE DUCT OR PIPING DIRECTLY ABOVE ELECTRICAL EQUIPMENT FOOTPRINT. SEE ELECTRICAL PLANS FOR EXACT LOCATION. (TYPICAL)
- 13 REFER TO SPECIFICATION FOR DDC CONTROLS AND SEQUENCES OF OPERATION.
- 14 REBALANCE EXISTING SUPPLY DIFFUSER TO CFM VALUES SHOWN.
- 15 PROVIDE STAINLESS STEEL WALL PLATE WHERE THERMOSTAT WAS PREVIOUSLY LOCATED.
- 16 PROVIDE LOUVER AS SCHEDULED. COORDINATE FINAL FINISH, SIZE AND LOCATION WITH ARCHITECT PRIOR TO ORDERING.
- 17 PROVIDE OUTSIDE AIR DUCT TO LOUVER AS SHOWN. REFER TO MECHANICAL SCHEDULES FOR LOUVER REQUIREMENTS. (TYPICAL)
- 18 PROVIDE MOTORIZED OUTSIDE AIR DAMPER WITH STEP DOWN TRANSFORMER IN VERTICAL RISE. REFER TO ELEVATION FOR MORE INFORMATION.
- 19 PROVIDE VFD AS SCHEDULED.
- 20 PROVIDE 2" DOUBLE WALL EXPOSED-PAINTED ROUND DUCT AS PER SPECIFICATIONS WITH DIFFUSERS AS SCHEDULED. PROVIDE HIGH PERFORMANCE PAINT AND COORDINATE FINAL COLOR OF DUCTS AND DIFFUSERS WITH ARCHITECT BEFORE ORDERING AND INSTALLING. ALL EXPOSED DUCTS SHALL BE PAINTED.



LEGEND	
	EXISTING EQUIPMENT TO REMAIN
	EQUIPMENT TO BE DEMOLISHED
	NEW EQUIPMENT
	NEW CONCRETE HOUSEKEEPING PAD
	EXISTING DUCTWORK TO REMAIN
	DUCTWORK TO BE DEMOLISHED
	NEW DUCTWORK
	T-STAT TO BE DEMOLISHED
	NEW T-STAT
	NEW STAINLESS STEEL WALL PLATE
	PIPING TO BE DEMOLISHED
	NEW PIPING AS NOTED

01 GYMNASIUM MECHANICAL DEMOLITION PLAN

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



02 GYMNASIUM MECHANICAL PLAN

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



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CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS PHASE II



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 Architects-Planners
 Interior Designers

Date: FEBRUARY 01, 2022
 Scale: As Noted
 Project Architect: Roan G. Gomez, AIA
 Drawn By: B.B.
 Job No.: 22x114
 Sheet:



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M3.1

AIR HANDLING UNIT SCHEDULE (ALTERNATE #2)

MARK	UNIT TYPE	TOTAL CFM	OUTSIDE AIR CFM	ESP IN WG	FAN TYPE	EX. MIN HP	MAX MOTOR BHP	ELECT. V/PH	COOLING				HEATER SECTION				STAGES	WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER
									TOTAL BTUH	SENS. BTUH	EAT DB/WB (F)	LAT DB/WB (F)	HEAT KW	HEAT CFM	ELECT. V/PH					
AHU-1	VERTICAL DX SPLIT	12,200	3,000	1.25	FC	15	13.179	208/360	490,970	280,810	76.8/67.4	55.8/64.5	80	6100	208/360	SCR	1484	ALL	PCC	

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS AND SUBSTITUTION PROCEDURES.
 - ESP IS STRICTLY EXTERNAL STATIC PRESSURE AND IS IN ADDITION TO ANY FILTERS, COILS, HEATERS OR OTHER ACCESSORIES INCLUDED WITH THE AIR HANDLING UNIT.
 - PROVIDE GALVANIZED STEEL FILTER PAD FRAMES NO LONGER THAN 24" UNLESS APPROVED BY ENGINEER.
 - PROVIDE STAINLESS STEEL DRAIN PAN.
 - ALL MOTORS SHALL BE NON-OVERLOADING TYPE, PREMIUM EFFICIENCY (E-3 RATING), TEFC RATED.
 - PROVIDE INVERTER RATED MOTORS FOR VFD DUTY.
 - UNIT CONFIGURATION (VERTICAL COIL SECTIONS, COIL CONNECTION SIDES, ACCESS DOORS, ETC.) SHALL MATCH BASIS OF DESIGN UNITS PRECISELY.
 - PROVIDE AIR HANDLING UNIT WITH TWO CIRCUIT INTERLACED DX COIL THAT PROVIDES FULL FACE ACTIVATION AT PART LOADS, MINIMUM 4 STAGES TOTAL.
 - PROVIDE DEDICATED ELECTRICAL POINTS OF CONNECTION FOR FAN MOTOR AND HEATER. DISCONNECT BY DIV. 26. COORDINATE WITH ELECTRICAL CONTRACTOR.
 - PROVIDE DDC CONTROLLER FOR 4 STAGES OF COOLING CAPACITY. COORDINATE WITH CONTROLS CONTRACTOR.
 - PROVIDE APR VALVE.

ACCU SCHEDULE (ALTERNATE #2)

MARK	SERVING	TOTAL BTUH	COND DB	ELECTRIC V-PH-HZ	EER / IER AT ARI	STEPS OF CAPACITY	FANS HP	(CIRCUIT)			WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER
								MCA	(CIRCUIT) MOCP	MOCP			
ACCU-1A, 1B	AHU-1	245,485	100	208/360	12.1	2	1	98	125	778	ALL	TTA240	

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS AND SUBSTITUTION PROCEDURES.
 - PROVIDE SINGLE REFRIGERATION CIRCUIT CONDENSING UNITS, WITH TWO COMPRESSORS. AHU WILL HAVE TWO CONDENSING UNITS.
 - EER SHALL EXCEED IECC MINIMUM EFFICIENCY AT DESIGN CONDITIONS.
 - PROVIDE LOUVERED HAIL GUARD, LOW AMBIENT KIT, SIGHT GLASS, SERVICE VALVES, FILTER DRYER, SOLENOID VALVES, TXV'S, ANTI-SHORT CYCLE TIMER
 - PROVIDE FREEZE/STAT/DEFROST CONTROLLER TO PROTECT COMPRESSOR WHEN ICE BUILD-UP IS DETECTED IN THE EVAPORATOR COIL.
 - PROVIDE CONDENSER COIL COATING AS PER SPECIFICATIONS.
 - SAFETY DISCONNECT TO BE PROVIDED BY DIV. 26.
 - INSULATE REFRIGERANT LINES AS PER SPECIFICATIONS. PROVIDE UV RESISTANT PAINTED JACKETING AROUND INSULATION FOR ALL EXTERIOR EXPOSED LINES.
 - INSTALL ON 4" CONCRETE HOUSEKEEPING PAD AND MAINTAIN MANUFACTURER'S RECOMMENDED CLEARANCES. BOLT CONDENSING UNIT DOWN TO CONCRETE PAD.
 - PROVIDE FACTORY INSTALLED APR VALVE. PROVIDE THERMOSTAT TO PROVIDE 2 STAGES OF MODULATION PER CONDENSING UNIT.

AIR DEVICE & DIFFUSER SCHEDULE (ALTERNATE #2)

SUPPLY AIR GRILLE (SDL-1) DUCT MOUNTED				
CFM RANGE	NOMINAL DUCT SIZE INCHES (INLET)	FACE SIZE INCHES (INCLUDING FRAME)	DIFFUSER DIFFUSION PATTERN & CFM	NOTES
0 - 700	24 X 12	INLET SIZE PLUS 1-3/4"	SDL1-CFM	1-5
RETURN AIR GRILLE (RL-1) SIDE WALL				
CFM RANGE	FACE SIZE INCHES LENGTH & WIDTH	DIFFUSER DIFFUSION PATTERN & CFM	NOTES	
0 - 3050	48 X 20	RL1-CFM	1,4,5	
RETURN AIR GRILLE (RG-1)				
CFM RANGE	CLG. MODULE SIZE INCHES LENGTH & WIDTH	DIFFUSER DIFFUSION PATTERN & CFM	NOTES	
0-1600	24 X 24	RG1-CFM	1,4,5	

- NOTES:
- PROVIDE MANUFACTURER'S STANDARD BAKED WHITE ENAMEL FINISH.
 - PROVIDE FULL SIZE BACK PAN WITH DUCT ADAPTER.
 - INSULATE BACK PAN ON ALL SUPPLY AIR DIFFUSERS AND GRILLES.
 - PROVIDE MOUNTING FRAME TYPE COMPATIBLE WITH SCHEDULED CEILING OR WALL (SURFACE OR LAY-IN).
 - AIR DEVICES SHALL MATCH ARCHITECTURAL FINISH. COORDINATE COLOR WITH ARCHITECT.

LOUVER SCHEDULE (ALTERNATE #2)

MARK	SERVES	CFM RANGE	FACE SIZE (WXH)	MIN. FREE AREA (F ²)	MANUFACTURER & MODEL NUMBER	NOTES
SUPPLY	AHU-1	3000	64 X 32	6.24	RUSKIN EMES20MD	ALL

- NOTES:
- PRIOR TO ORDERING, COORDINATE LOUVER FINISH AND EXACT FACE SIZE WITH ARCHITECT.
 - PROVIDE STAINLESS STEEL BIRD SCREEN AND HARDWARE.
 - PROVIDE FACTORY APPLIED KYMAR 500 FINISH.
 - PROVIDE WITH TDI PRODUCT EVALUATION REPORT.

VFD SCHEDULE (ALTERNATE #2)

MARK	EQUIPMENT SERVED	MOTOR HP	FL AMPS	ELECTRICAL V/PHz	MANUFACTURER & MODEL NUMBER	NOTES
VFD-AHU-1	AHU-1	15	46.2	208/360	TRANE TR200	ALL

- NOTES:
- PROVIDE NEMA 1 ENCLOSURE FOR VFD LOCATED INDOORS.
 - PROVIDE INTEGRAL DISCONNECT.
 - PROVIDE BYPASS WITH VFD'S.

MINI-SPLIT INDOOR UNIT SCHEDULE (BASE BID)

MARK	SERVED BY	LOCATION	CFM	ESP IN WG	ELECTRICAL V-PH-HZ	COOLING		HEATING		WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER
						TOTAL (BTU/H)	DB/WB	TOTAL (BTU/H)	EAT DB/WB			
WAC-1	HP-1	CONCESSIONS	364	0.10	240-1-60	12,193	80/67	14,400	70/60	22	ALL	NTXSWST12

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS, AND SUBSTITUTION PROCEDURES.
 - FILTER SECTION SHALL BE WIRE FRAMED SECTION.
 - PROVIDE MOUNTING BRACKET
 - PROVIDE WALL MOUNTED AND WIRED 7-DAY PROGRAMMABLE T-STAT IN LIEU OF WIRELESS REMOTE.
 - ELECTRICAL CONTRACTOR TO PROVIDE SINGLE CIRCUIT POWER FROM SERVICE TO OUTDOOR UNIT AND WIRE TO INDOOR UNIT.

MINI-SPLIT HEAT PUMP SCHEDULE (BASE BID)

MARK	SERVING	TOTAL COOLING CAPACITY (BTU/H)	COND DB (CLG/HTG)	ELECTRICAL V-PH-HZ	SEER ARI CONDITIONS	HSPF ARI CONDITIONS	COMPR STAGES	MCA	MOCP	WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS, AND SUBSTITUTION PROCEDURES.
 - INSULATE REFRIGERANT LINES AS PER SPECIFICATIONS. PROVIDE ALUMINUM METAL JACKETING AROUND INSULATION FOR ALL EXTERIOR EXPOSED LINES.
 - EER SHALL EXCEED IECC MINIMUM EFFICIENCY AT ARI CONDITIONS.
 - PROVIDE EVAPORATOR DEFROST CONTROLLER FOR MINIMUM CIRCUIT.
 - PROVIDE INVERTER DRIVEN COMPRESSOR FOR IMPROVED HUMIDITY CONTROL.
 - PROVIDE CONTROL WIRING FROM OUTDOOR UNIT TO ALL INDOOR UNITS. CONDUITS TO BE PROVIDED BY DIV. 26. COORDINATE WITH ELECTRICAL CONTRACTOR.
 - SAFETY DISCONNECT TO BE PROVIDED BY DIV. 26. ELECTRICAL CONTRACTOR TO PROVIDE SINGLE CIRCUIT POWER FROM SERVICE TO OUTDOOR UNIT AND WIRE TO INDOOR UNIT.
 - PROVIDE ATTACHMENT OF ACCU TO CONCRETE SLAB CAPABLE OF WITHSTANDING THE LOCAL WIND PRESSURES AS PER IBC. PROVIDE CALCULATIONS AND ATTACHMENT INSTALLATION INSTRUCTIONS SEALED BY A LICENSED ENGINEER. REFER TO SPECIFICATIONS FOR MORE INFORMATION ON THIS DELEGATED DESIGN.
 - PROVIDE COIL PROTECTION PER SPECIFICATIONS.

MINI-SPLIT INDOOR UNIT SCHEDULE (ALTERNATE #2)

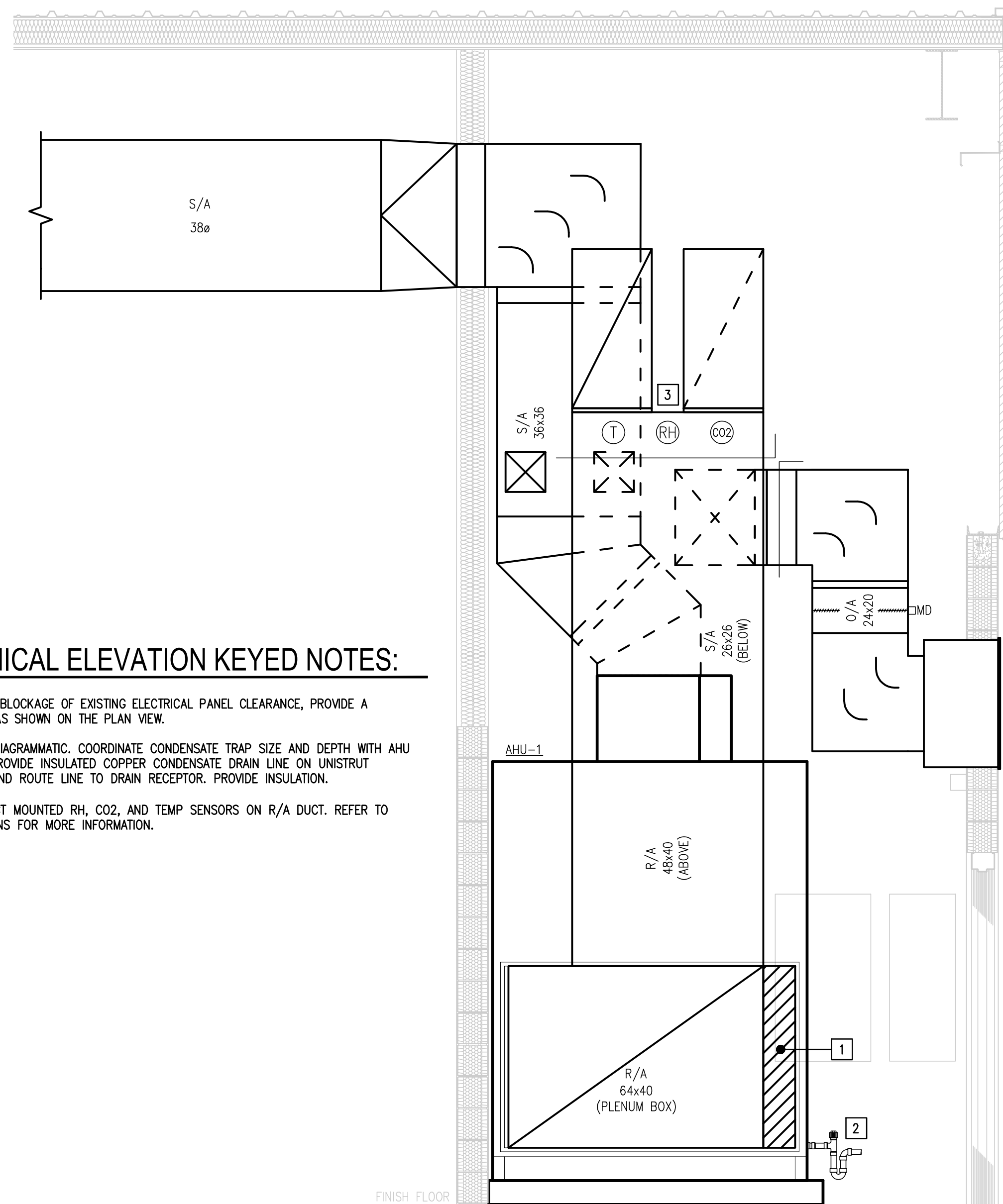
MARK	SERVED BY	LOCATION	CFM	ESP IN WG	ELECTRICAL V-PH-HZ	COOLING		HEATING		WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER
						TOTAL (BTU/H)	DB/WB	TOTAL (BTU/H)	EAT DB/WB			
WAC-1	HP-1	CONCESSIONS	364	0.10	208-1-60	12,193	80/67	14,400	70/60	22	ALL	NTXSWST12

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS, AND SUBSTITUTION PROCEDURES.
 - FILTER SECTION SHALL BE WIRE FRAMED SECTION.
 - PROVIDE MOUNTING BRACKET
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MINI-SPLIT HEAT PUMP SCHEDULE (ALTERNATE #2)

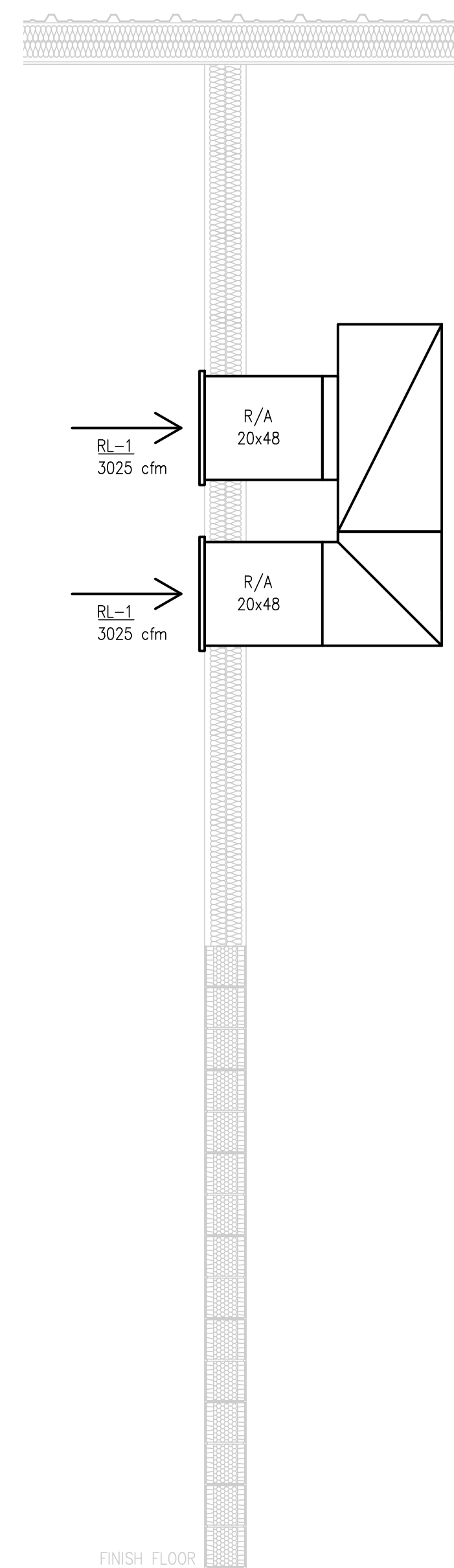
MARK	SERVING	TOTAL COOLING CAPACITY (BTU/H)	COND DB (CLG/HTG)	ELECTRICAL V-PH-HZ	SEER ARI CONDITIONS	HSPF ARI CONDITIONS	COMPR STAGES	MCA	MOCP	WEIGHT (LBS)	NOTES	TRANE MODEL NUMBER

- NOTES:
- MANUFACTURER AND MODEL NUMBER LISTED ARE "OR APPROVED EQUAL". SEE SPECIFICATIONS FOR APPROVED MANUFACTURERS, AND SUBSTITUTION PROCEDURES.
 - INSULATE REFRIGERANT LINES AS PER SPECIFICATIONS. PROVIDE ALUMINUM METAL JACKETING AROUND INSULATION FOR ALL EXTERIOR EXPOSED LINES.
 - EER SHALL EXCEED IECC MINIMUM EFFICIENCY AT ARI CONDITIONS.
 - PROVIDE EVAPORATOR DEFROST CONTROLLER FOR MINIMUM CIRCUIT.
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 - PROVIDE COIL PROTECTION PER SPECIFICATIONS.



MECHANICAL ELEVATION KEYED NOTES:

- TO PREVENT BLOCKAGE OF EXISTING ELECTRICAL PANEL CLEARANCE, PROVIDE A TRANSITION AS SHOWN ON THE PLAN VIEW.
- SYMBOL IS DIAGRAMMATIC. COORDINATE CONDENSATE TRAP SIZE AND DEPTH WITH AHU SUPPLIER. PROVIDE INSULATED COPPER CONDENSATE DRAIN LINE ON UNISTRUT SLEEPERS, AND ROUTE LINE TO DRAIN RECEPTOR. PROVIDE INSULATION.
- PROVIDE DUCT MOUNTED RH, CO2, AND TEMP SENSORS ON R/A DUCT. REFER TO SPECIFICATIONS FOR MORE INFORMATION.



01 AHU-1 MECHANICAL ELEVATION
SCALE: 1/2" = 1'-0"

02 RETURN AIR GRILLES ELEVATION
SCALE: 1/2" = 1'-0"

REVISIONS	BY
ADD 02/16/2023	ETHOS

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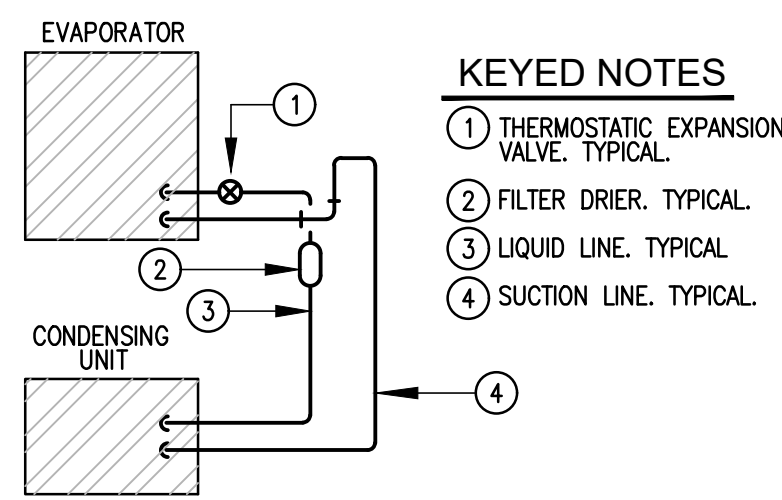
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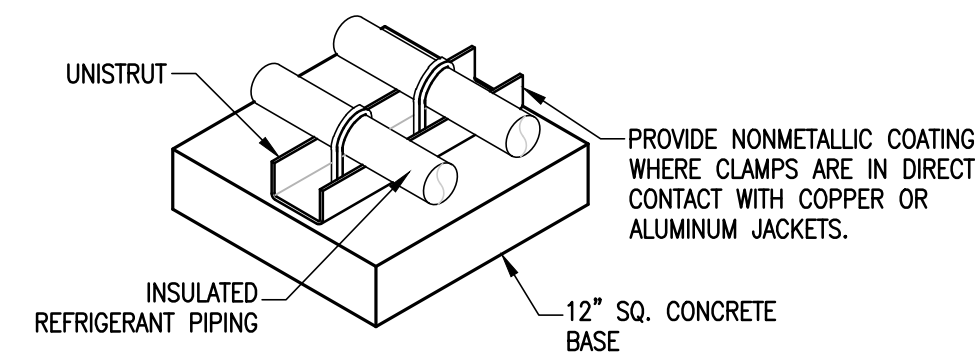
KEYED NOTES

- ① THERMOSTATIC EXPANSION VALVE. TYPICAL.
- ② FILTER DRIER. TYPICAL.
- ③ LIQUID LINE. TYPICAL.
- ④ SUCTION LINE. TYPICAL.

NOTE: SIZE REFRIGERANT PIPING PER MFR. RECOMMENDATION.

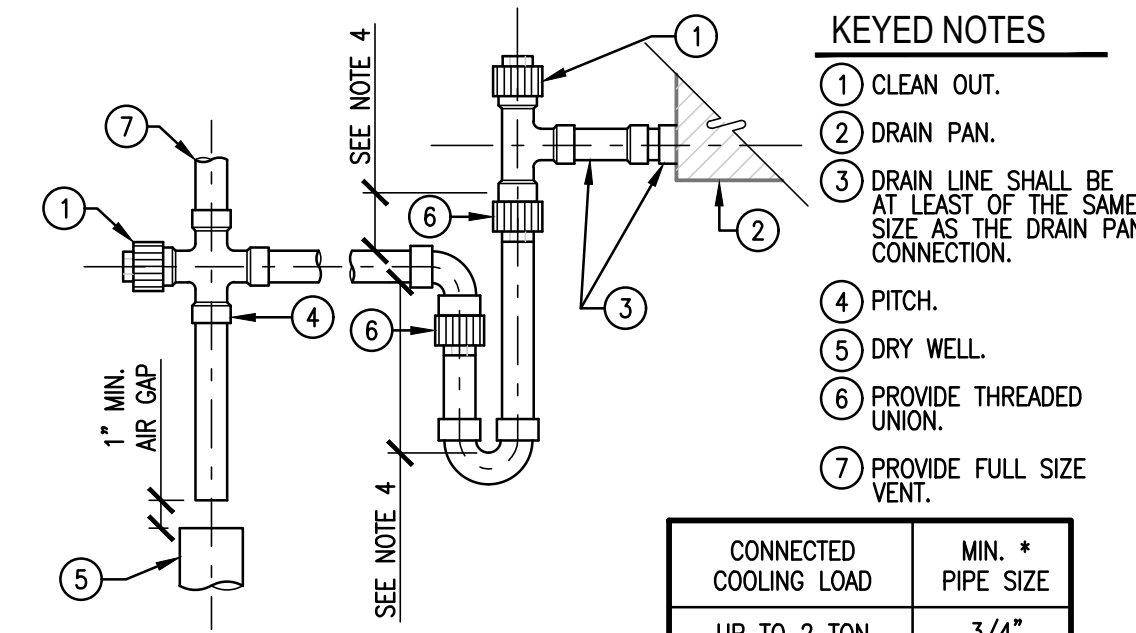
01 REFRIGERANT PIPING DETAIL

SCALE: NOT TO SCALE



02 REFRIGERANT PIPING SUPPORT DETAIL

SCALE: NOT TO SCALE



KEYED NOTES

- ① CLEAN OUT.
- ② DRAIN PAN.
- ③ DRAIN LINE SHALL BE AT LEAST OF THE SAME SIZE AS THE DRAIN PAN CONNECTION.
- ④ PITCH.
- ⑤ DRY WELL.
- ⑥ PROVIDE THREADED UNION.
- ⑦ PROVIDE FULL SIZE VENT.

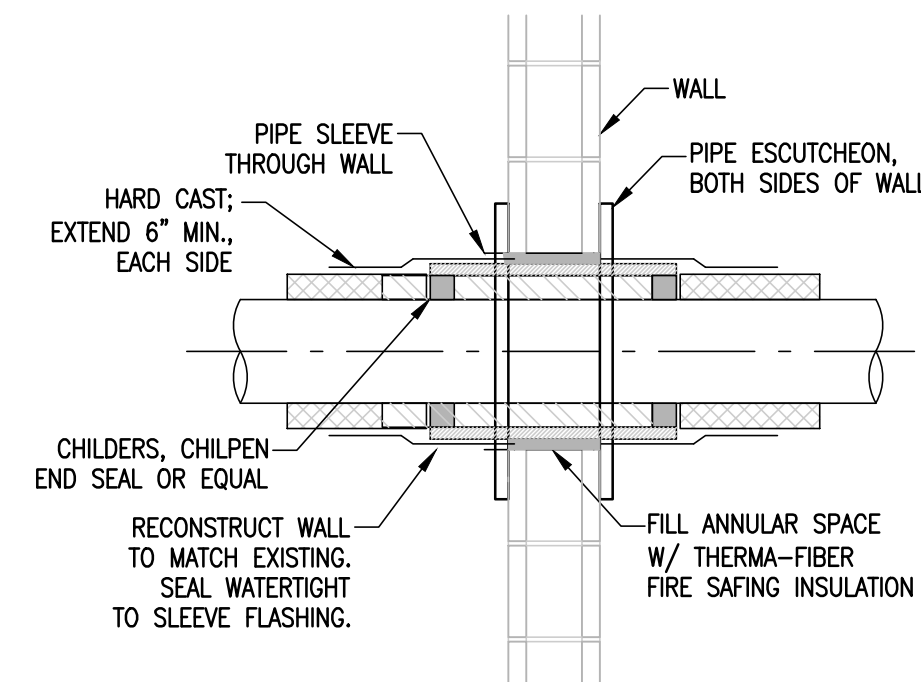
CONNECTED COOLING LOAD	MIN. PIPE SIZE
UP TO 2 TON	3/4"
2-5	1"
5-30	1-1/4"
30-50	1-1/2"
50-160	2"
160-300	3"
300-430	4"

* NOT SMALLER THAN OUTLET SIZE.

- NOTES:
1. MANUALLY PRIME TRAP BEFORE START UP.
 2. SUPPORT DRAIN LINES TO PREVENT SAG TO DRAIN.
 3. ALLOW SUFFICIENT SPACE BELOW PAN FOR TRAP AND PITCH TO DRAIN.
 4. COORDINATE WITH MANUFACTURER OF AHU.

03 CONDENSATE DRAIN TRAP PIPE DETAIL

SCALE: NOT TO SCALE

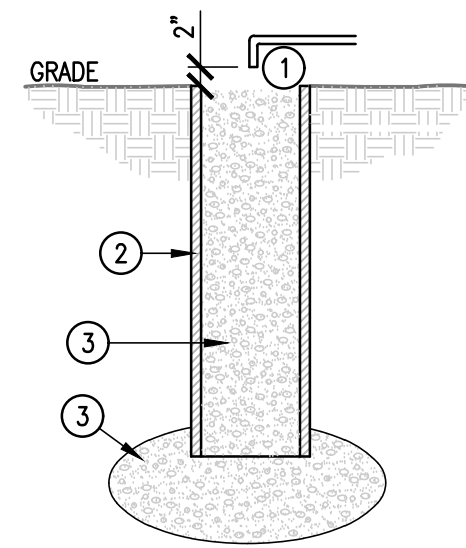


04 PIPE PENETRATION DETAIL

SCALE: NOT TO SCALE

KEYED NOTES

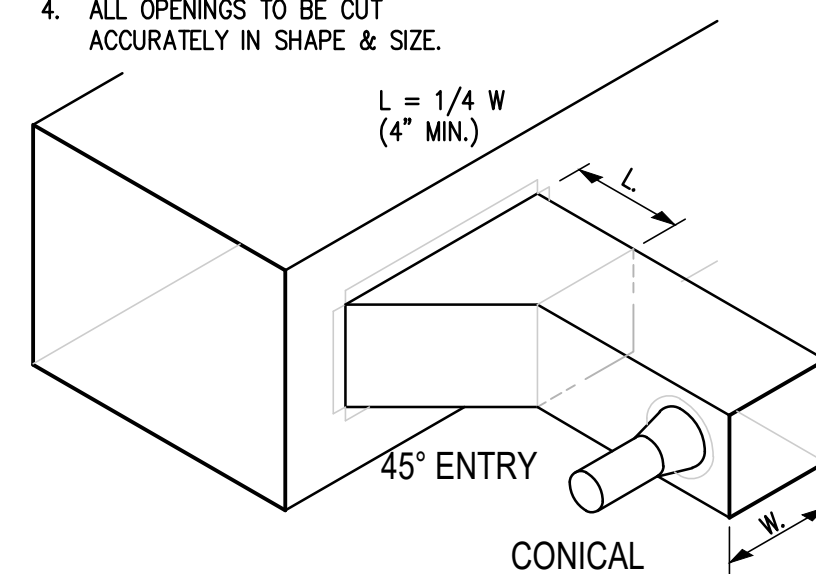
- ① PROVIDE 1" COPPER CONDENSATE PIPING FROM EQUIP.
- ② 18" x 5'-0" LENGTH OF SCH80 PVC PERFORATED PIPE TO SERVE EQUIP. CONDENSATE PIPING.
- ③ PROVIDE GRAVEL FILL.



05 DRY-WELL DETAIL

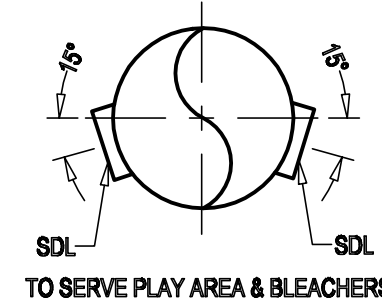
SCALE: NOT TO SCALE

- NOTES:
1. FIT ALL CONNECTIONS TO AVOID VISIBLE OPENINGS & SECURE SUITABLY FOR THE PRESSURE CLASS.
 2. ADDITIONAL MECHANICAL FASTENERS REQ'D. FOR 4" W.G. & OVER.
 3. DO NOT EXPOSE LINER EDGES ON LINED DUCT CONNECTIONS.
 4. ALL OPENINGS TO BE CUT ACCURATELY IN SHAPE & SIZE.



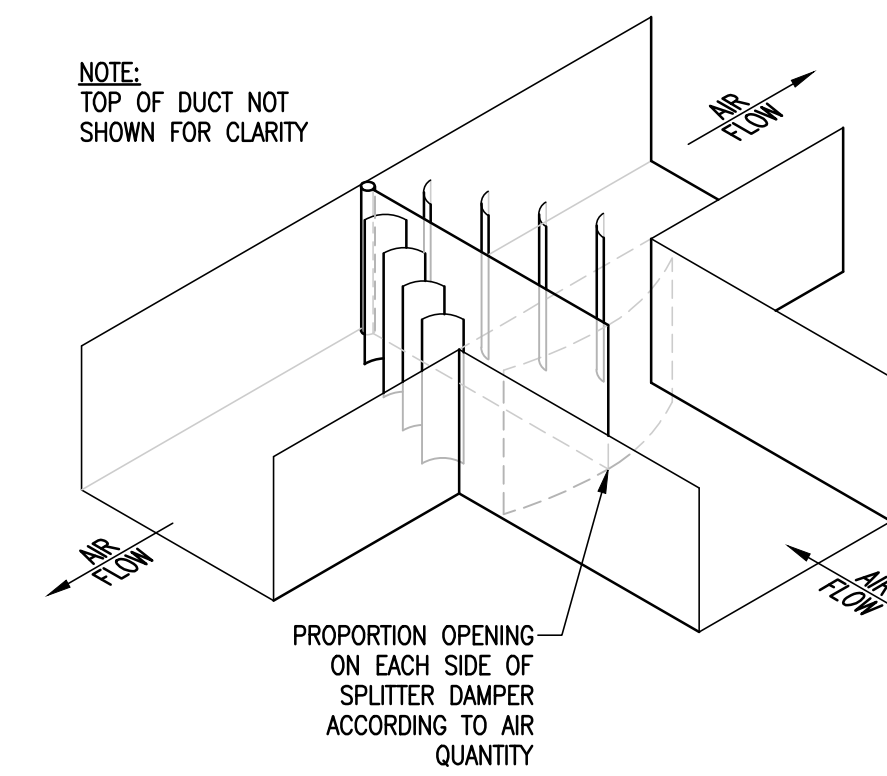
06 BRANCH CONNECTION DETAIL

SCALE: NOT TO SCALE



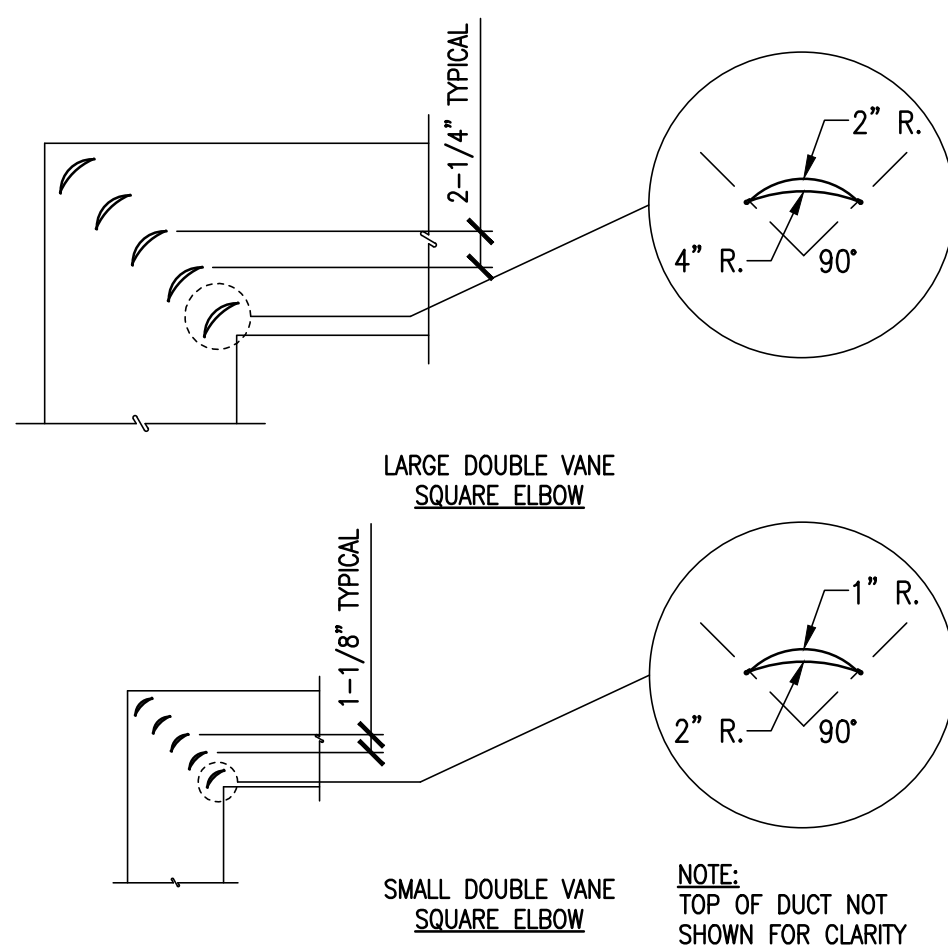
07 SDL-1 MECHANICAL ELEVATION (GYMNASIUM)

SCALE: NOT TO SCALE



08 TYPICAL SPLITTER DAMPER DETAIL

SCALE: NOT TO SCALE



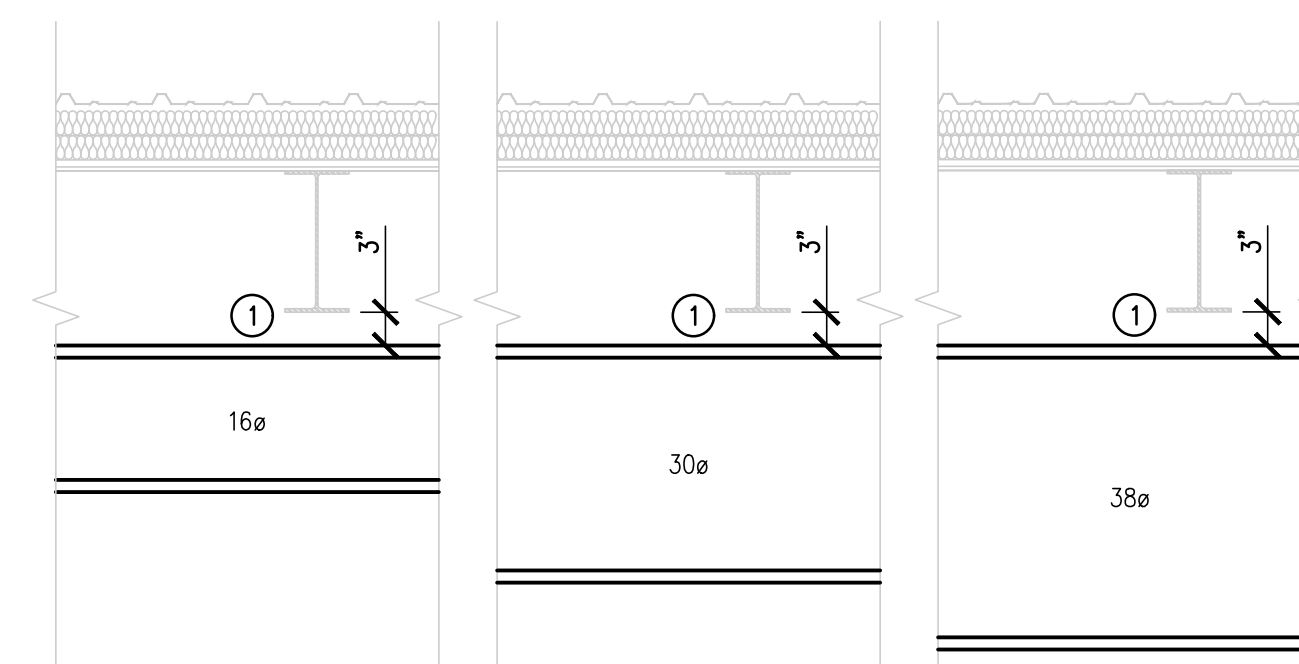
09 TYPICAL VANED DUCT ELBOWS DETAIL

SCALE: NOT TO SCALE



10 EXISTING FAN COIL UNITS

SCALE: NOT TO SCALE



KEYED NOTES

- ① EXPOSED DUCTWORK IN GYM TO BE MOUNTED AS HIGH AS ALLOWED BY STRUCTURAL MEMBERS AND ARCHITECTURAL ELEMENTS. DUCTWORK SHOULD MAINTAIN THIS TOP OF DUCT HEIGHT TO ALLOW THE MAXIMUM FREE SPACE BELOW.

11 GYM EXPOSED DUCT MOUNTING HEIGHTS

SCALE: NOT TO SCALE

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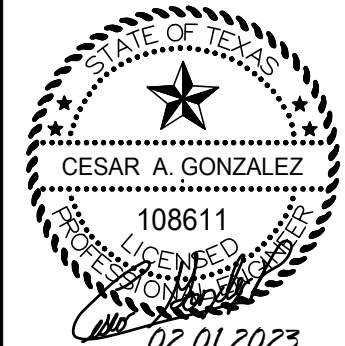
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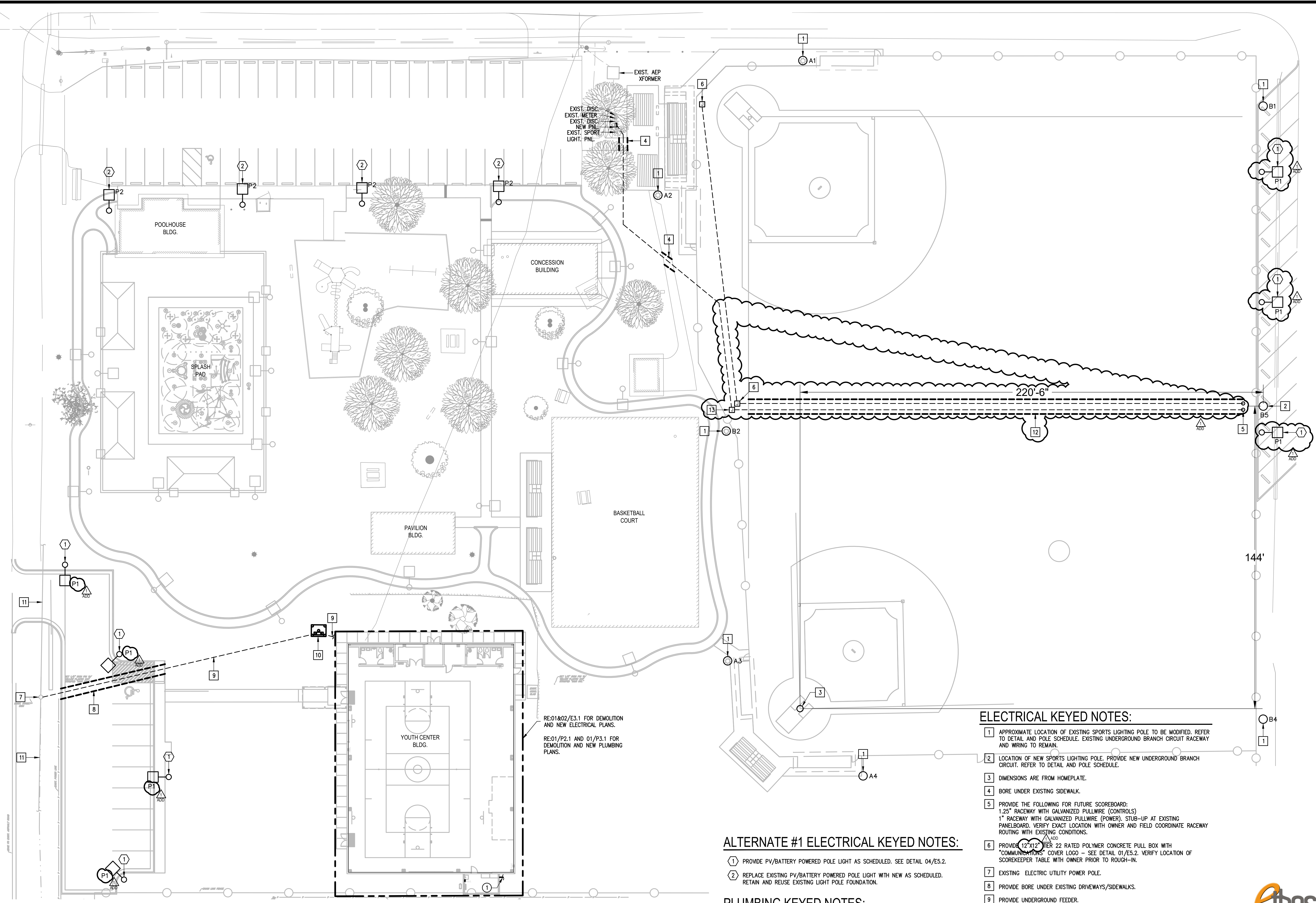


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EP1.1



RE:01&02/E3.1 FOR DEMOLITION AND NEW ELECTRICAL PLANS.
 RE:01/P2.1 AND 01/P3.1 FOR DEMOLITION AND NEW PLUMBING PLANS.

01 E.P. SITE PLAN
 SCALE: 1" = 20'-0"



ELECTRICAL KEYED NOTES:

- 1 APPROXIMATE LOCATION OF EXISTING SPORTS LIGHTING POLE TO BE MODIFIED. REFER TO DETAIL AND POLE SCHEDULE. EXISTING UNDERGROUND BRANCH CIRCUIT RACEWAY AND WIRING TO REMAIN.
- 2 LOCATION OF NEW SPORTS LIGHTING POLE. PROVIDE NEW UNDERGROUND BRANCH CIRCUIT. REFER TO DETAIL AND POLE SCHEDULE.
- 3 DIMENSIONS ARE FROM HOMEPLATE.
- 4 BORE UNDER EXISTING SIDEWALK.
- 5 PROVIDE THE FOLLOWING FOR FUTURE SCOREBOARD:
 1.25" RACEWAY WITH GALVANIZED PULLWIRE (CONTROLS)
 1" RACEWAY WITH GALVANIZED PULLWIRE (POWER). STUB-UP AT EXISTING PANELBOARD. VERIFY EXACT LOCATION WITH OWNER AND FIELD COORDINATE RACEWAY ROUTING WITH EXISTING CONDITIONS.
- 6 PROVIDE 12"x12" TIER 22 RATED POLYMER CONCRETE PULL BOX WITH "COMMUNICATIONS" COVER LOGO - SEE DETAIL 01/E5.2. VERIFY LOCATION OF SCOREKEEPER TABLE WITH OWNER PRIOR TO ROUGH-IN.
- 7 EXISTING ELECTRIC UTILITY POWER POLE.
- 8 PROVIDE BORE UNDER EXISTING DRIVEWAYS/SIDEWALKS.
- 9 PROVIDE UNDERGROUND FEEDER.
- 10 PROVIDE NEW ELECTRIC UTILITY PAD MOUNT TRANSFORMER CONCRETE PAD.
- 11 EXISTING ELECTRIC 3Ø UTILITY OVERHEAD SERVICE LINES.
- 12 BORE UNDER EXISTING FIELD. DO NOT TRENCH.
- 13 PROVIDE 12"x12" TIER 22 RATED POLYMER CONCRETE PULL BOX WITH "ELECTRICAL" COVER LOGO - SEE DETAIL 01/E5.2.

ALTERNATE #1 ELECTRICAL KEYED NOTES:

- 1 PROVIDE PV/BATTERY POWERED POLE LIGHT AS SCHEDULED. SEE DETAIL 04/E5.2.
- 2 REPLACE EXISTING PV/BATTERY POWERED POLE LIGHT WITH NEW AS SCHEDULED. RETAIN AND REUSE EXISTING LIGHT POLE FOUNDATION.

PLUMBING KEYED NOTES:

- 1 PROVIDE NEW 2" SANITARY SEWER LINE. SEE PLUMBING DRAWINGS FOR MORE DETAILS AND CIVIL DRAWINGS FOR CONNECTION AND CONTINUATION.

ABBREVIATIONS:

A	AMPS	EMS	ENERGY MANAGEMENT SYSTEM	MOCP	MAX. OVERCURRENT PROTECTION
ABC	ABOVE CEILING LINE	EXT.	EXTERNAL OR EXTERIOR	NTS	NOT TO SCALE
AC	ABOVE COUNTER BACKSPLASH	FACP	FIRE ALARM CONTROL PANEL	OA	OUTSIDE AIR
ACCU	AIR COOLED CONDENSING UNIT	FCU	FAN COIL UNIT	OAU	OUTSIDE AIR UNIT
AHU	AIR HANDLING UNIT	FD	FIRE DAMPER	P	POLE(S)
AFF	ABOVE FINISHED FLOOR	FS	FLAT SCREEN	PA	PUBLIC ADDRESS
ACB	ABOVE COUNTER BACKSPLASH	G.	GROUND	PH	PHASE
B.	BOTTOM	GA.	GAGE	RM.	ROOM
BLC.	BELOW CEILING LINE	GALV.	GALVANIZED	SS	STAINLESS STEEL
C.	CONDUIT OR COMMON	GRND.	GROUND	TSTAT	THERMOSTAT
CLG.	CEILING	HP	HORSEPOWER	UG	UNDERGROUND
COMB.	COMBINATION	HVAC	HEATING, VENTILATION, & AIR CONDITIONING	UNO	UNLESS OTHERWISE NOTED
COND.	CONDUIT			V	VOLTS
CU.	COPPER	IG	ISOLATED GROUND	VAV	VARIABLE AIR VOLUME
DDC	DIRECT DIGITAL CONTROLS	INT.	INTRUSION DETECTION	VFD	VARIABLE FREQUENCY DRIVE
DISC.	DISCONNECT	MECH	MECHANICAL	WACU	WALL AIR CONDITIONING UNIT
EDH	ELECTRIC DUCT HEATER	MS	MOTOR STARTER	W	WIRE
EF	EXHAUST FAN				

LIGHTING SYMBOL LEGEND:

SYMBOL	DESCRIPTION	MNTG. HT. UNO (SEE NOTE 1)
	2'X4' LIGHT FIXTURE - TYPE AS NOTED	----
	EMERGENCY 2'X4' LIGHT FIXTURE-TYPE AS NOTED CONNECT BATTERY PACK TO BE ON AT ALL TIMES (UNSWITCHED)	----
	SURFACE/WRAPAROUND LIGHT FIXTURE	----
	SURFACE/WRAPAROUND EMERGENCY LIGHT FIXTURE CONNECT BATTERY PACK TO BE ON AT ALL TIMES (UNSWITCHED)	----
	SINGLE FACE EXIT SIGN CEILING OR WALL MOUNTING (DIRECTIONAL ARROWS WHERE INDICATED)	12" ABV. EGRESS OPENING
	DOUBLE FACE EXIT SIGN CEILING OR WALL MOUNTING (DIRECTIONAL ARROWS WHERE INDICATED)	12" ABV. EGRESS OPENING
	EMERGENCY LIGHTING UNIT	8'-0" AFF
	WALL MOUNT LIGHT FIXTURE - TYPE AS NOTED	----
	HIGH BAY FIXTURE - TYPE AS NOTED	----

NOTES:

1.) REFERENCE LIGHT FIXTURE SCHEDULE FOR ALL MOUNTING HEIGHTS.

LIGHTING WIRING DEVICES SYMBOL LEGEND:

SYMBOL	DESCRIPTION	MNTG. HT. UNO (SEE NOTE 1)
	SINGLE POLE TOGGLE SWITCH - HUBBELL MODEL #HBL1221W (WHITE)	48" AFF
	VACANCY WALL SENSOR SWITCH - LUTRON MODEL #MS-OPS2-WH (CW-1-WH). CONTROLLED LIGHT FIXTURE	48" AFF
	1P TOGGLE SWITCH-THERMAL TYPE - SQUARE "D" CLASS 2510 W/ RED PILOT LIGHT & HANDLE GUARD/LOCK OFF	AS REQUIRED
	OUTDOOR PHOTO CELL WALL MOUNTED	----

NOTES:

1.) 48" AFF INDICATES TO TOP OF DEVICE;
ALL OTHER MOUNTING HEIGHTS REFER TO CENTERLINE OF DEVICE.

GENERAL SYMBOL LEGEND:

SYMBOL	DESCRIPTION	MNTG. HT. UNO (SEE NOTE 1)
	ELECTRICAL PANELBOARD - SURFACE MOUNTED	AS REQUIRED
	CONCEALED RACEWAY	AS REQUIRED

SPECIAL SYSTEMS SYMBOL LEGEND:

SYMBOL	DESCRIPTION	MNTG. HT. UNO (SEE NOTE 1)
	DATA OUTLET/VOICE OVER IP - PROVIDE BACK BOX WITH 1" RACEWAY STUBBED INTO ACCESSIBLE CLG. WITH PULL WIRE - SEE DETAIL. NUMBER INDICATES AMOUNT OF DATA DROPS.	18" AFF

NOTES:

1.) 48" AFF INDICATES TO TOP OF DEVICE;
ALL OTHER MOUNTING HEIGHTS REFER TO CENTERLINE OF DEVICE.

LUMINAIRE SCHEDULE

CALLOUT	LAMP	DESCRIPTION	DRIVER	MOUNTING	MODEL	INPUT WATTS	VOLTS	NOTE 1	LUMENS / LAMP	LUMENS MAINT.	HOURS
A2	LED	2'X4' LAY-IN INDIRECT TROFFER	0-10V	RECESSED	LITHONIA: 2BLT4 40L ADSM MVOLT GZ10 LP840 LSI: OPT24 LED FS1 4066LM UNV DIM	34	MULTIPLE		4032	L80	60,000
A2E	LED	2'X4' LAY-IN INDIRECT TROFFER	0-10V	RECESSED	LITHONIA: 2BLT4 40L ADSM MVOLT GZ10 LP840 EL14L LSI: OPT24 LED FS1 4066LM UNV DIM EM	34	MULTIPLE	PROVIDE WITH AN EMERGENCY BATTERY PACK.	4032	L80	60,000
D2	LED	4' WRAPAROUND	0-10V	SURFACE/ROD	LITHONIA: BLWP4 48L SDSM GZ10 LP840 WILLIAMS: 17-4-L55/840-AF-DIM-UNV	40	120V 1P 2W		5205	L90	50,000
D2E	LED	4' WRAPAROUND	0-10V	SURFACE/ROD	LITHONIA: BLWP4 48L SDSM GZ10 LP840 E10WLCF WILLIAMS: 17-4-L55/840-AF-EM/TOW-DIM-UNV	40	120V 1P 2W	PROVIDE WITH AN EMERGENCY BATTERY PACK.	5205	L90	50,000
E1	LED	EMERGENCY LIGHTING UNIT		WALL	LITHONIA: INDL SP2200L UVOLT LTP EHO SDRT ELA WG2M MULE: MP-M60-2-L15-D	20	120V 1P 2W	PROVIDE WITH A WIREGUARD, SELF-DIAGNOSTICS, LOAD DISCONNECT, & TIME DELAY.	2950		
H4	LED	15" ROUND HIGH BAY	0-10V	SURFACE	AEL: LUF0HB-14-4K-PRM-BLK-UNV LITHONIA: JEEL 12L 40K 80CRI WH	100	120V 1P 2W		13961	L70	141,000
H6	LED	15" ROUND HIGH BAY	0-10V	SURFACE	AEL: LUF0HB-21-4K-PRM-BLK-UNV LITHONIA: JEEL 18L 40K 80CRI WH	150	120V 1P 2W		20799	L70	141,000
ME	LED	WALLPACK	0-10V	SURFACE	LITHONIA: AFF OEL DDBTXD UVOLT LTP SDRT WT CW	11	MULTIPLE	PROVIDE UL LISTED FOR WET LOCATIONS AND WITH AN EMERGENCY BATTERY PACK. VERIFY FINISH WITH ARCHITECT PRIOR TO ORDERING.	635	L70	55,000
N	LED	WALLPACK	0-10V	SURFACE	LITHONIA: WDGE2 LED P4 40K 80CRI VF MVOLT DDBXD RAYON: T630LEDB 45 UN12 40 T3 BZ G2	50	MULTIPLE	PROVIDE UL LISTED FOR WET LOCATIONS. VERIFY FINISH WITH ARCHITECT PRIOR TO ORDERING.	6000	L80	50,000
P1	LED	LED SOLAR AREA LIGHT		POLE	ROMANSO: RMS-H210460 POLE: ENERGY LIGHT INC H18A5RS125 8.3" X 6.3" X 3.5"	60	MULTIPLE	PROVIDE FIXTURE UL LISTED FOR WET LOCATIONS AND WITH A MOTION SENSOR & TIME CONTROLLER TOGETHER. POLE SHALL BE 18" ROUND STRAIGHT ALUMINUM & RATED FOR 138MPH WINDS. PROVIDE POLE WITH A VIBRATION DAMPER. STANDARD COLOR FINISH TO BE SELECTED AT A LATER DATE. COLOR TEMPERATURE 57K. 5 YEARS OF WARRANTY.	10594	LM-70	50,000
P2	LED	LED SOLAR AREA LIGHT		POLE	ROMANSO: RMS-H210460 POLE: ENERGY LIGHT INC H18A5RS125 39" X 20.47" X 12.48"	80	MULTIPLE	PROVIDE FIXTURE UL LISTED FOR WET LOCATIONS AND WITH A MOTION SENSOR & TIME CONTROLLER TOGETHER. POLE SHALL BE 18" ROUND STRAIGHT ALUMINUM & RATED FOR 138MPH WINDS. PROVIDE POLE WITH A VIBRATION DAMPER. STANDARD COLOR FINISH TO BE SELECTED AT A LATER DATE. COLOR TEMPERATURE 57K. 5 YEARS OF WARRANTY.	15110	LM-70	50,000
S	LED	WRAPAROUND	0-10V	SURFACE	VENTURE: VP4-40NA-BF1 BEGHELLI: BS101LED 4 HT LO WT40 120-277V SS TPS	50	120V 1P 2W	PROVIDE UL LISTED FOR DAMP LOCATIONS AND PROVIDE CORNER MOUNT BRACKET. PROVIDE LIGHT GRAY FINISH TO MATCH PHASE 1.	6318	L70	60,000

GENERAL NOTES:

1. OTHER LIGHT FIXTURE MANUFACTURERS THAN THOSE LISTED ON THIS SCHEDULE ARE REQUIRED TO OBTAIN PRIOR APPROVAL BY SUBMITTING CUT SHEETS OF THEIR SUBSTITUTIONS AT LEAST (10) DAYS PRIOR TO BID. CUT SHEETS SHALL INDICATE/HIGHLIGHT PHOTOMETRIC CURVE, EFFICIENCY & CONSTRUCTION FOR DIRECT COMPARISON WITH SPECIFIED FIXTURES.
2. EXTRA MATERIALS: SEE SPECIFICATIONS.
3. EMERGENCY BATTERY PACKS SHALL BE COMPLETE FACTORY INSTALLED WITH NI-CAD BATTERY, CHARGER INDICATING LIGHT, ELECTRONIC CIRCUITRY, 1400 LUMENS OUTPUT, 90 MINUTES DURATION & FIVE FULL YEARS WARRANTY.



01 TYPE A2, A2E, A3, A3E
SCALE: NOT TO SCALE



02 TYPE D2, D2E
SCALE: NOT TO SCALE



03 TYPE H4, H6
SCALE: NOT TO SCALE



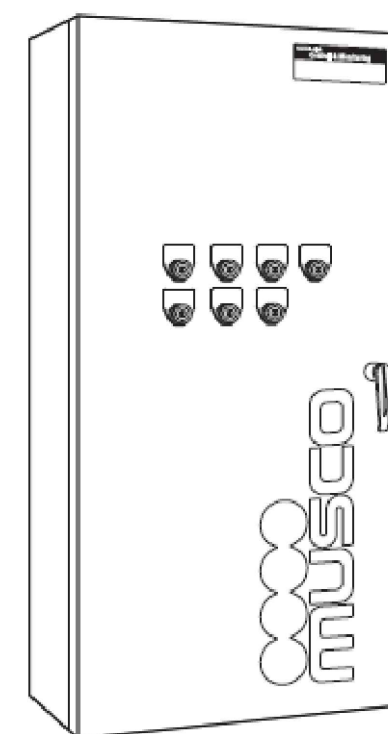
04 TYPE ME, N
SCALE: NOT TO SCALE



05 TYPE S
SCALE: NOT TO SCALE



06 TYPE P1 & P2
SCALE: NOT TO SCALE



07 MUSCO CONTROL-LINK CONTACTOR CABINET IMAGE
SCALE: NOT TO SCALE



08 TYPE E1
SCALE: NOT TO SCALE



09 WALL SENSOR SWITCH MODEL #MS-OPS6-WH
SCALE: NOT TO SCALE

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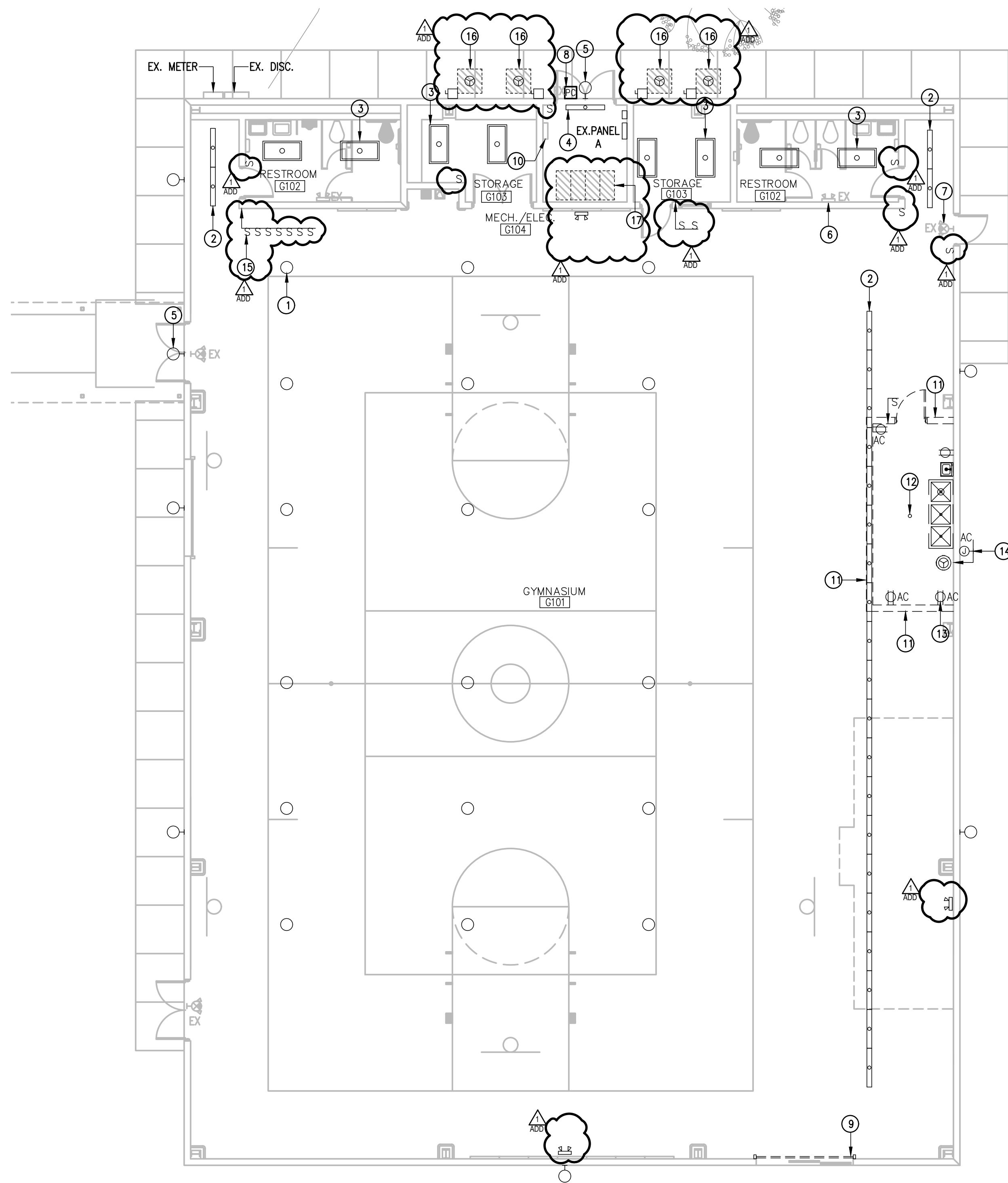
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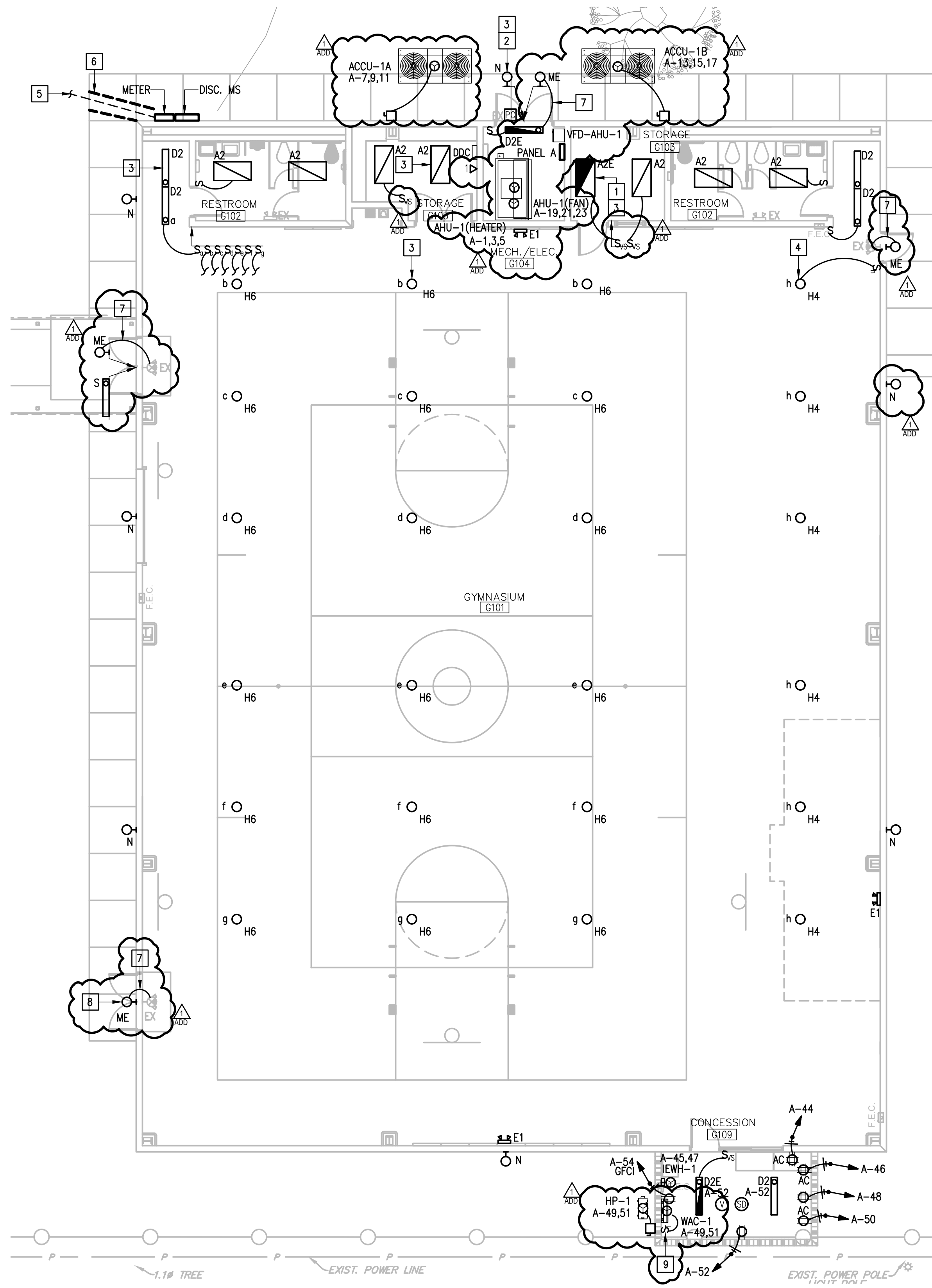
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Date: FEBRUARY 01, 2022
Scale: As Noted
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01 GYMNASIUM DEMOLITION PLAN
SCALE: 1/8" = 1'-0"
NORTH



02 GYMNASIUM LIGHTING & ELECTRICAL PLAN
SCALE: 1/8" = 1'-0"
NORTH

DEMOLITION GENERAL NOTES:

- REFER TO ARCHITECTURAL SPECIFICATIONS FOR PHASING REQUIREMENTS.
- THE EXTENT OF DEMOLITION WORK IS INDICATED ON THE ARCHITECTURAL DRAWINGS AND BY THE REQUIREMENTS OF THIS SECTION. A VISIT TO THE SITE IS REQUIRED TO PROPERLY BID THE DEMOLITION WORK.
- REMOVED MATERIALS SHALL BELONG TO OWNER. DELIVER THEM TO OWNERS DESIGNATED LOCATION. IF OWNER DOES NOT WANT THE REMOVED MATERIALS THEN REMOVE THEM FROM SITE & PROPERLY DISPOSE OF THEM.
- IF REMOVAL OF EXISTING ELECTRICAL SYSTEMS RENDERS EXISTING ELECTRICAL SYSTEMS DOWNSTREAM TO REMAIN INOPERABLE, PROVIDE J-BOXES, CONDUIT WIRING AND SPLICES ABOVE ACCESSIBLE CEILINGS IN ORDER TO CONTINUE OPERATION.
- REFER TO ARCHITECTURAL DEMOLITION DRAWINGS FOR WALL AND CEILINGS TO BE REMOVED.
- ITEMS DESIGNATED WITH AN "EX" ARE EXISTING TO REMAIN AS IS.
- PRIOR TO DEMOLITION, IN CEILINGS SCHEDULED TO BE REMOVED AND (OR) REPLACED FOR NEW WORK, PREPARE REFLECTED CEILING PLAN SKETCH SHOWING LOCATIONS OF ALL CEILING COMPONENTS AND DEVICES TO BE RE-USED INCLUDING BUT NOT LIMITED TO:
 - LIGHT FIXTURES
 - SPEAKERS
 - WIRELESS ACCESS POINTS
 - FIRE ALARM DEVICES
 - ETC.
 IF ANY OF THE ABOVE ITEMS ARE IN NON-WORKING CONDITION, SUBMIT A WRITTEN REPORT TO OWNER/ARCHITECT. TEMPORARY SUPPORT AND/OR REMOVAL OF THESE SYSTEMS SHALL BE PROVIDED FOR NEW WORK.
- PROVIDE BLANK COVERPLATE FOR UNUSED BACKBOXES.

DEMOLITION KEYED NOTES:

- DISCONNECT AND REMOVE EXISTING HIGH BAY LIGHT FIXTURE TO BE REPLACED - TYPICAL.
- DISCONNECT AND REMOVE EXISTING SUSPENDED LINEAR LIGHT FIXTURE TO BE REPLACED - TYPICAL.
- DISCONNECT AND REMOVE EXISTING TROFFER LIGHT FIXTURE TO BE REPLACED - TYPICAL.
- DISCONNECT AND REMOVE EXISTING WALL MOUNTED LINEAR LIGHT FIXTURE TO BE REPLACED.
- DISCONNECT AND REMOVE EXISTING WALL MOUNTED EXTERIOR LIGHT FIXTURE TO BE REPLACED - TYPICAL.
- EXISTING EMERGENCY LIGHT FIXTURE TO REMAIN AS IS - TYPICAL.
- EXISTING EXIT SIGN FIXTURE TO REMAIN AS IS - TYPICAL.
- EXISTING PHOTOCELL TO REMAIN AS IS.
- DISCONNECT AND REMOVE OVERHEAD DOOR CONTACT ALONG WITH RELATED RACEWAY, WIRING AND SUPPORT HARDWARE.
- APPROXIMATE LOCATION OF EXISTING FIRE LITE ALARMS BY HONEYWELL MODEL "MS-9050UD" ADDRESSABLE FIRE ALARM CONTROL PANEL.
- DISCONNECT AND REMOVE ANY AND ALL LIGHTING, ELECTRICAL AND SPECIAL SYSTEMS ALONG WITH RELATED RACEWAYS, WIRING AND SUPPORT HARDWARE LOCATED ON WALLS TO BE REMOVED - TYPICAL.
- DISCONNECT AND REMOVE EXISTING CEILING MOUNTED LIGHT FOR REMOVAL.
- DISCONNECT AND REMOVE EXISTING RECEPTACLE ALONG WITH RELATED RACEWAY, WIRING AND SUPPORT HARDWARE - TYPICAL.
- DISCONNECT EXISTING WATER HEATER FOR REMOVAL ALONG WITH RELATED RACEWAY, WIRING AND SUPPORT HARDWARE.
- DISCONNECT AND REMOVE EXISTING SWITCH. EXISTING LIGHTING CIRCUIT AND SWITCH LEG TO BE REUSED.
- DISCONNECT EXISTING HVAC EQUIPMENT FOR REMOVAL ALONG WITH RELATED DISCONNECT, RACEWAY, WIRING, SUPPORT HARDWARE, ETC.
- DISCONNECT EXISTING HVAC EQUIPMENT FOR REMOVAL ALONG WITH RELATED RACEWAY, WIRING, SUPPORT HARDWARE, ETC.

GENERAL NOTES:

- LIGHTING BRANCH CIRCUIT HOMERUNS SHALL BE 3/4" - 2#12 & #12G. 20A/120V HOMERUNS EXCEEDING 200FT THE WIRE SIZE SHALL BE #10 & #8 FOR 275'.
- INTERIOR LIGHTING CONTROLS ARE EXISTING TO REMAIN.
- EXTERIOR LIGHTING CONTROLS SHALL BE BY EXISTING PHOTOCELL.
- EACH 20A/1P BRANCH CIRCUIT SHALL HAVE A DEDICATED NEUTRAL.
- IF NEW DEVICES ARE TO BE INSTALLED ON EXISTING WALLS; PROVIDE SURFACE MOUNTED METAL RACEWAYS AND BOXES (WIREMOLD).

KEYED NOTES:

- CONNECT EMERGENCY BATTERY PACK TO BE CHARGING AT ALL TIMES (UNSWITCHED). LIGHT FIXTURE SHALL BE OPERATED BY THE CORRESPONDING SWITCH - TYPICAL.
- PROVIDE NEW UNSWITCHED HOT WIRE FROM EXISTING LIGHTING CIRCUIT FOR INTEGRAL EMERGENCY BATTERY.
- CONNECT TO AN EXISTING ROOM CIRCUIT - TYPICAL.
- PROVIDE NEW LIGHT FIXTURE TYPE "H4".
- PROVIDE UNDERGROUND FEEDER.
- BORE UNDER EXISTING SIDEWALK.
- CONNECT NEW FIXTURE TYPE "ME" TO EXISTING EXIT/EMERGENCY LIGHT CIRCUIT IN THE VICINITY.
- MOUNT LIGHT FIXTURE TYPE "ME" AT 12" ABOVE TOP OF DOOR - TYPICAL
- MOUNT THERMAL SWITCH AT 90" AFF.

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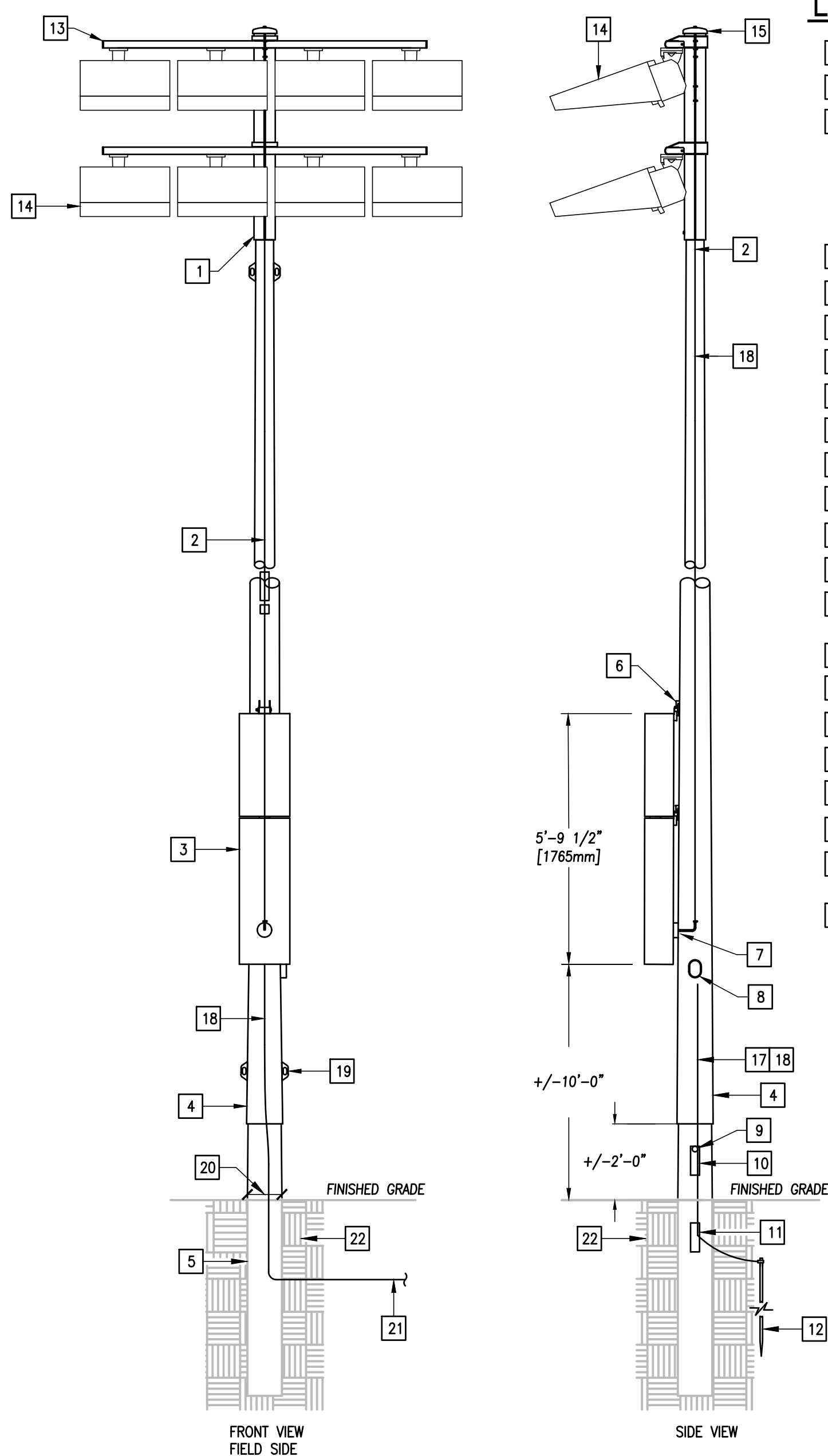
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LIGHT POLE DETAIL KEYED NOTES:

- 1 POLETOP LUMINAIRE ASSEMBLY.
- 2 PROVIDE WIRE HARNESS.
- 3 PROVIDE ELECTRICAL COMPONENTS ENCLOSURES
 - a. DRIVERS
 - b. CAPACITORS
 - c. SMART LAMP CONTROL
 - d. FUSING
 - e. PRIMARY LANDING LUGS
 - f. ONE DISCONNECT PER CIRCUIT
 - g. PER LIGHT-STRUCTURE GREEN SYSTEM
 - h. GROUNDING LUG
- 4 PROVIDE GALVANIZED STEEL POLE (1, 2, 3, OR 4 SECTIONS).
- 5 PRECAST CONCRETE BASE (CENTRIFUGALLY SPUN PRESTRESSED).
- 6 ATTACHMENT BRACKET.
- 7 WIRE ACCESS HUB.
- 8 HANDHOLE WITH GROUNDING LUG ACCESS.
- 9 LIFTING BAR HOLE.
- 10 ABOVE GROUND ACCESS HOLE.
- 11 UNDERGROUND ACCESS HOLE.
- 12 PROVIDE 3/4" X 10' GROUNDING ROD.
- 13 PROVIDE HOT DIP GALVANIZED CROSS ARM WITH CONCEALED WIRING.
- 14 EACH LIGHT FIXTURE SHALL BE INDIVIDUALLY FUSED. SEE POLE SCHEDULE FOR NUMBER OF LIGHT FIXTURES AT EACH POLE.
- 15 REMOVABLE POLE CAP.
- 16 NOT USED.
- 17 PROVIDE #2 GROUND WIRE.
- 18 PROVIDE WIRING INSIDE POLE - TYP.
- 19 JACKING EAR.
- 20 POLE DIAM. AT BASE. COORDINATE W/ SUPPLIER.
- 21 PROVIDE SPORTS LIGHTING ELECTRICAL RACEWAY TO POWER SOURCE SEE SHEET SITE PLAN.
- 22 PROVIDE CONCRETE BACKFILL ALL AROUND POLE PER POLE MANUF. RECOMMENDATIONS.

NORTH FIELD ILLUMINATION SUMMARY

MAINTAINED HORIZONTAL FOOTCANDLES		
	Infield	Outfield
Guaranteed Average:	50	30
Scan Average:	52.82	31.39
Maximum:	64	47
Minimum:	38	19
Avg / Min:	1.40	1.64
Guaranteed Max / Min:	2	2.5
Max / Min:	1.70	2.48
UG (adjacent pts):	1.41	1.72
UG:	0.73	
No. of Points:	25	71

LUMINAIRE INFORMATION
Applied Circuits: A
No. of Luminaires: 15
Total Load: 16.99 kW

SOUTH FIELD ILLUMINATION SUMMARY

MAINTAINED HORIZONTAL FOOTCANDLES		
	Infield	Outfield
Guaranteed Average:	50	30
Scan Average:	50.27	32.56
Maximum:	64	47
Minimum:	40	20
Avg / Min:	1.25	1.67
Guaranteed Max / Min:	2	2.5
Max / Min:	1.60	2.42
UG (adjacent pts):	1.26	1.58
UG:	0.73	
No. of Points:	25	67

LUMINAIRE INFORMATION
Applied Circuits: B
No. of Luminaires: 15
Total Load: 16.4 kW

SPORTS LIGHTING - POLE SCHEDULE

DESIG	POLE HT.	MOUNTING HT.	NO. OF FIXTURES "SL1"	NO. OF FIXTURES "SL2"	NO. OF FIXTURES "SL3"	NO. OF DRIVERS	NOTES	CONTRACTOR I.D. /AMPS/ZONE
SOFTBALL FIELD								
A1	60 FT	60 FT	2	1	-	3	1	C1/30/1
A2	60 FT	60 FT	2	1	-	3	1	C2/30/1
A3	60 FT	60 FT	2	1	-	3	1	C5/30/3
A4	60 FT	60 FT	2	1	-	3	1	C6/30/2
B1	70 FT	70 FT	5	-	-	5	1	C3/30/1
B2	70 FT	70 FT	4	-	-	4	1	C4/30/1
B3	70 FT	70 FT	3	-	-	1	4	C7/30/2
B4	70 FT	70 FT	5	-	-	5	1	C8/30/2
B5	70 FT	70 FT	5	-	-	5	2	C10/30/4

- NOTES:
1. EXISTING SPORTS LIGHTING POLE.
2. NEW SPORTS LIGHTING POLE.

POLE CONNECTION SCHEDULE:

POLE ID	FLA	OCF	VOLTAGE/PHASE	APPROX. DIST. (FT)	%VD	BRANCH CIRCUIT
B5	10.5	20	480V/3PH	450	2.15	1" - 3#10 & #10G

- GENERAL NOTES:
1. FEEDER DISTANCES ARE FOR VOLTAGE DROP CALCULATIONS ONLY, NOT FOR BIDDING PURPOSES.
2. DON'T SPICE WIRING BELOW GRADE. PROVIDE ABOVE GRADE CAST ALUMINUM BOXES AT POLE BASE.
3. PROVIDE PULLBOXES AS REQUIRED, SIZE PER NEC. PROVIDE WHERE REQUIRED FOR PULLING NEEDED.

FEEDER SCHEDULE:

FEEDER AMPS	CONDUIT AND FEEDER	FEEDING THESE DEVICES
400	4" - 4#600KCMIL	METER
400	4" - 4#600KCMIL & #3G	A, DISC. MS

SIZING METHOD: COPPER 75°C

SPORTS LIGHTING FIXTURE SCHEDULE

Type	Model	Source	Wattage	Lumens
SL1	MUSCO: TLC-LED-1200	LED 5700K - 75 CRI	1170W	136,000
SL2	MUSCO: TLC-LED-900	LED 5700K - 75 CRI	890W	89,600
SL3	MUSCO: TLC-LED-600	LED 5700K - 75 CRI	580W	65,600

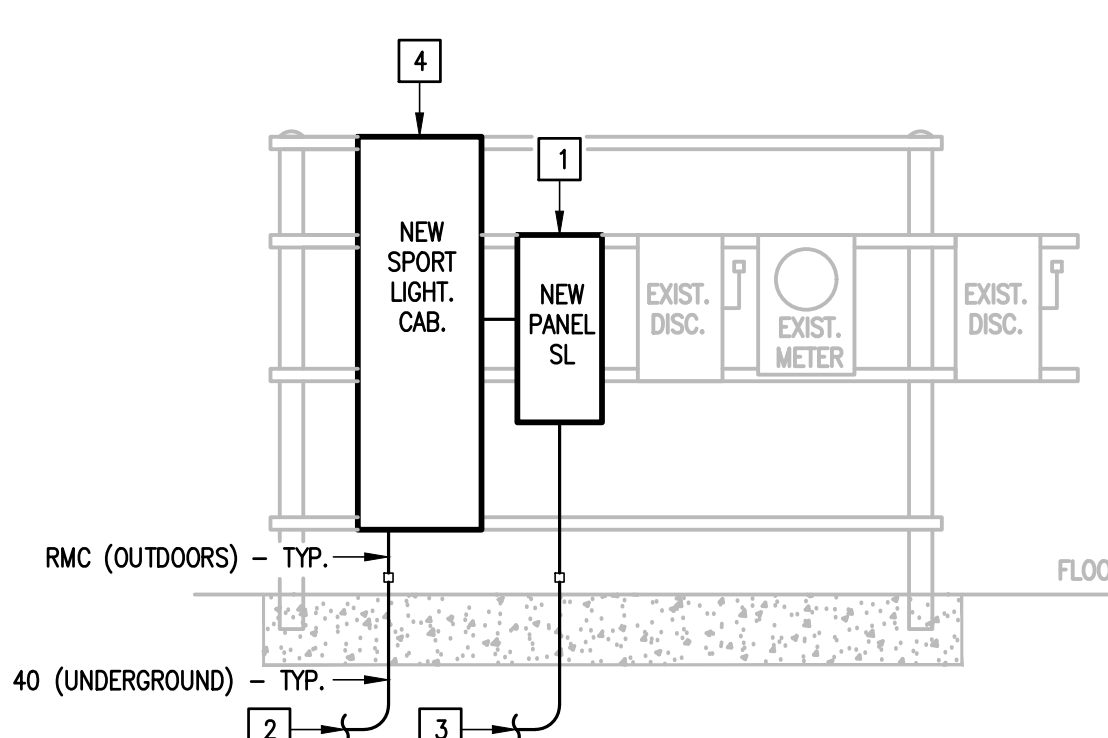
EQUIPMENT CONNECTION SCHEDULE:

DESIGN	HP/KW	FLA	MCA	MOCP	VOLTAGE	DISCONNECT	BRANCH CIRCUIT (75°C COPPER)
IEWH-1	13.9 KW	57.9	-	80	240V/1PHASE	1) CIRCUIT BREAKER.	1" - 2#4 & #8G
WAC-1	-	-	-	-	240V/1PHASE	3) 4) THERMAL SWITCH.	1/2" - 2#12 & #12G
HP-1	-	-	9	15	240V/1PHASE	30A, 2PNF, 240V, N3R	1/2" - 2#12 & #12G
ALTERNATE #2:							
IEWH-1	13.1 KW	62.9	-	80	208V/1PHASE	1) CIRCUIT BREAKER.	1" - 2#4 & #8G
WAC-1	-	-	-	-	208V/1PHASE	3) 4) THERMAL SWITCH.	1/2" - 2#12 & #12G
HP-1	-	-	9	15	208V/1PHASE	30A, 2PNF, 240V, N3R	1/2" - 2#12 & #12G
AHU-1(FAN)	15 HP	46.2	57.7	125	208V/3PHASE	2) VARIABLE FREQUENCY DRIVE.	1.25" - 3#1 & #6G
AHU-1(HEATER)	60 KW	166.6	208.3	225	208V/3PHASE	5) NONE.	2" - 3#4/0 & #4G
ACCU-1A	-	-	98	125	208V/3PHASE	200A, 3PNF, 240V, N3R	1.25" - 3#1 & #6G
ACCU-1B	-	-	98	125	208V/3PHASE	200A, 3PNF, 240V, N3R	1.25" - 3#1 & #6G

- 1) PROVIDE LOCK SAFE CIRCUIT BREAKER PER NEC 110.25.
2) PROVIDE BY DIV. 23. INSTALLED AND CONNECTED BY DIV. 26.
3) EATON MANUAL STARTER "MS" SERIES.
4) OBTAIN POWER FROM HP-1.
5) MEANS OF DISCONNECT IS THE CIRCUIT BREAKER (WITHIN SIGHT).

ELECTRICAL RISER DIAGRAM KEYED NOTES:

- 1 EXISTING ELECTRIC UTILITY POLE.
- 2 NEW PAD MOUNTED UTILITY TRANSFORMER. PROVIDE NEW CONCRETE PAD AS PER DETAIL.
- 3 PROVIDE NEW FEEDER, DISCONNECT AND REMOVE EXISTING REFER TO FEEDER SCHEDULE - TYPICAL.
- 4 DISCONNECT AND REMOVE EXISTING SERVICE DISCONNECT FOR REPLACEMENT. COORDINATE WITH OWNER AND AEP FOR TEMPORARY SERVICE DISCONNECTION.
- 5 PROVIDE FUSED DISCONNECT, 400A, 3P3F, 400AF, S/N, NEMA 3R ENCLOSURE.
- 6 ELECTRIC UTILITY METER.
- 7 COORDINATE ELECTRICAL SERVICE UPGRADE TO A 120/208V, 3Ø, 4-WIRE SYSTEM WITH AEP.
- 8 NOT USED.
- 9 NEW ELECTRIC UTILITY UNDERGROUND SECONDARY.
- 10 EXISTING SQUARE D 400A, 120/240V, 1Ø, 3-WIRE PANELBOARD "A" TO BE REPLACED. TEMPORARILY DISCONNECT FEEDER AND BRANCH CIRCUITS FOR THE REMOVAL OF EXISTING PANELBOARD. PROVIDE NEW PANEL AND FEEDER AS PER SCHEDULE. TERMINATE EXISTING TO REMAIN BRANCH CIRCUITS TO NEW PANEL.
- 11 DISCONNECT AND REMOVE EXISTING EATON 125A, 120/240V, 1Ø PANELBOARD ALONG WITH RELATED RACEWAY, WIRING, AND SUPPORT HARDWARE.
- 12 PROVIDE NEW #1/0 GROUNDING ELECTRODE CONDUCTOR IN 3/4" RACEWAY TO EXISTING GROUND ROD.
- 13 PROVIDE CONTINUOUS DETECTABLE UNDERGROUND WARNING TAPE.
- 14 PROVIDE 4" PVC CONDUIT. PROVIDE LONG SWEEP RADIUS ELBOWS.



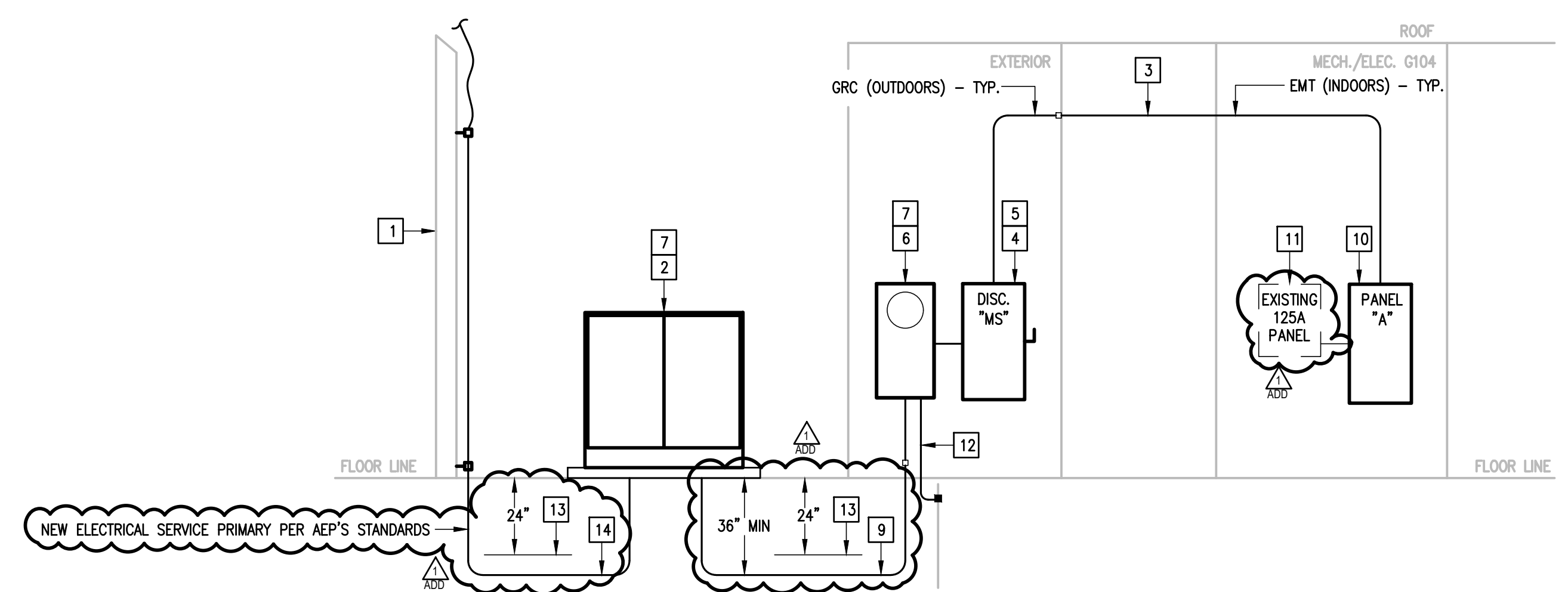
ELECTRICAL RISER DIAGRAM KEYED NOTES:

- 1 EXISTING EATON 225A, 480/277V, 3Ø, 4-WIRE, N3R PANELBOARD TO BE REPLACED. TEMPORARILY DISCONNECT FEEDER AND BRANCH CIRCUITS FOR THE REMOVAL OF EXISTING PANELBOARD. PROVIDE NEW PANEL AS PER SCHEDULE. TERMINATE FEEDER AND BRANCH CIRCUITS TO NEW PANEL.
- 2 PROVIDE SPORTS LIGHTING BRANCH CIRCUIT TO NEW POLE "B5". SEE SITE PLAN AND SCHEDULES.
- 3 PROVIDE FUTURE SCOREBOARD RACEWAY WITH GALVANIZED PULLWIRE. SEE SITE PLAN.
- 4 EXISTING SPORTS LIGHTING CONTROL CABINET TO BE REPLACED. TEMPORARILY DISCONNECT BRANCH CIRCUITS FOR THE REMOVAL OF EXISTING CABINET. PROVIDE NEW AS PER SCHEDULE. TERMINATE SPORTS LIGHTING BRANCH CIRCUITS TO NEW SPORTS LIGHTING CONTROL CABINET.

EXTERIOR ELECTRICAL RACK ELECTRICAL RISER DIAGRAM

SCALE: NONE

01 TYPICAL NEW SPORTS LIGHTING LIGHT POLE DETAIL
SCALE: NOT TO SCALE



02 YOUTH CENTER ELECTRICAL RISER DIAGRAM

SCALE: NONE

REVISIONS

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F-15998

SL											
ROOM		OUTDOORS		VOLTS 480Y/277V 3P 4W				AIC 22,000			
MOUNTING SURFACE		BUS AMPS 225				MAIN BKR MLO					
FED FROM UTILITY		NEUTRAL 100%				LUGS STANDARD					
NOTE PROVIDE A TYPE WRITTEN AS BUILT DIRECTORY.											
CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA			CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA		
			A	B	C				A	B	C
1	40/3	EXISTING LOAD	0			2	40/3	EXISTING LOAD	0		
3			0	0		4			0	0	
5						6					0
7	20/3	EXISTING LOAD	0			8	20/3	EXISTING LOAD	0		
9						10			0	0	
11						12					0
13	20/3	EXISTING LOAD	0			14	20/3	EXISTING LOAD	0		
15						16			0	0	
17						18					0
19	30/3	EXISTING LOAD	0			20	20/2	EXISTING LOAD	0		
21						22			0	0	
23						24	20/1	SPACE			0
25	20/3	POLE B5	2.91			26	20/1	SPACE	0		
27				2.91		28	20/1	SPACE		0	
29					2.91	30	20/1	SPACE			0
31	20/1	SPACE	0			32	20/1	SPACE	0		
33	20/1	SPACE			0	34	20/1	SPACE		0	
35	20/1	SPACE			0	36	20/1	SPACE			0
37	20/1	SPACE	0			38	20/1	SPACE	0		
39	20/1	SPACE			0	40	20/1	SPACE		0	
41	20/1	SPACE			0	42	20/1	SPACE			0
TOTAL CONNECTED KVA BY PHASE									2.91	2.91	2.91
			CONN KVA	CALC KVA					CONN KVA	CALC KVA	
LIGHTING			8.73	10.9	(125%)	TOTAL LOAD			10.9		
						BALANCED 3-PHASE LOAD			13.1 A		

1. PROVIDE NEMA 3R OUTDOOR ENCLOSURE.

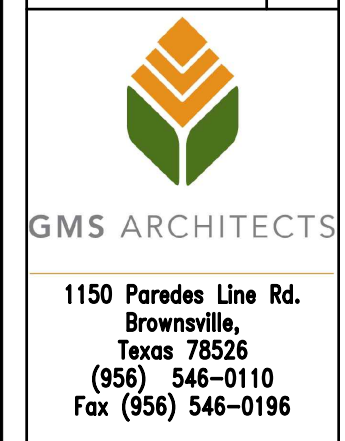
A (ALTERNATE #2)											
ROOM		MECH/ELEC. G104		VOLTS 208Y/120V 3P 4W				AIC 14,000			
MOUNTING SURFACE		BUS AMPS 400				MAIN BKR MLO					
FED FROM UTILITY		NEUTRAL 100%				LUGS STANDARD					
NOTE PROVIDE A TYPE WRITTEN AS BUILT DIRECTORY THAT INCLUDES ROOM NUMBERS.											
CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA			CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA		
			A	B	C				A	B	C
1	225/3	AHU-1(HEATER)	20			2	20/1	EXISTING LOAD	0		
3				20		4	20/1	EXISTING LOAD		0	
5					20	6	20/1	EXISTING LOAD			0
7	125/3	ACCU-1A	11.8			8	20/1	EXISTING LOAD	0		
9					11.8	10	20/1	EXISTING LOAD			
11						12	20/1	EXISTING LOAD			0
13	125/3	ACCU-1B	11.8			14	20/1	EXISTING LOAD	0		
15					11.8	16	20/1	EXISTING LOAD			
17						18	25/1	EXISTING LOAD			0
19	125/3	AHU-1(FAN)	5.82			20	20/1	EXISTING LOAD	0		
21					5.82	22	20/1	EXISTING LOAD		0	
23						24	20/1	EXISTING LOAD			0
25	30/1	EXISTING LOAD	0			26	20/1	EXISTING LOAD	0		
27	20/1	EXISTING LOAD			0	28	20/1	EXISTING LOAD		0	
29	20/1	EXISTING LOAD			0	30	20/1	EXISTING LOAD			0
31	20/1	EXISTING LOAD	0			32	20/1	EXISTING LOAD	0		
33	20/1	EXISTING LOAD			0	34	20/1	EXISTING LOAD		0	
35	20/1	EXISTING LOAD			0	36	20/1	EXISTING LOAD			0
37	20/1	EXISTING LOAD	0			38	20/1	EXISTING LOAD	0		
39	20/1	EXISTING LOAD			0	40	20/1	EXISTING LOAD		0	
41	20/1	EXISTING LOAD			0	42	20/1	EXISTING LOAD			0
43	20/1	EXISTING LOAD	0			44	20/1	RECEPT.	0.36		
45	80/2	IEWH-1			6.5	46	20/1	RECEPT.		0.36	
47						48	20/1	RECEPT.			0.36
49	15/2	HP-1, WAC-1	0.95			50	20/1	RECEPT.	0.18		
51					0.95	52	20/1	LIGHTING, RECEPT.			0.18
53	20/1	SPACE			0	54	20/1	RECEPT.			0.18
55	20/1	SPACE	0			56	20/1	SPACE	0		
57	20/1	SPACE			0	58	20/1	SPACE		0	
59	20/1	SPACE			0	60	20/1	SPACE			0
TOTAL CONNECTED KVA BY PHASE									50.8	57.4	56.4
			CONN KVA	CALC KVA					CONN KVA	CALC KVA	
LIGHTING			0.08	0.1	(125%)	RECEPTACLES			1.62	1.62	(50%>10)
LARGEST MOTOR			35.3	8.83	(25%)	NONCONTINUOUS			13	13	(100%)
MOTORS			88.1	88.1	(100%)	HEATING			60	60	(100%)
						COOLING			1.9	0	(0%)
						TOTAL LOAD			172		
						BALANCED 3-PHASE LOAD			476 A		

GENERAL NOTE: EXISTING SQUARE D 400A, 120/240V, 1φ, 3-WIRE PANELBOARD "A" TO BE REPLACED. TEMPORARILY DISCONNECT FEEDER AND BRANCH CIRCUITS FOR THE REMOVAL OF EXISTING PANELBOARD. PROVIDE NEW PANEL AND FEEDER AS PER SCHEDULE. TERMINATE EXISTING TO REMAIN BRANCH CIRCUITS TO NEW PANEL.

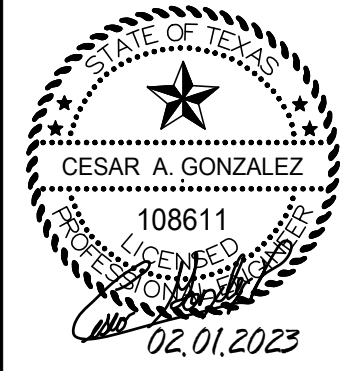
A (BASE BID)											
ROOM		MECH/ELEC. G104		VOLTS 240/120V 2P 3W				AIC 14,000			
MOUNTING SURFACE		BUS AMPS 400				MAIN BKR MLO					
FED FROM UTILITY		NEUTRAL 100%				LUGS STANDARD					
NOTE PROVIDE A TYPE WRITTEN AS BUILT DIRECTORY THAT INCLUDES ROOM NUMBERS.											
CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA		CKT #	CKT BKR	CIRCUIT DESCRIPTION	LOAD KVA			
			A	B				A	B		
1	20/2	EXISTING LOAD	0		2	20/1	EXISTING LOAD	0			
3				0	4	20/1	EXISTING LOAD		0		
5	60/2	EXISTING LOAD	0		6	20/1	EXISTING LOAD	0			
7					8	20/1	EXISTING LOAD		0		
9	60/2	EXISTING LOAD	0		10	20/1	EXISTING LOAD	0			
11					12	20/1	EXISTING LOAD		0		
13	20/2	EXISTING LOAD	0		14	20/1	EXISTING LOAD	0			
15					16	20/1	EXISTING LOAD		0		
17	60/2	EXISTING LOAD	0		18	25/1	EXISTING LOAD	0			
19					20	20/1	EXISTING LOAD		0		
21	60/2	EXISTING LOAD	0		22	20/1	EXISTING LOAD	0			
23					24	20/1	EXISTING LOAD		0		
25	60/2	EXISTING LOAD	0		26	20/1	EXISTING LOAD	0			
27					28	20/1	EXISTING LOAD		0		
29	60/2	EXISTING LOAD	0		30	20/1	EXISTING LOAD	0			
31					32	20/1	EXISTING LOAD		0		
33	20/1	EXISTING LOAD	0		34	20/1	EXISTING LOAD	0			
35	20/1	EXISTING LOAD			36	20/1	EXISTING LOAD		0		
37	20/1	EXISTING LOAD	0		38	20/1	EXISTING LOAD	0			
39	20/1	EXISTING LOAD			40	20/1	EXISTING LOAD		0		
41	100/2	EXISTING PANELBOARD	0		42	20/1	EXISTING LOAD	0			
43					44	20/1	RECEPT.		0.36		
45	80/2	IEWH-1	6.95		46	20/1	RECEPT.	0.36			
47					48	20/1	RECEPT.		0.36		
49	15/2	HP-1, WAC-1	0.95		50	20/1	RECEPT.	0.18			
51					52	20/1	LIGHTING, RECEPT.		0.26		
53	20/1	SPACE	0		54	20/1	RECEPT.	0.18			
55	20/1	SPACE			56	20/1	SPACE	0			
57	20/1	SPACE	0		58	20/1	SPACE		0		
59	20/1	SPACE			60	20/1	SPACE		0		
TOTAL CONNECTED KVA BY PHASE									8.62	8.88	
			CONN KVA	CALC KVA					CONN KVA	CALC KVA	
LIGHTING			0.08	0.1	(125%)	RECEPTACLES			1.62	1.62	(50%>10)
LARGEST MOTOR			1.9	0.475	(25%)	NONCONTINUOUS			13.9	13.9	(100%)
						COOLING			1.9	1.9	(100%)
						TOTAL LOAD			18		
						BALANCED LOAD			75 A		

GENERAL NOTE: EXISTING SQUARE D 400A, 120/240V, 1φ, 3-WIRE PANELBOARD "A" TO BE REPLACED. TEMPORARILY DISCONNECT FEEDER AND BRANCH CIRCUITS FOR THE REMOVAL OF EXISTING PANELBOARD. PROVIDE NEW PANEL AS PER SCHEDULE. EXISTING FEEDER TO BE REUSED. TERMINATE EXISTING TO REMAIN BRANCH CIRCUITS TO NEW PANEL.

REVISIONS	BY
ADD	ETHOS
02/16/2023	



CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS PHASE II



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Architects-Planners
Interior Designers

Date: FEBRUARY 01, 2022
Scale: As Noted
Project Architect: Roan G. Gomez, AIA
Drawn By: ETHOS
Job No: 22x114
Sheet: 22x114



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E4.2

REVISIONS	BY
ADD	ETHOS
02/16/2023	

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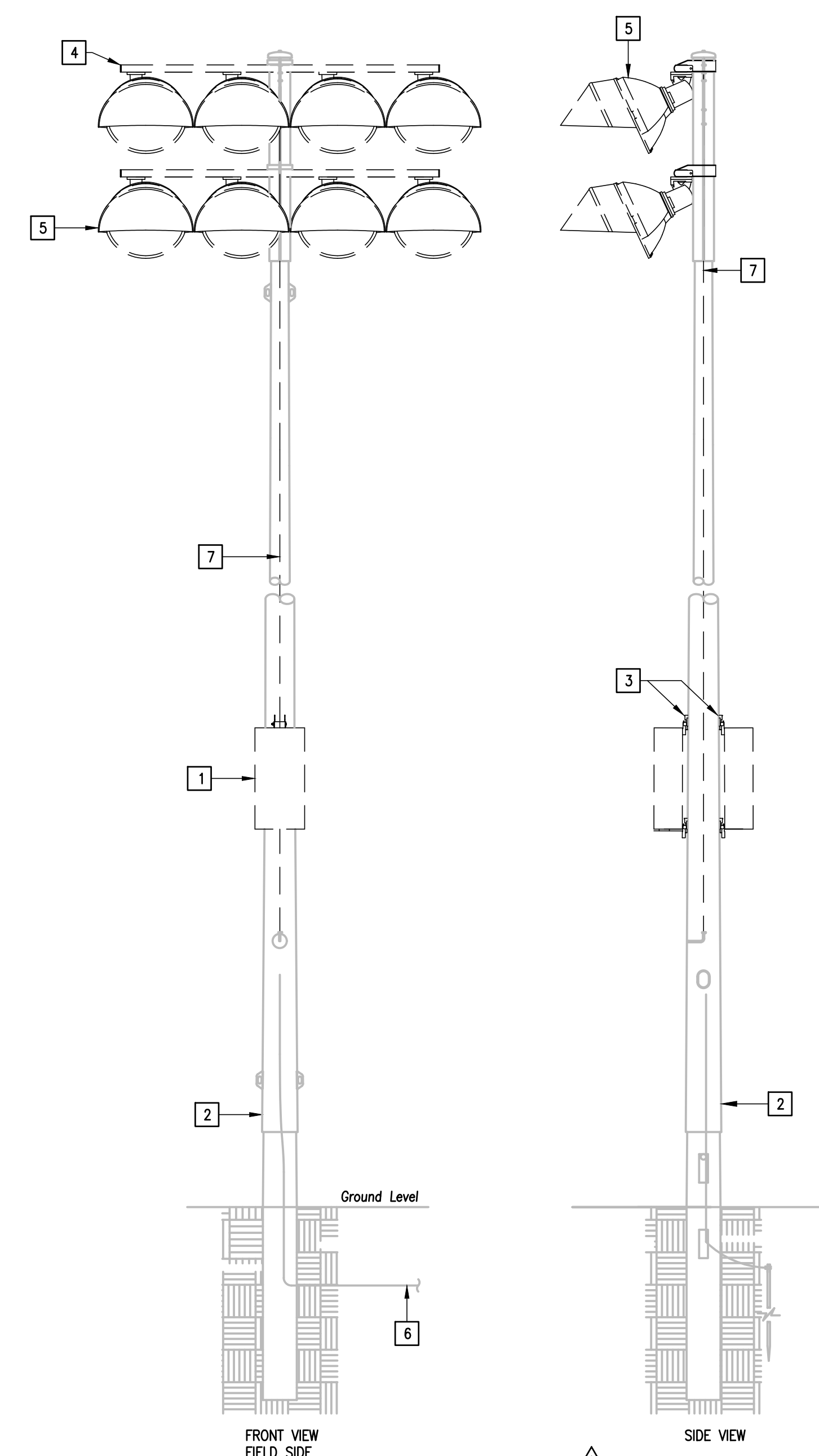


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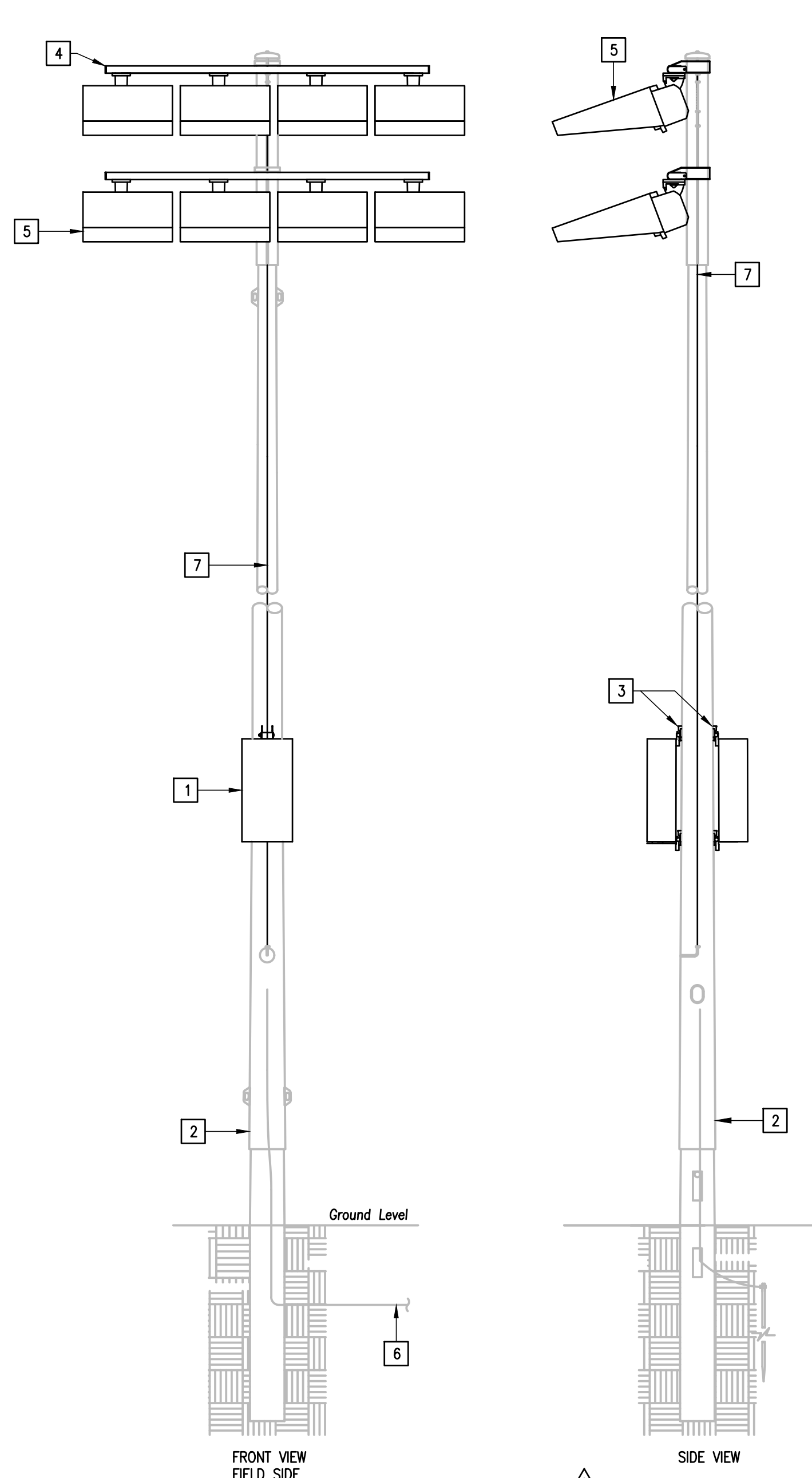
E5.1



LIGHT POLE DEMOLITION DETAIL NOTES:

- 1 ELECTRICAL COMPONENTS ENCLOSURES TO BE REMOVED FOR REPLACEMENT.
- 2 EXISTING GALVANIZED STEEL POLE TO REMAIN.
- 3 ATTACHMENT BRACKET TO BE REMOVED.
- 4 REMOVE EXISTING CROSS ARM.
- 5 DISCONNECT AND REMOVE EXISTING LIGHT FIXTURES FOR REPLACEMENT.
- 6 EXISTING SPORTS LIGHTING ELECTRICAL BRANCH CIRCUITS TO REMAIN.
- 7 REMOVE EXISTING WIRE HARNESS FOR REPLACEMENT.

01 TYPICAL EXISTING SPORTS LIGHTING LIGHT POLE DEMOLITION DETAIL
 SCALE: NOT TO SCALE



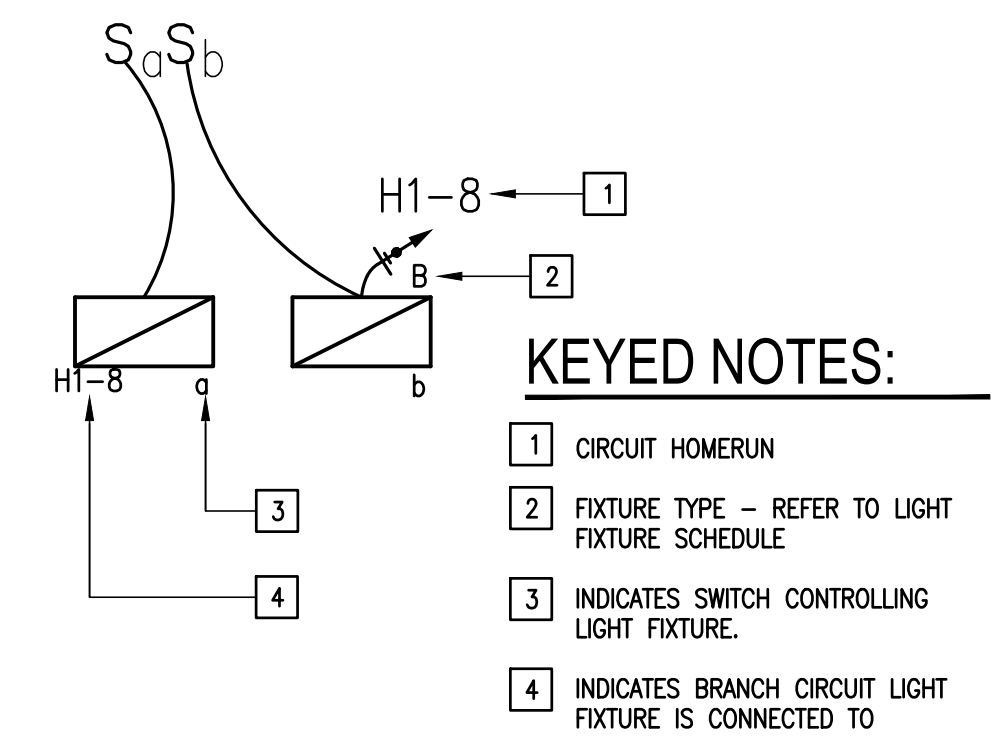
LIGHT POLE MODIFICATIONS DETAIL NOTES:

- 1 PROVIDE NEW ELECTRICAL COMPONENTS ENCLOSURES.
- 2 EXISTING GALVANIZED STEEL POLE.
- 3 PROVIDE NEW ATTACHMENT BRACKET.
- 4 PROVIDE NEW CROSS ARM.
- 5 PROVIDE NEW LIGHT FIXTURES. EACH LIGHT FIXTURE SHALL BE INDIVIDUALLY FUSED. SEE POLE SCHEDULE FOR NUMBER OF LIGHT FIXTURES AT EACH POLE.
- 6 EXISTING SPORTS LIGHTING ELECTRICAL BRANCH CIRCUITS.
- 7 PROVIDE NEW WIRE HARNESS.

02 TYPICAL EXISTING SPORTS LIGHTING LIGHT POLE MODIFICATIONS DETAIL
 SCALE: NOT TO SCALE

NOTES:

- 1. INSTALL ALL ROUGH-INS IN STRICT ACCORDANCE WITH MANUFACTURER PUBLISHED TEMPLATES. PROVIDE MOCK-UP FOR OWNER REPRESENTATIVE APPROVAL.
- 2. TEMPLATE TO BE PROVIDED BY PROJECTOR MANUFACTURER/OWNER. COORDINATE WITH OWNER PRIOR TO ANY ROUGH-IN.
- 3. ROUGH-INS ARE LOCATED ON LEFT OR RIGHT HAND SIDE OF MARKER BOARD. REFER TO ELECTRICAL DRAWINGS FOR LOCATIONS.
- 4. PROVIDE A DATA CONNECTOR AND CAT6 WIRING AT PROJECTOR MOUNT.



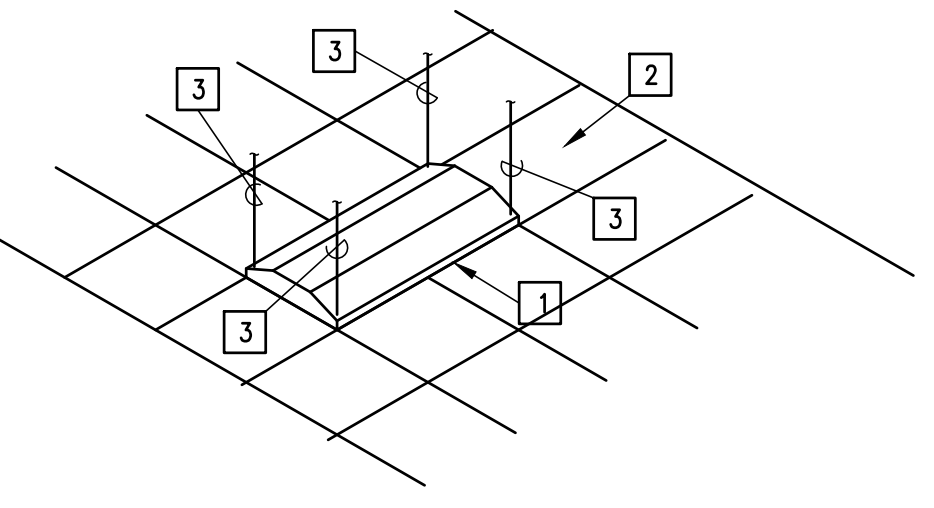
KEYED NOTES:

- 1 CIRCUIT HOMERUN
- 2 FIXTURE TYPE - REFER TO LIGHT FIXTURE SCHEDULE
- 3 INDICATES SWITCH CONTROLLING LIGHT FIXTURE.
- 4 INDICATES BRANCH CIRCUIT LIGHT FIXTURE IS CONNECTED TO

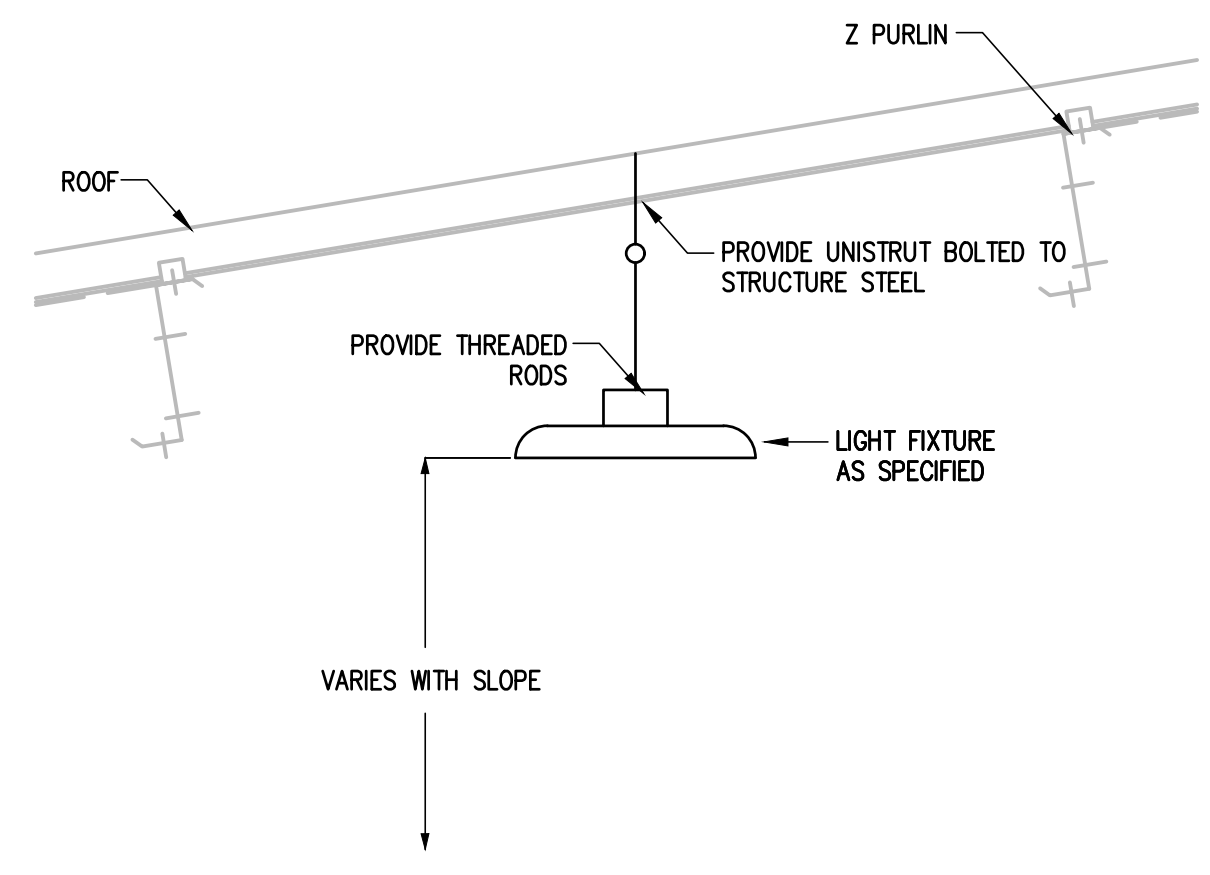
03 LIGHTING LEGEND DETAIL
 SCALE: NOT TO SCALE

KEYED NOTES:

- 1 PROVIDE 2' x 4' LAY-IN LED FIXTURE
- 2 SUSPENDED CEILING
- 3 PROVIDE TIE WIRE, CONNECT TO ALL FOUR CORNERS OF FIXTURE TO STRUCTURE ABOVE, INDEPENDENT OF CEILING SUPPORTS. ALL TIE WIRES TO BE PAINTED ORANGE OR OTHER EFFECTIVE MEANS OF IDENTIFICATION SO OTHER TRADES CANT BE ATTACHED TO IT.



04 TYPICAL LAY-IN FIXTURE SUPPORT
 SCALE: NOT TO SCALE



05 GYMNASIUM LIGHT FIXTURE MOUNTING DETAIL
 SCALE: NOT TO SCALE

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02/16/2023	ETHOS

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 Sheet:

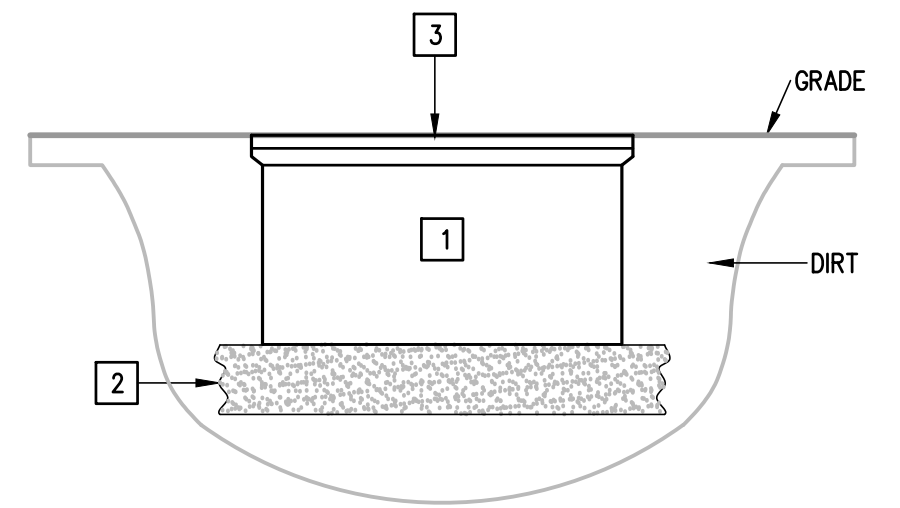


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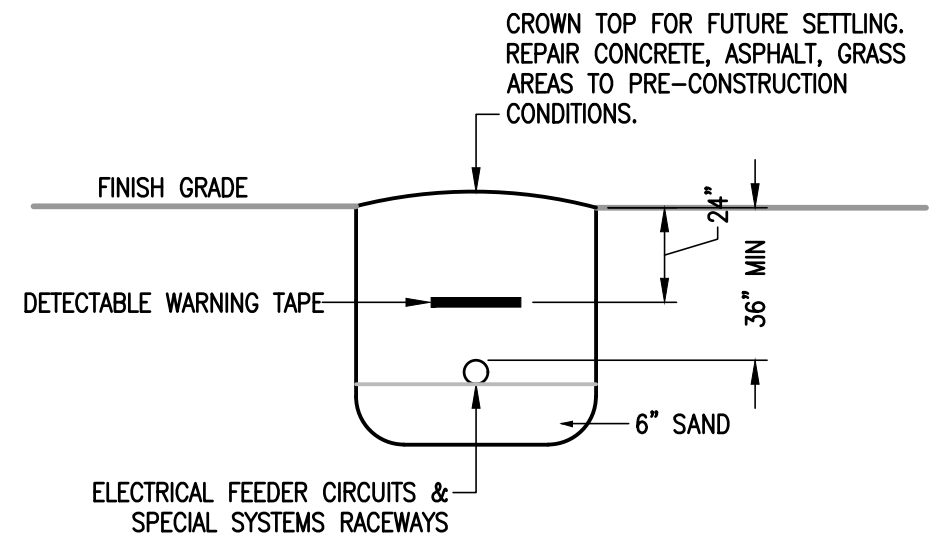
KEYED NOTES:

- 1 PROVIDE POLYMER CONCRETE PULL BOX TIER 22 RATED, COMPLYING WITH ANS/SCIE 77 AND NEC 314.30.
- 2 PROVIDE 8" OF GRAVEL OR CRUSHED ROCK.
- 3 PROVIDE ONE PIECE LOCKING COVER WITH LOGO TIER 22 RATED. INSTALL COVER LEVEL WITH GRADE.

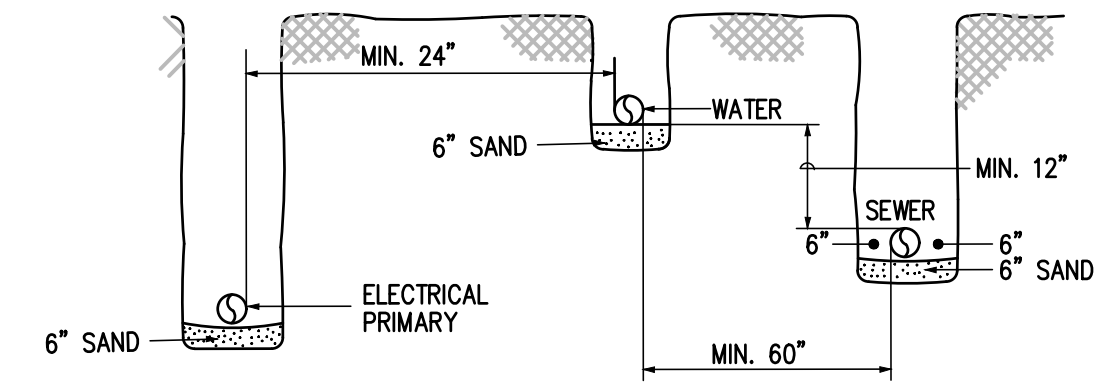


01 POLYMER CONCRETE PULLBOX DETAIL
 SCALE : NONE

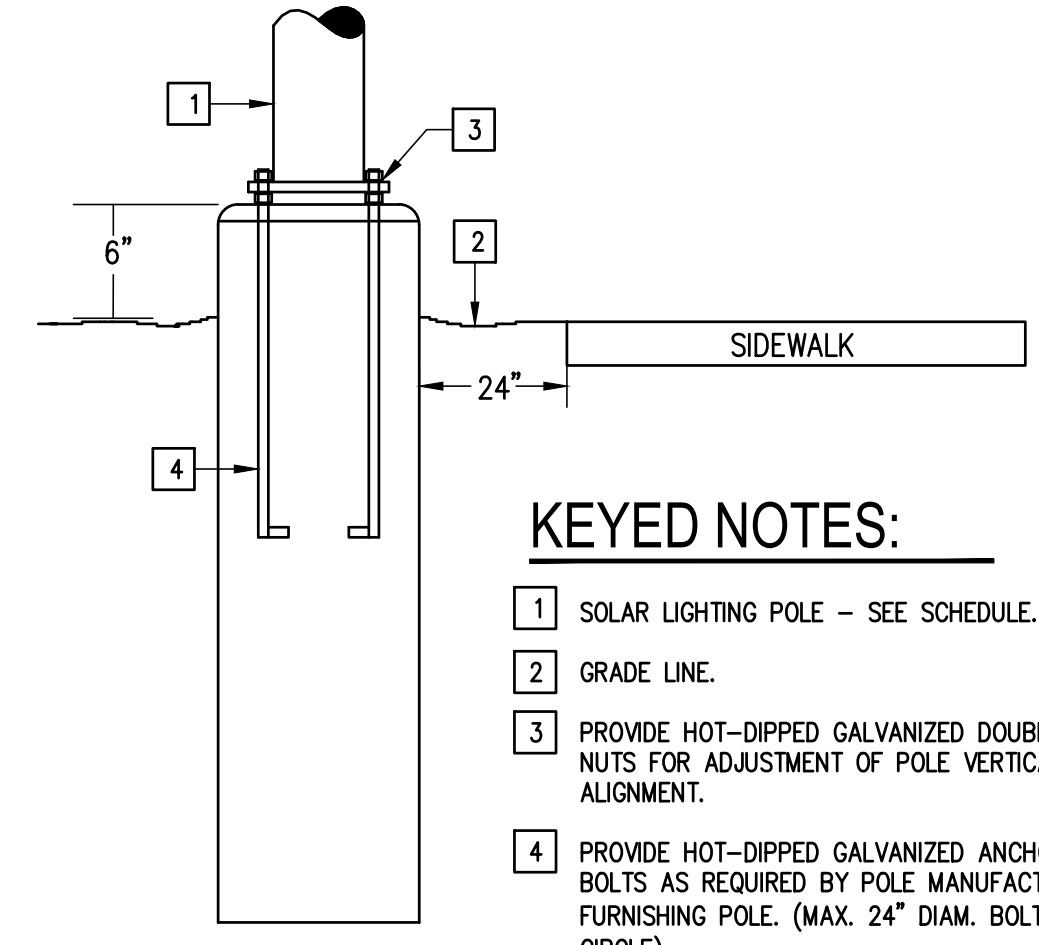
CLEAR TRENCH OF ALL ROCKS AND DEBRIS BEFORE ADDING SAND CUSHION.
 COMPACT TRENCH FILL TO 90% PROCTOR DENSITY IN 6" LIFTS.
 MAINTAIN A MINIMUM OF 60 INCHES UNDISTURBED EARTH BETWEEN PARALLEL WATER AND SEWER LINES OR SUPPORT WATER LINE ON SEPARATE SHELF A MINIMUM OF 12" ABOVE SEWER LINE.
 MAINTAIN A MINIMUM OF 24" HORIZONTALLY BETWEEN ELECTRICAL PRIMARY AND SEWER. MAINTAIN A MINIMUM OF 12" VERTICALLY OR 24" HORIZONTALLY BETWEEN ELECTRICAL PRIMARY AND WATER LINES, GAS LINES, TELEPHONE RACEWAYS AND CABLE RACEWAYS.



02 BURIAL DETAIL FOR ELECTRICAL RACEWAYS
 SCALE : NONE



03 TRENCHING DETAIL
 SCALE : NONE

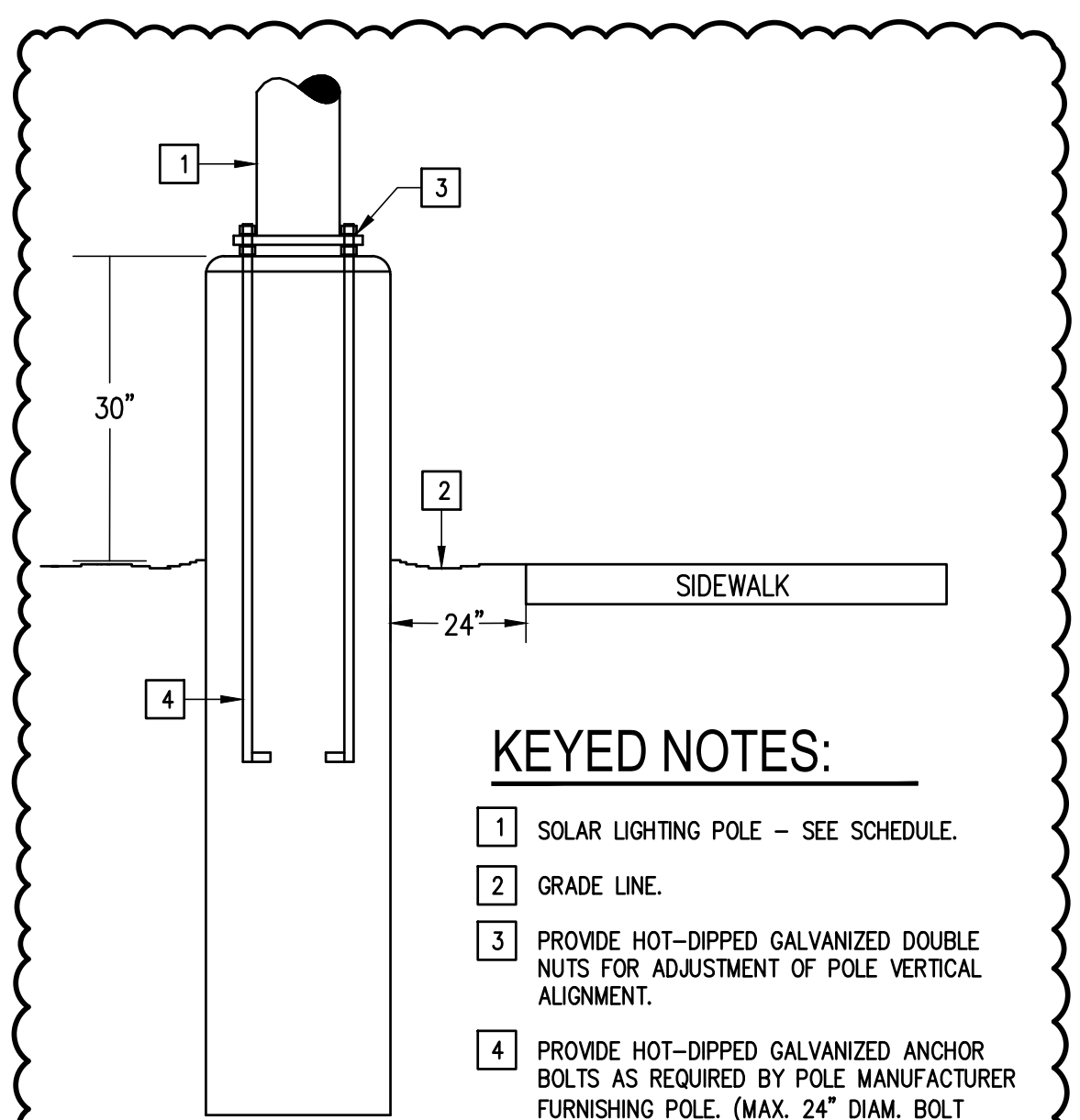


KEYED NOTES:

- 1 SOLAR LIGHTING POLE - SEE SCHEDULE.
- 2 GRADE LINE.
- 3 PROVIDE HOT-DIPPED GALVANIZED DOUBLE NUTS FOR ADJUSTMENT OF POLE VERTICAL ALIGNMENT.
- 4 PROVIDE HOT-DIPPED GALVANIZED ANCHOR BOLTS AS REQUIRED BY POLE MANUFACTURER FURNISHING POLE. (MAX. 24" DIAM. BOLT CIRCLE).

NOTE : COORDINATE WITH GENERAL CONTRACTOR.

04 SOLAR LIGHT POLE EXISTING FOUNDATION DETAIL
 SCALE : NOT TO SCALE

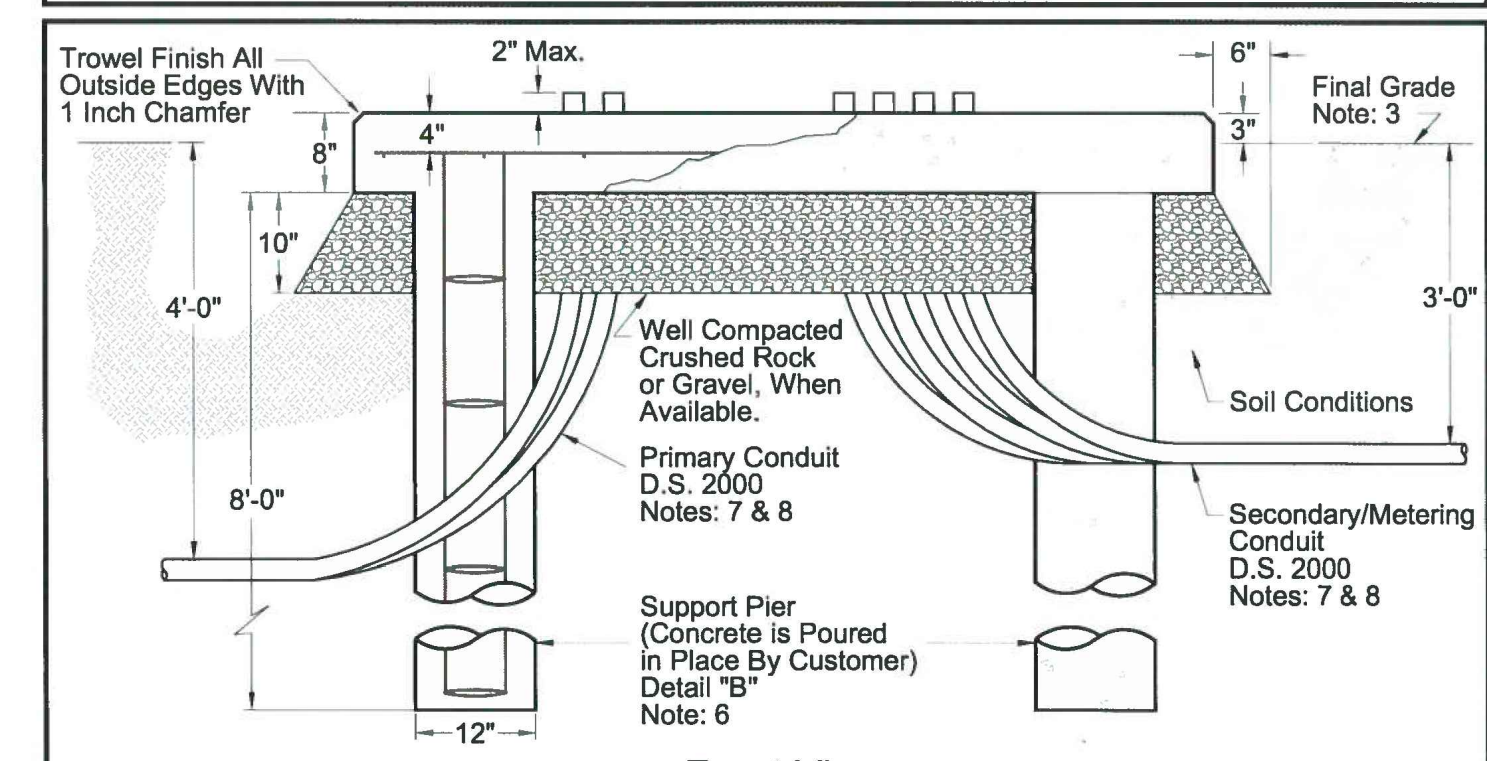
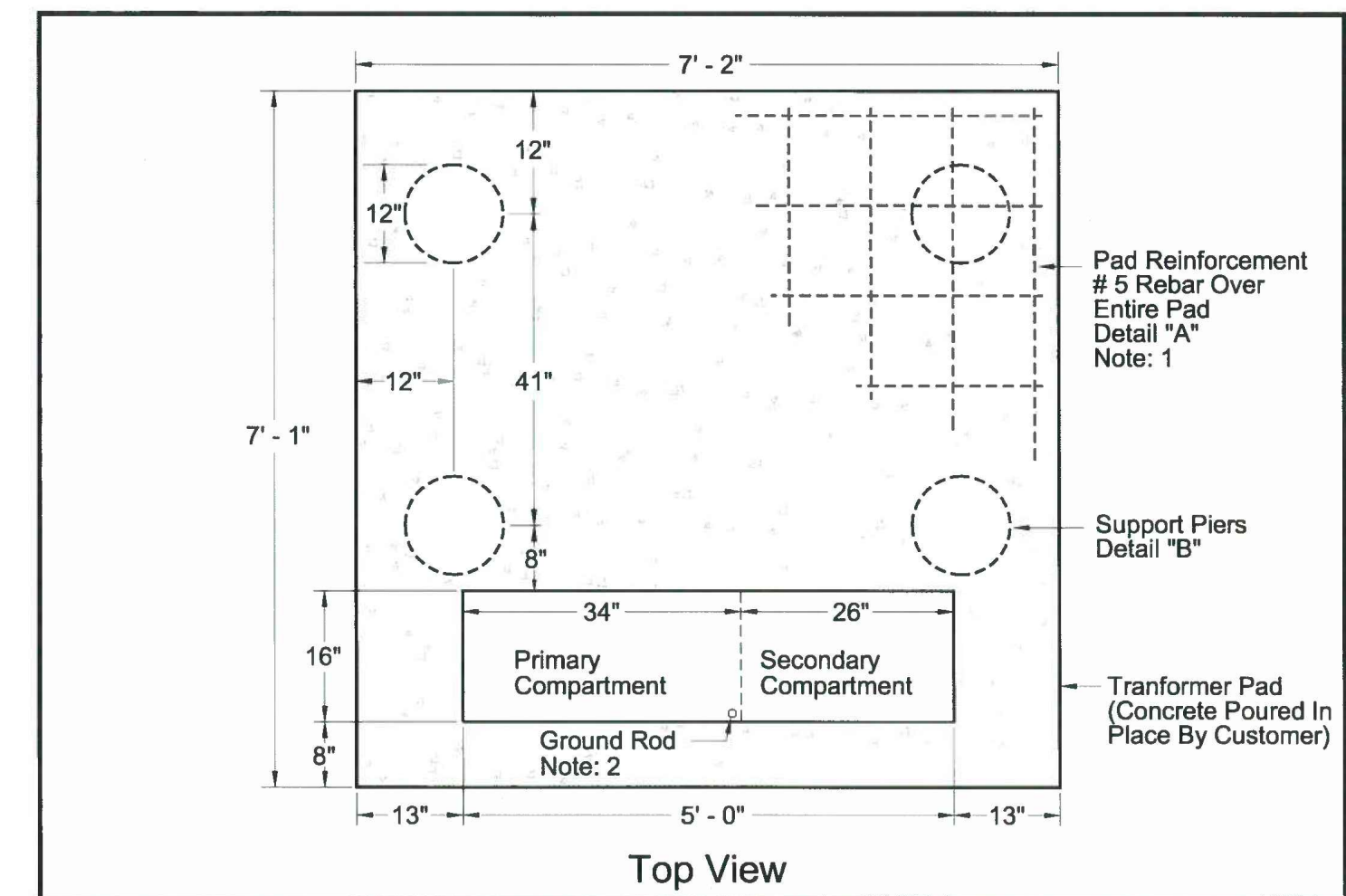


KEYED NOTES:

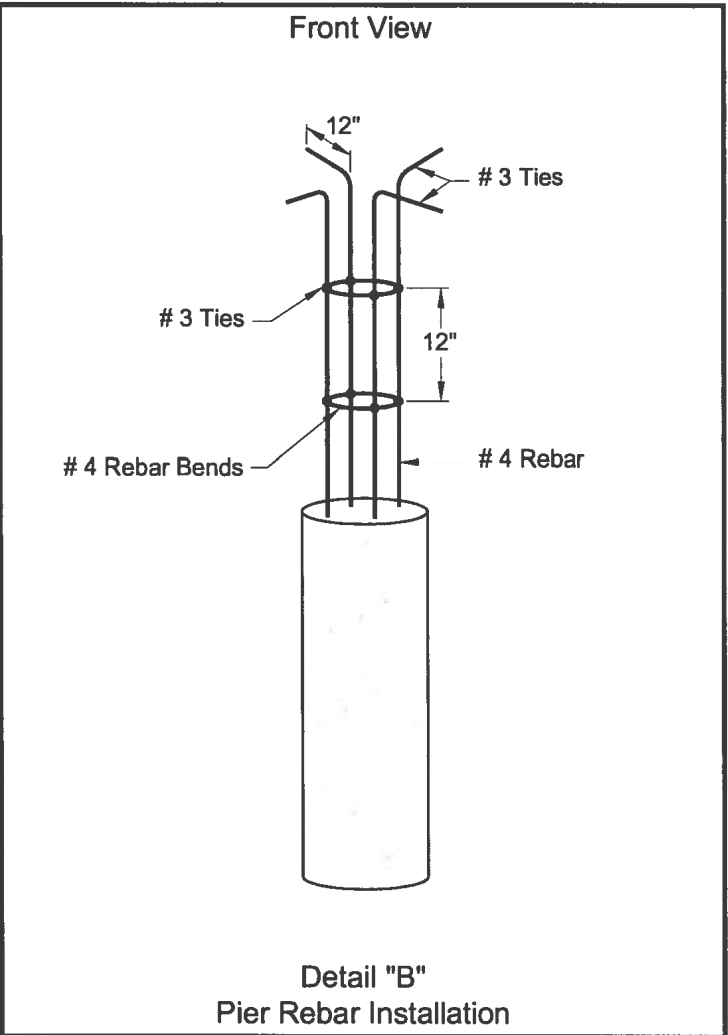
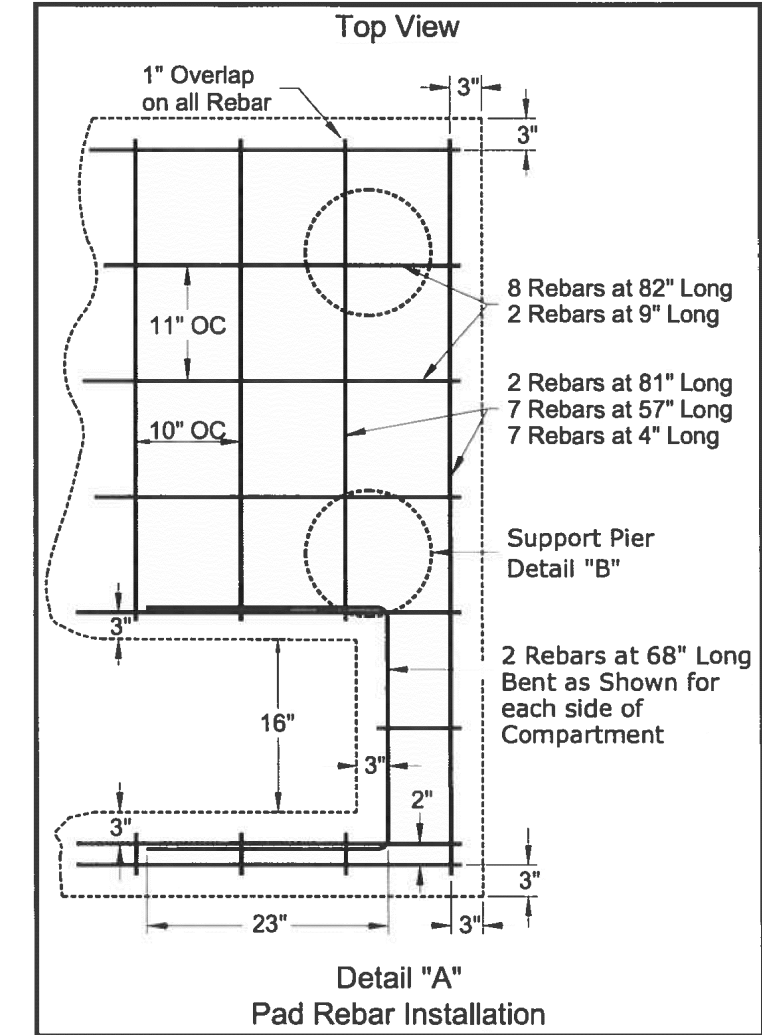
- 1 SOLAR LIGHTING POLE - SEE SCHEDULE.
- 2 GRADE LINE.
- 3 PROVIDE HOT-DIPPED GALVANIZED DOUBLE NUTS FOR ADJUSTMENT OF POLE VERTICAL ALIGNMENT.
- 4 PROVIDE HOT-DIPPED GALVANIZED ANCHOR BOLTS AS REQUIRED BY POLE MANUFACTURER FURNISHING POLE. (MAX. 24" DIAM. BOLT CIRCLE).

NOTE : COORDINATE WITH GENERAL CONTRACTOR.

05 SOLAR LIGHT POLE NEW FOUNDATION DETAIL
 SCALE : NOT TO SCALE



Concrete Pad & Piers for Three Phase Pad-Mounted Transformer
 DATE: 04/30/2012 Revised Date: 10/02/2013 SCALE: None Page 3 of 7



Concrete Pad and Piers for Three Phase Pad-Mounted Transformer 75 KVA -2500 KVA
 Date: 04/30/2012 Revised Date: 10/02/2013 Scale: None Page 4 of 7

06 AEP TRANSFORMER CONCRETE PAD DETAIL
 SCALE : NOT TO SCALE

REVISIONS	BY
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02/16/2023	ETHOS

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CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS PHASE II



SEAL OF CAMERON COUNTY TEXAS
 CESAR A. GONZALEZ
 108611
 02.01.2023

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 Interior Designers
 Date: FEBRUARY 01, 2022
 Scale: As Noted
 Project Architect: Roan G. Gomez, AIA
 Drawn By: MOV
 Job No. 22v114
 Sheet:

DP2.1

DEMOLITION GENERAL NOTES:

1. ALL DEMOLITION WORK SHALL BE DONE IN ACCORDANCE WITH ALL APPLICABLE CODES INCLUDING THOSE PUBLISHED BY OSHA.
2. THE EXTENT OF DEMOLITION WORK IS INDICATED ON THE ARCHITECTURAL DRAWINGS AND BY THE REQUIREMENTS OF THIS SECTION. A VISIT TO THE SITE IS REQUIRED TO PROPERLY BID THE DEMOLITION WORK.
3. PROVIDE ALL DEMOLITION WORK REQUIRED FOR THE REMOVAL OF EXISTING NON REUSED PLUMBING EQUIPMENT AND ASSOCIATED DEVICES. PROVIDE A COMPLETE AND OPERABLE SYSTEM UPON COMPLETION OF THE PROJECT.
4. COORDINATE DEMOLITION OF DIVISION 22 SYSTEM AS REQUIRED WITH ALL OTHER TRADES.
5. ALL EXISTING EQUIPMENT REMOVED DURING CONSTRUCTION, THAT IS NOT TO BE REUSED, SHALL BE REMOVED FROM THE JOB SITE AND PROPERLY RETURNED TO THE OWNER, IF DESIRED BY OWNER.
6. IT IS INTENDED THAT DEMOLITION WORK LEAVE THE ENTIRE AREA FREE OF ABOVE-GRADE ITEMS, INCLUDING PIPIN, CONCRETE PADS, STRUCTURAL SUPPORTS AND MISCELLANEOUS ITEMS. ALL INDICATED TO BE REUSED.
7. OWNER MAY WISH TO KEEP DEMOLISHE EQUIPMENT AND MATERIALS. COORDINATE WITH OWNER, AND DISPOSE OF EQUIPMENT AND MATERIALS THAT OWNER DOES NOT REMAIN.
8. PREPARE AREA FOR INSTALLATION OFF NEW PLUMBING SYSTEM. REFER TO NEW PLANS AND COORDINATE WITH DEMOLITION WORK.
9. ALL PLUMBING FIXTURES WITH ASSOCIATED PLUMBING PIPING SYSTEM TO BE REMOVED.

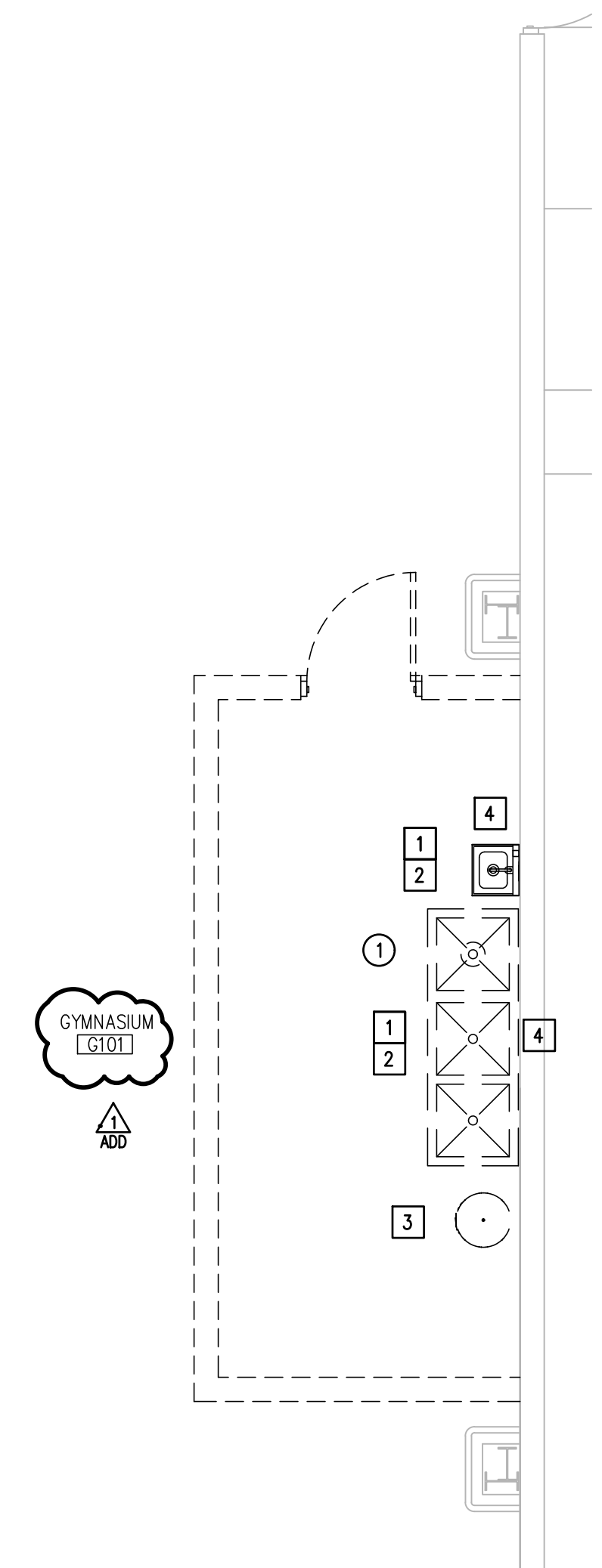
GENERAL CONST. KEYED NOTES:

- 1 REFER TO ARCHITECTURAL PLANS FOR REMOVAL AND REPLACEMENT OF ARCHITECTURAL FEATURES.

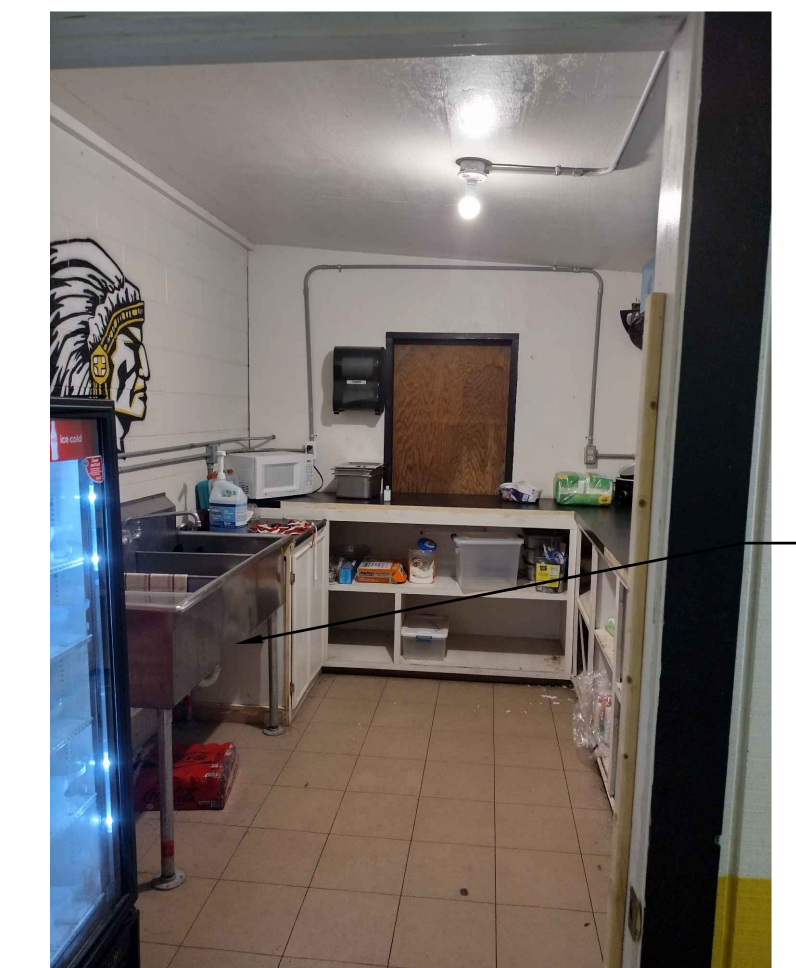
PLUMBING DEMO KEYED NOTES:

- 1 DEMOLISH EXISTING HOT AND COLD WATER PIPES SERVING CONCESSION BUILDING FIXTURES, CAP AND ABANDON AT PERIMETER WALL.
- 2 REMOVE EXISTING PLUMBING FIXTURES AT THIS APPROXIMATE LOCATION.
- 3 REMOVE EXISTING ELECTRIC WATER HEATER. DEMOLISH HOT AND COLD WATER PIPING SERVING WATER HEATER.
- 4 CAP AND ABANDON EXISTING SANITARY SEWER PIPE.

PLUMBING LEGEND	
---	WALL TO BE DEMOLISHED AND REPAIRED

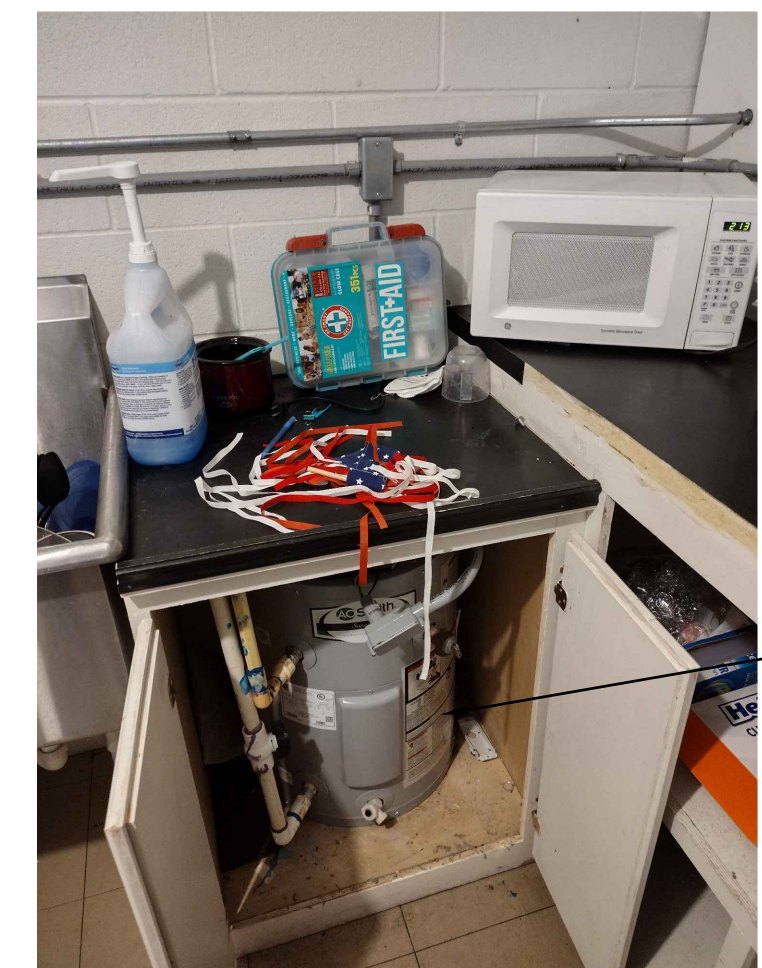


01 GYMNASIUM CONCESSION DEMOLITION PLAN
 SCALE: 1/4" = 1'-0"
 NORTH



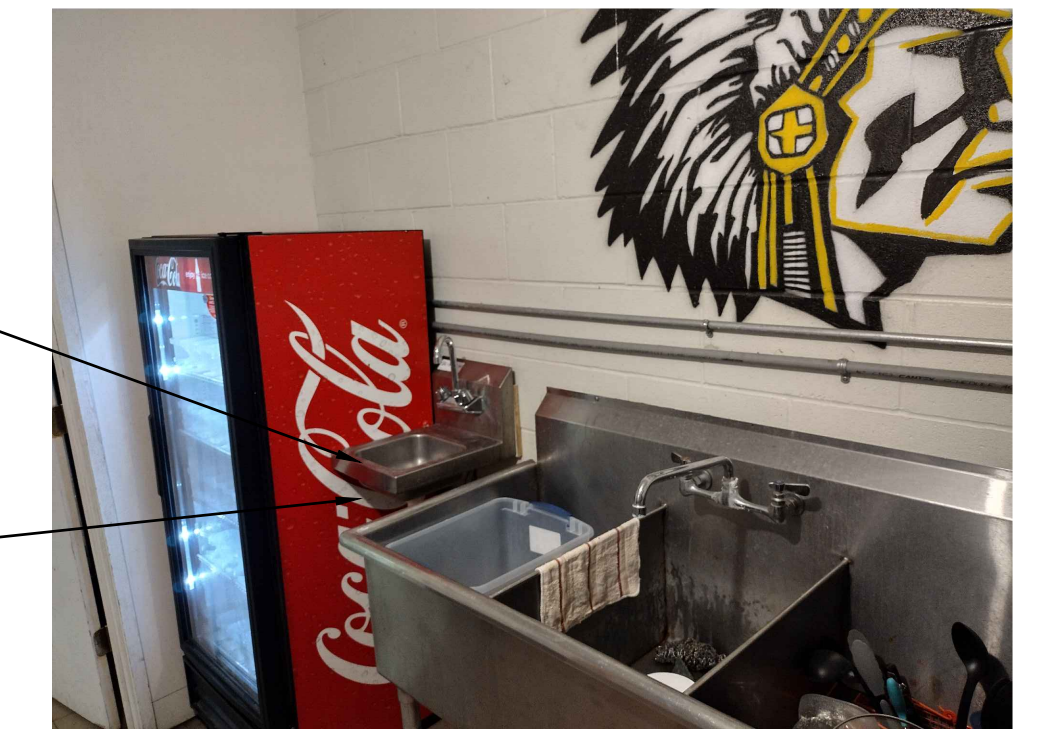
4
1 2
EXISTING THREE COMPARTMENT SINK TO BE REMOVED.

02 EXISTING CONDITIONS
 SCALE: NOT TO SCALE



3
EXISTING ELECTRIC WATER HEATER TO BE REMOVED.

03 EXISTING CONDITIONS
 SCALE: NOT TO SCALE



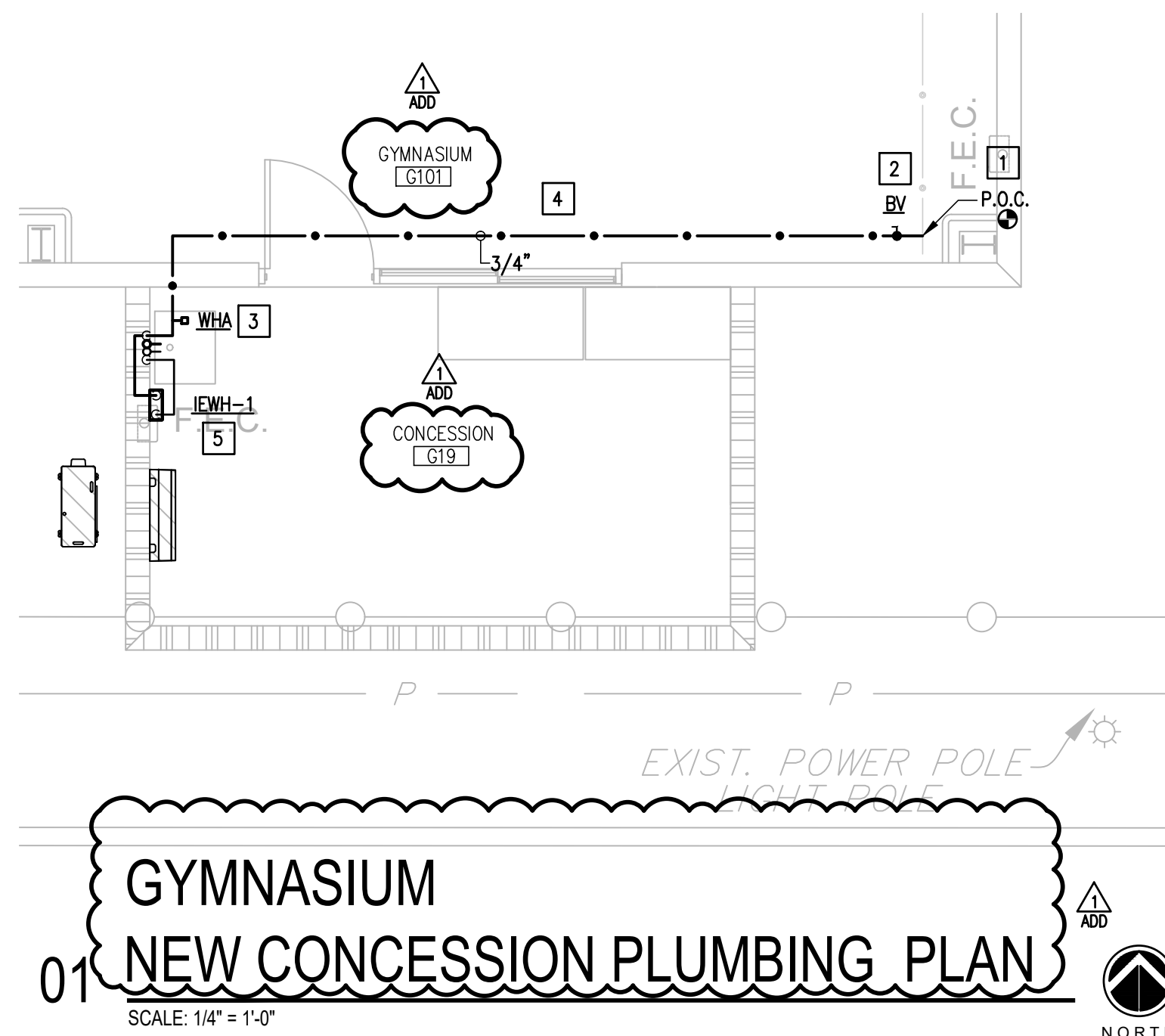
1 2
EXISTING HAND SINK TO BE REMOVED.

4

04 EXISTING CONDITIONS
 SCALE: NOT TO SCALE

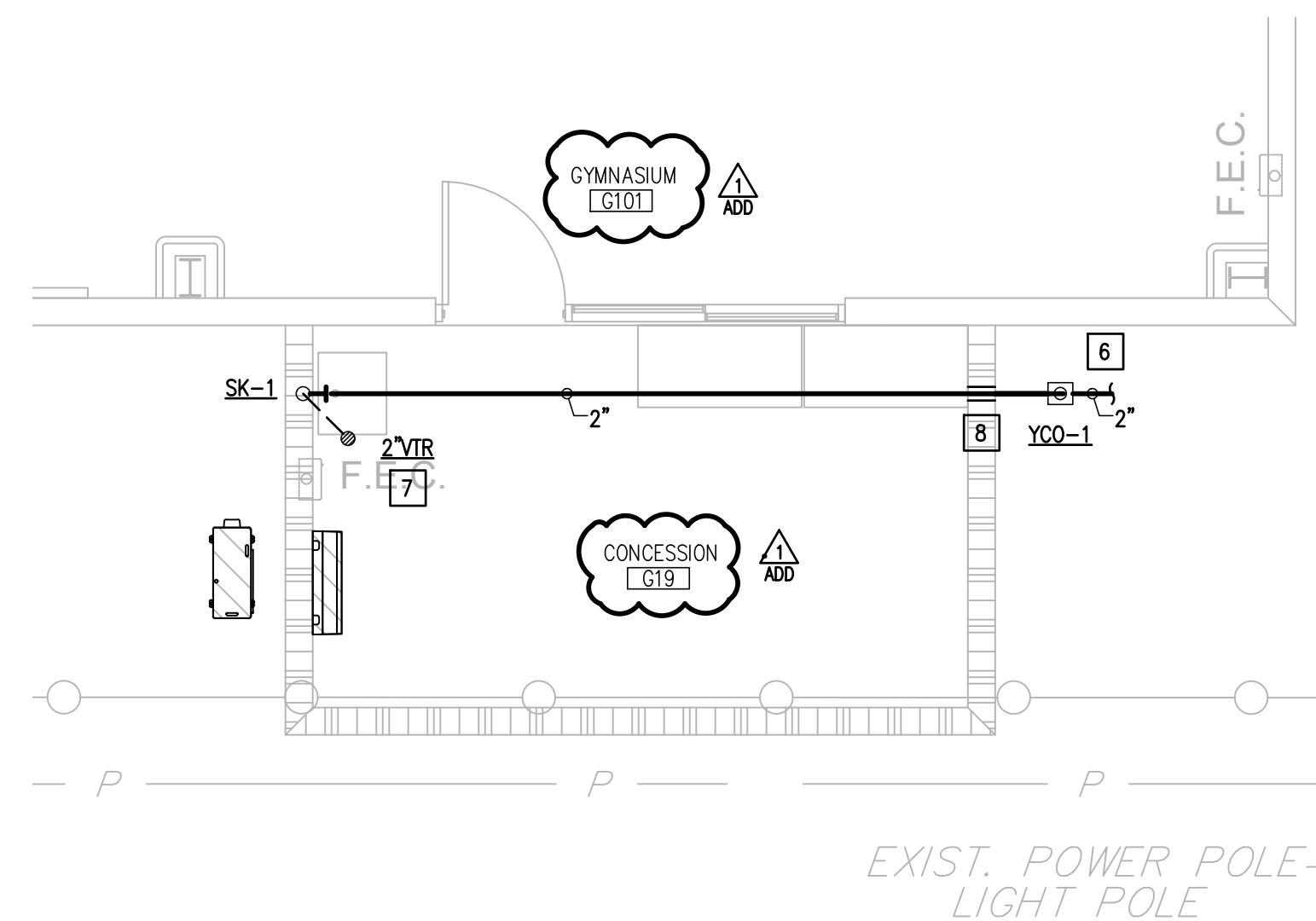


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01 GYMNASIUM
NEW CONCESSION PLUMBING PLAN

SCALE: 1/4" = 1'-0"



02 GYMNASIUM NEW CONCESSION
WASTE AND VENT PLAN

SCALE: 1/4" = 1'-0"



PLUMBING KEYED NOTES:

- 1 CONECT NEW 3/4" COLD WATER PIPE TO SERVE NEW SINK AT THIS APPROXIMATE POINT.
- 2 PROVIDE BRONZE ISOLATION BALL VALVE ABOVE CEILING OR BEHIND WALL. PROVIDE 12"x12" ACCESS PANEL WHERE INSTALLED IN AN INACCESSIBLE AREA. ACCESS PANEL EQUAL TO ACUDOR MODEL UF5000 WITH CYLINDER LOCK AND KEY AND PAINT TO MATCH THE WALL/CEILING. PROVIDE VALVE IDENTIFICATION TAGS AS PER SPECIFICATIONS. (TYPICAL)
- 3 PROVIDE BELLOWS TYPE WATER HAMMER ARRESTOR (WHA), MIFAB OR APPROVED EQUAL INDICATED MODEL (A,B,C,D,E,F) AS PER MIFAB SIZING CHART. PROVIDE 12"x12" ACCESS PANEL WHERE INSTALLED IN AN INACCESSIBLE AREA. ACCESS PANEL EQUAL TO ACUDOR MODEL UF5000 WITH CYLINDER LOCK AND KEY AND PAINT TO MATCH THE WALL/CEILING. (TYPICAL)
- 4 PROVIDE PIPING SUPPORT AS PER SPECS AND DETAIL. SEE ASSOCIATED DETAIL ON DETAIL SHEET - TYPICAL.
- 5 PROVIDE INSTANTANEOUS ELECTRIC WATER HEATER (IEWH-1) AS SCHEDULED.
- 6 PROVIDE NEW 2" SANITARY SEWER LINE. PROVIDE ONE WAY YARD CLEANOUT. SEE CIVIL DRAWINGS FOR CONNECTION AND CONTINUATION. REFER TO MEP SITE PLAN FOR LOCATION.
- 7 PROVIDE 2" VENT UP THROUGH ROOF. (VTR)
- 8 SLEEVE ALL GRADES BEAMS, FLOOR SLABS AND MASONRY WALL PENETRATIONS PER DETAIL WHETHER SPECIFICALLY INDICATED ON PLANS OR NOT.

REVISIONS	BY
ADD	ETHOS
02/16/2023	ETHOS

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CAMERON COUNTY PARKS
SANTA ROSA PARK IMPROVEMENTS PHASE II



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 Gomez Mendez Saenz Inc.
 Architects-Planners
 Interior Designers

Date:	FEBRUARY 01, 2022
Scale:	As Noted
Project Architect:	Ronan G. Gomez, AIA
Drawn By:	MOV
Job No.:	22x114
Sheet:	



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PLUMBING FIXTURE SCHEDULE

Project: Santa Rosa Park Improvements Phase II									
MARK	MANUFACTURER & MODEL NUMBER		DESCRIPTION	CONNECTIONS					REMARKS
	MARK	MODEL NUMBER		WASTE	VENT	CW	HW	NOTES	
SK-1	ELKAY SS8124 ELKAY #LK940GN05T4H 0.5 GPM AERATOR LK335 DRAIN TRUEBRO KIT MIXING VALVE LEONARD #270-LF-BRKT		27" X 27-1/2" X 14" SINGLE COMPARTMENT SCULLERY SINK. 14 GAUGE TYPE 304 STAINLESS STEEL WITH A BUFFED SATIN FINISH. SINK SUPPORTED BY (4) 16 GAUGE STAINLESS STEEL, 1-5/8" TUBULAR LEGS WITH BULLET SHAPED FEET ADJUSTABLE UP TO 1". BACK MOUNTED INSTALLATION WITH 4" ON CENTER HOLES, REAR CENTER DRAIN. TWO HANDLE BACK MOUNT GOOSE NECK FAUCET. 3.5" DRAIN WITH CUP STRAINER. 1-1/2" 17 GAUGE CHROME PLATED TAILPIECE AND P-TRAP WITH CLEANOUT AND CHROME PLATED SUPPLY STOPS WITH STAINLESS STEEL FLEXIBLE CONNECTORS. POINT-OF-USE THERMOSTATIC VALVE. SET HOT WATER TEMPERATURE AT NO MORE THAN 105 DEGREES FAHRENHEIT.	2"	2"	1/2"	1/2"	1,2	SEE ARCHITECTURAL

NOTES:

- PROVIDE TRUEBRO LAVATORY GUARD MODEL #103 E-Z COLOR WHITE. COVER SHALL BE SECURED WITH SNAP-SLIP FLUSH REUSABLE FASTENERS.
- PROVIDE OFFSET TAILPIECE FOR ALL ADA SINKS.

INSTANTANEOUS ELECTRIC WATER HEATER SCHEDULE

Project: Santa Rosa Park Improvements Phase II								
MARK	LOCATION	MINIMUM FLOW RATE GPM	DEGREE RISE AT FLOW RATE	ELECTRICAL V/PH	KW	DIMENSIONS LENGTH X WIDTH	MANUFACTURER & MODEL NUMBER	NOTES
IEWH-1	NEW CONCESSION	0.35	73°	240V / 1PH	14	9-7/8"X10-5/8"X4-1/4"	CHRONOMITE R-58L	1,2

NOTES:

- MANUFACTURER & MODEL NUMBER ARE "OR APPROVED EQUAL".
- SET TEMPERATURE AT 110 DEGREE.

INSTANTANEOUS ELECTRIC WATER HEATER SCHEDULE (ALT. #2)

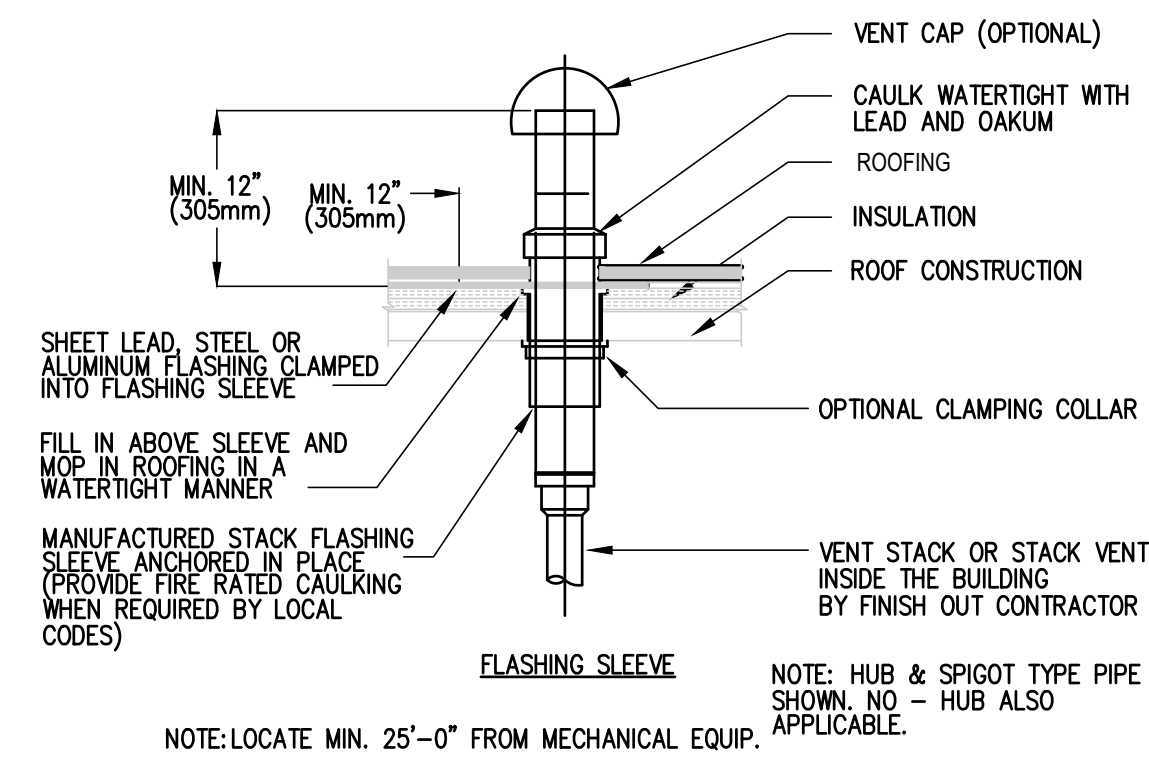
Project: Santa Rosa Park Improvements Phase II								
MARK	LOCATION	MINIMUM FLOW RATE	DEGREE RISE AT FLOW RATE	ELECTRICAL V/PH	KW	DIMENSIONS LENGTH X WIDTH	MANUFACTURER & MODEL NUMBER	NOTES
IEWH-1	NEW CONCESSION	0.35	73°	208V / 1PH	13	9-7/8"X10-5/8"X4-1/4"	CHRONOMITE R-63L	1,2

NOTES:

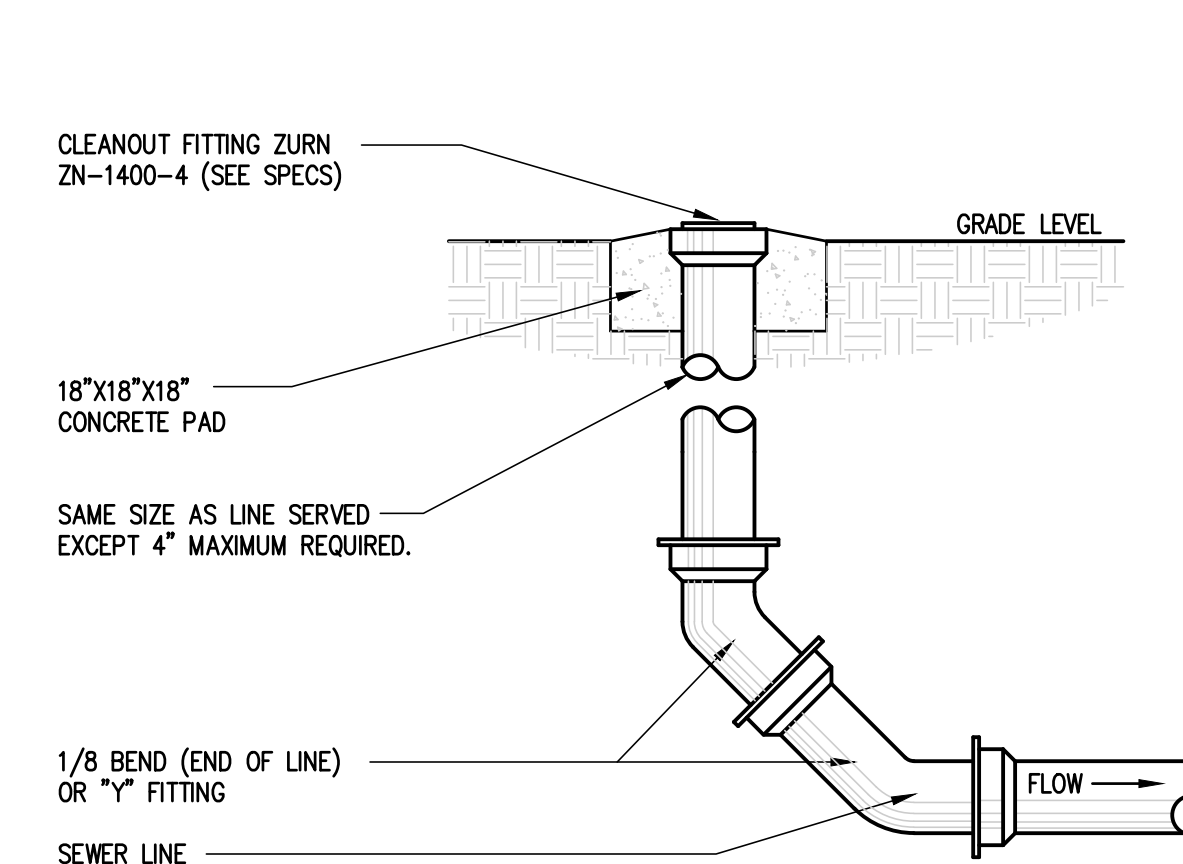
- MANUFACTURER & MODEL NUMBER ARE "OR APPROVED EQUAL".
- SET TEMPERATURE AT 110 DEGREE.

GENERAL NOTES: (APPLY TO ALL PLUMBING SHEETS)

- ALL PLUMBING WORK SHALL BE IN COMPLIANCE WITH ALL APPLICABLE CODES AS ADAPTED AND AMENDED BY THE INSPECTING AUTHORITIES.
- DRAWING IS DIAGRAMMATIC ONLY. CONTRACTOR SHALL COORDINATE EXACT LOCATIONS OF PIPING, DEVICES AND EQUIPMENT WITH BUILDING ELEMENTS AND THE WORK OF OTHER TRADES.
- ALL PLUMBING WORK SHALL BE INSTALLED SO AS TO AVOID CONFLICT WITH THE WORK OF OTHER TRADES. COORDINATE WITH MECHANICAL, ELECTRICAL AND STRUCTURAL FOR PROPER CLEARANCES.
- REFER TO ARCHITECTURAL DRAWINGS AND SPECIFICATIONS FOR PHASING AND SEQUENCE OF CONSTRUCTION WORK.
- COORDINATE WORK AMONG ALL DISCIPLINES. IT IS NOT THE INTENT OF THESE DOCUMENTS TO DICTATE WHO MUST DO THE WORK. ALL WORK SHOWN IS THE RESPONSIBILITY OF THE PRIME CONTRACTOR.
- SLEEVE ALL OUTSIDE WALLS, FOUNDATION GRADE BEAMS, INTERIOR WALL PENETRATIONS, AND FIRE SEAL ALL PENETRATION THROUGH FIRE WALLS AND FLOORS WHETHER SHOWN ON PLANS OR NOT.
- PROVIDE MINIMUM 15' OF SEPARATION BETWEEN HVAC INTAKES AND VENT THRU ROOFS.
- RECORD INVERT ELEVATIONS OF ALL YARD CLEAN OUT (YCO) ON "AS-BUILT" DRAWINGS.
- PROVIDE SHUT-OFF VALVES (STOPS) ON ALL ROUGH-INS TO FIXTURES AND EQUIPMENTS.
- PROVIDE WATER HAMMER ARRESTORS AS INDICATED ON THE DRAWINGS. AIR CHAMBERS NOT AN APPROVED SUBSTITUTE.
- PROVIDE ANY BACKFLOW PREVENTION DEVICE REQUIRED BY CODE OR LOCAL AUTHORITIES. CONTRACTOR SHALL VERIFY THIS WITH CITY AND LOCAL AGENCIES AND INCLUDE COST IN BID. CONTRACTOR TO HAVE BACK FLOWS CERTIFIED.
- REFER TO PLUMBING FIXTURE ROUGH-IN SCHEDULE FOR INDIVIDUAL PIPE CONNECTIONS TO FIXTURES.
- PRIOR TO POURING FOUNDATION AND ERECTING WALLS, COORDINATE INSTALLATION OF PLUMBING FIXTURE CARRIERS WITH GENERAL CONTRACTOR.
- STUDS AT DRY WALLS SHALL NOT BE CUT THRU HORIZONTAL DIRECTION. COORDINATE WITH DRY WALL CONTRACTOR.
- CONTRACTOR SHALL NOT CUT ANY EXTERIOR WALL STUD.



01 VENT THRU ROOF
SCALE: NOT TO SCALE

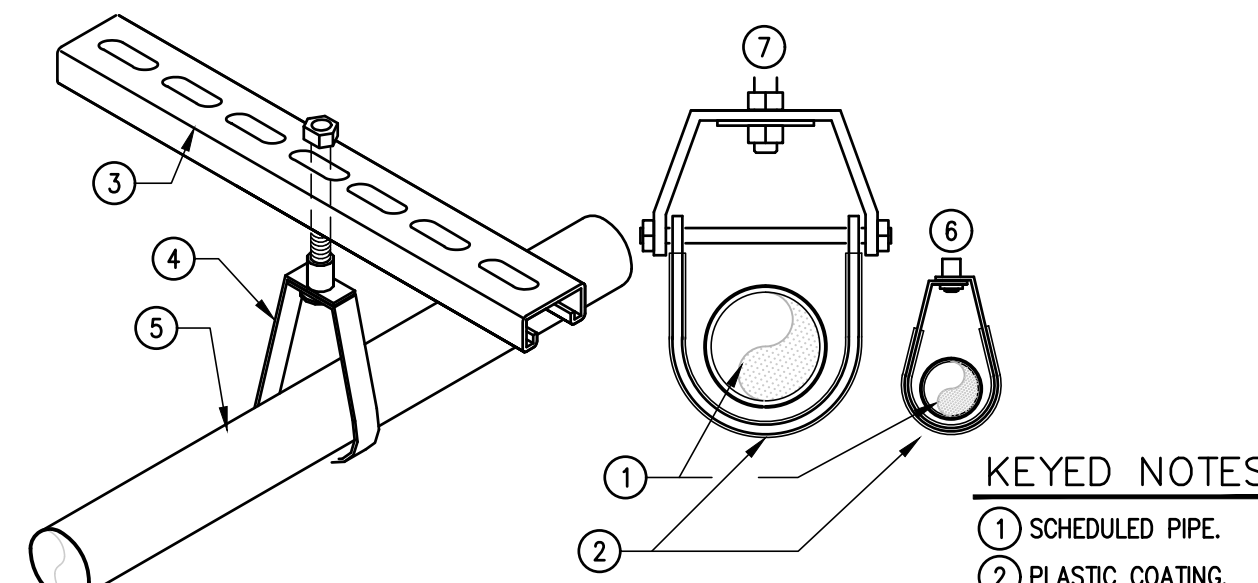


02 YARD CLEANOUT DETAIL
SCALE: NOT TO SCALE

PLUMBING SYMBOLS LEGEND

	COLD WATER SUPPLY		WALL CLEANOUT
	HOT WATER SUPPLY		*GATE VALVE (GV)
	TO BE DEMOLISHED		*BALL VALVE (BV)
	SOIL & WASTE LINE - ENLARGED PLANS		VALVE IN RISER TYPE AS NOTED
	VENT LINE - ENLARGED PLANS		WC WATER CLOSET
	EXISTING COLD WATER LINE		UR URINAL
	ACID VENT LINE - ENLARGED PLANS		L LAVATORY
	FIRE SPRINKLER LINE		SK SINK
	FLOOR CLEANOUT		EDF ELECTRIC DRINKING FOUNTAIN
	FLOOR CLEANOUT - 2 WAY		MSB MOP SERVICE BASIN
	FLOOR DRAIN (FD) WITH DEEP SEAL TRAP		EESH EMERGENCY EYE/SHOWER
	HUB DRAIN WITH DEEP SEAL TRAP		TP TRAP PRIMER
	FLOOR SINK		EWH ELECTRIC WATER HEATER
	YARD CLEANOUT		VTR VENT THRU ROOF
	YARD CLEANOUT - 2 WAY		CO CLEANOUT
	WALL HYDRANT		A.F.F. ABOVE FINISH FLOOR
	TRAP PRIMER		ADT ACID DILUTION TANK
	*WATER HAMMER ARRESTOR (WHA)		GT GREASE TRAP

* PROVIDE 12"x12" ACCESS PANEL WHERE INSTALLED IN AN INACCESSIBLE AREA.



03 DOMESTIC WATER LINE
PIPING SUPPORT DETAIL
SCALE: NOT TO SCALE



04 SK-1
SCALE: NOT TO SCALE

REVISIONS	BY
ADD	ETHOS
02/16/2023	



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SANTA ROSA PARK IMPROVEMENTS PHASE II



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Architects-Planners
Interior Designers

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Project Architect: Roan G. Gomez, AIA
Drawn By: MOV
Job No. 22x114
Sheet:



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