



**ENERGY
OUTREACH
COLORADO**
Together We Power Stability

**REQUEST FOR PROPOSALS (RFP) FOR
WEATHERIZATION CONSTRUCTION SERVICES**



TERRY ST APARTMENTS

2011 Terry St.

Longmont, CO 80501

Mandatory Bidders Meeting

Wednesday, February 3, 2021

ALL TRADES: 10:00 AM

MASK MUST BE WORN AT ALL TIMES

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I. INTRODUCTION

1. OVERVIEW

Energy Outreach Colorado Efficiency LLC (EOCE) is a non-profit organization that operates and administers the Colorado Energy Office (CEO) statewide Multi-Family Weatherization Program on behalf of the U.S. Department of Energy's (DOE) Weatherization Assistance Program. The Program reduces energy costs for low-income households by increasing the energy efficiency of their homes, while ensuring their health and safety. The Program prioritizes services to the elderly, people with disabilities, and families with children. Typical weatherization services may include: installing insulation; tuning and replacing heating and cooling systems; mitigating air infiltration; and reducing electric base load consumption. Energy-related health and safety issues may also be addressed through this program.

2. PURPOSE OF THIS REQUEST FOR PROPOSAL

Energy Outreach Colorado Efficiency LLC is soliciting for energy efficiency construction services proposals for the Multi-Family Weatherization Assistance Program.

EOCE has conducted an energy audit and has identified energy efficiency measures using a DOE approved energy modeling software. EOCE is seeking bid proposals from Vendors who can agree to the terms of the weatherization enhancements and will perform the work specified in this public solicitation document. Accordingly, EOCE, the property owner and the selected Vendor will enter into a contract to address the rights, obligations, and requirements necessary for Vendors to receive funding to perform the specified weatherization enhancements.

3. MAJOR OBJECTIVES OF REQUEST FOR THIS PROPOSAL

The major objectives of this solicitation are to:

- a. Identify Vendors that will provide energy efficiency measures for Energy Outreach Colorado Efficiency LLC 's Multi-Family Weatherization Program.
- b. To ensure that all materials and/or services meet the standards and requirements of Energy Outreach Colorado Efficiency LLC, DOE, and CEO.

- c. To ensure that all materials and/or services are provided in the timeframe established by Vendors and submitted with this proposal as described in this RFP.
- d. To obtain a cost effective, line item proposal for the requested services (**Attachment A**).
- e. To obtain Vendors' references for similar work performed in Colorado.

4. MANAGEMENT AND INQUIRIES

In no case shall oral communications take precedence over written communications. Only written communications shall be binding on this RFP. During the procurement process, all inquiries concerning this RFP shall be submitted in writing to:

Program Manager
vrick@energyoutreach.org
 cc: afeiertag@energyoutreach.org

SUBJECT: "TERRY ST APARTMENTS"

Energy Outreach Colorado Efficiency LLC assumes no responsibility for representations concerning conditions made by its Officers or Staff prior to the execution of an agreement, unless such representations are specifically incorporated into the RFP by subsequent official written Addendum(s). Oral conversations pertaining to modifications or clarifications of the RFP shall not be considered part of the RFP unless confirmed in writing by official written Addendum(s).

II. PROJECT SPECIFICATIONS

1. PROPERTY DESCRIPTION

TERRY ST APARTMENTS - 2011 Terry St, Longmont, CO 80501

Terry St Apartments is a 7,100 square foot, two story, wood-frame building. There are 10 one bedroom units with a mix of elderly and disabled residents.

2. ENERGY AUDIT SUMMARY AND BID SPECIFICATIONS

EOCE is seeking weatherization construction services for the following energy efficiency measures for **TERRY ST APARTMENTS_**:

(Full details regarding each measure are provided in **Attachment B**)

| Energy Efficiency and Health & Safety Measures | | | | |
|---|---------------------|-------------------|--------------------------|--------------------------|
| HVAC | LED Lighting | Appliances | Low Flow Fixtures | Safety |
| DHW/Mixing Valves | Common Area | Refrigerators | Bath Aerators | CO/Smoke Alarms |
| Furnaces | In-Unit | | Kitchen Aerators | Laundry Rm Louvered door |
| DHW/Space Heating Laundry Room | Insulation | | Showerheads | |

| | | | |
|---------------------|------------|--|--|
| Bath Exhaust Fans | Crawlspace | | |
| Programmable Tstats | Attic | | |

All companies submitting proposals must furnish labor, material, tools, and equipment necessary to perform the task and do all else, reasonably implied as necessary for the prompt and satisfactory completion of this contract. All companies submitting proposals must include all presumed taxes and duties however designated, including all sales, use, rental, receipt, value added, personal property, and other taxes that may be levied or assessed in connection with the Vendor’s possession, receipt, or use of the specified energy efficiency construction materials and/or services.

The Vendor must supply all materials using only new materials and supplies, or Approved Recycled Materials that to Vendor’s knowledge are free from defects and in compliance with 10 CFR 400 Appendix A located in **Attachment C** of this document. The Vendor must supply tools and labor necessary to complete the specified weatherization services according to the specifications, sequence and cost submitted in the Vendor’s proposal.

III. ENERGY OUTREACH COLORADO EFFICIENCY LLC PROPOSAL REQUIREMENTS

1. MANDATORY BIDDERS MEETING

A Bidders Meeting will be held at the following place and time:

TERRY ST APARTMENTS - 2011 Terry St, Longmont, CO 80501

February 3, 2020 at 10:00 am - ALL TRADES

This meeting is **MANDATORY** for all Vendors planning to submit a proposal to EOCE. At least one staff member must be present and must legibly sign the attendance log to record their company contact information. This contact information will be used to distribute answers to all submitted email questions by Vendors. All submitted email questions will be reviewed, answered, and distributed to all Vendors that attended the mandatory bidders meeting. Only Vendors that attend the bidders meeting will be considered for contract.

2. BIDDERS MEETING SCHEDULE

ALL TRADES - 10:00 AM

3. PROPOSAL SUBMISSION

Submission of a signed proposal is acknowledgment and acceptance of all terms and conditions of this solicitation. Energy Outreach Colorado Efficiency LLC reserves the right to reject all proposals including but not limited to proposals containing misleading and/or inaccurate information at any stage in the procurement process. It is the sole responsibility of prospective Vendors to take notice of the date and time that proposals are due, and to ensure their submittals are received prior to the due date and time. Late submissions will not be accepted. Proposals (bid forms) will not be accepted in person, by courier service, US Mail or facsimile. Items too large to email, such as plans, binders, etc., may be delivered to EOCE in person or mailed to EOCE; however, proposals (bid forms) shall be emailed only. Proposals must be emailed to:

Valerie Rick: vrick@energyoutreach.org and **Ashley Feiertag:** afeiertag@energyoutreach.org

SUBJECT: Request for Proposals: **Terry St Apartments**

Proposals Due Date/Time: **February 18 by 5:00 PM**

a. The Proposal Package

Additional promotional materials not in response to a specific requirement shall not be included in the proposals response package.

- i. **Attachment A:** Each proposal must use the documents found in Attachment A to prepare a bid package for this RFP. Specifically, all bids must separate out the costs associated with performing the specified energy efficiency measures, including subcontracting. These costs must be addressed in a separate line item on each submitted proposal for each individual measure. Additionally, the RFP Documentation Checklist must be included.
- ii. All bids MUST contain specs. Warrantees will be required to be submitted at completion of project prior to final payment.
- iii. In the event the Vendor proposes to subcontract for the services to be performed under the terms of the contract award, s/he shall state so in their bid and attach for approval a list of said subcontractors and an itemization of the products and/or services to be supplied by them.
- iv. All companies submitting proposals must provide construction scheduling for each measure in their proposal package. All work must be completed no later than **May 31, 2017** for projects funded by all other sources. Schedules are subject to change and EOCE holds the right to proceed under modified, accelerated schedules. For all projects, time is of the essence.
- v. **Minimum Vendor Requirements:** Proposals must address and meet each of the minimum Vendor requirements outlined in this RFP:
 1. All contractors' federal project eligibility will be verified through federal debarment and suspension list. The Vendor shall not be under suspension or debarment by the State of Colorado, any other state, or federal government. The list of ineligible Vendors can be accessed through www.sam.gov. Please be sure you are in good standing with the State of Colorado, any other state, or federal government before submitting a bid proposal.
 2. Vendors must demonstrate ability and specific approaches that best meet the project needs, including but not limited to:
 - i. Compensation for services (cost)
 - ii. Understanding of the project
 - iii. Recent experience with this type of work
 - iv. Personnel assigned to this project have experience working with property management and tenants, including seniors and disabled.

3. Each company must to submit references and experience for similar construction services provided in Colorado. The provided references and experience must pertain specifically to the Vendor who will execute the contract.

4. AFFIDAVIT OF PROPOSALS

- a. Cost for Preparation of Proposal

No payments shall be made to cover costs incurred by any Vendor in the preparation or submission of proposals, nor any other associated costs.

- b. Certification of Independent Price Determination

By submission of a response to this RFP, the Vendor certifies that in connection with this procurement:

- i. Prices in the proposals have been arrived at independently, without consultation, communication, or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any competitor.
- ii. He or she is the person, or the person authorized to act as agent for the person(s) in the Vendor's organization responsible for the decision as to any prices being offered herein, and that he or she has not participated in, and shall not participate in, any action contrary to the requirements of this document.
- iii. Any offer made in the submitted proposals, and any clarifications to the proposals shall be signed by an officer of the Vendor's organization or a designated agent empowered to bind the firm in an agreement.

- c. Integrity of Proposals

By signing a proposal(s), a Vendor affirms that s/he has not given any economic opportunity, future employment, gift, loan, gratuity, special discount, trip, favor, or service to an Energy Outreach Colorado Efficiency LLC member in connection with the submitted proposals. Failure to sign the proposals, or signing it with a false statement, shall void the submitted proposals or any resulting agreements, and the Vendor shall be removed from all supplier/Vendor lists.

- i. Conflict of Interest Statement:

It is the policy of the Organization to identify conflicts of interest involving the organization and related parties as well as situations which may give rise to an appearance of a conflict of interest, and to address such conflicts in a manner that will fully protect the integrity and reputation of the Organization as well as individuals serving as officers, directors and Grants Advisory Committee members. This policy is intended to supplement, but not replace, any applicable state and federal laws governing conflict of interest.

- ii. Prohibited Transactions

While in most circumstances the determination of a conflict of interest is decided by disinterested members of the board of directors or Grants Advisory Committee, there are certain situations listed below in which a conflict of interest is absolutely prohibited.

- a) No Interested Person shall participate in the selection, award or administration of a contract to be paid with federal funds if a real or apparent conflict of interest is present.
- b) No Interested Person shall receive a loan from the Organization.
- c) No Interested Person shall receive Compensation for exercising their duties as an officer, director, or Grants Advisory Committee member except for the reimbursement of expenses.
- d. Quote Applicability
Vendor must substantially conform to the terms, conditions, specifications and other requirements found within the text of the energy Audit Summary and Bid Specifications (Attachment B) All previous agreements or other documents, which have been executed between the Vendor and Energy Outreach Colorado Efficiency LLC , are not applicable to this Request for Proposal or any resultant agreement(s).

IV. INSURANCE, BONDS, LICENSING, PERMITS

1. INSURANCE

- a. The Vendor shall obtain and maintain insurance as specified here at all times during the term of the contract with EOCE. All policies evidencing the required insurance coverage shall be issued by insurance companies satisfactory to EOCE and CEO but in no circumstance can the insurance company have a Best rating lower than A-.
- b. Commercial General Liability with minimum limits as follows: (a) \$1,000,000 each occurrence; (b) \$2,000,000 general aggregate; and (c) \$2,000,000 products and completed operations aggregate. Can be demonstrated by a \$1,000,000 primary limits and \$1,000,000 umbrella policy. The policy shall name as additional insured and include a waiver of subrogation in favor of Property Owner, EOCE and CEO. The additional insured endorsement must provide products/completed operations hazard insurance to the additional insureds. Vendor warrants that no prior claims have impaired the limits of insurance required under this provision. Vendor further warrants that it will replenish any impaired limits so that the full amount of insurance required under this provision is available for any claims arising out of Vendor's work.
- c. Automobile Liability Insurance with a minimum limit of \$1,000,000 each accident combined single limit. The policy shall name as additional insured and include a waiver of subrogation in favor of Property Owner, EOCE and CEO.
- d. Workers' Compensation Insurance with the statutory limits to cover full liability under Colorado's Workers' Compensation laws. Vendor shall obtain and maintain \$1,000,000 per occurrence Employer's Liability or Stop-Gap coverage. The policy shall include a waiver of subrogation in favor of EOCE, Property Owner and Tenant. If contractor is a sole proprietor, contractor must fill out the *Declaration of Independent Contractor Status Form*.
- e. Pollution Occurrence Insurance with a minimum limit of \$500,000. The policy shall name as additional insured and include a waiver of subrogation in favor of EOCE, CEO, and Property Owner. EOCE will consider waiving this requirement on a case by case basis and only where circumstances warrant a waiver.

2. PAYMENT AND PERFORMANCE BOND

Vendor shall secure and post a Labor and Materials Bond and a Performance Bond, each in the amount of one-hundred percent (100%) of the Funding Amount as provided in Exhibit A-1 of the final contract. Such bonds shall be issued by a surety company authorized to do business in the State of Colorado and the cost of all such bonds shall be included in the Cost of the Work. Bonding requirements are at EOCE's sole discretion and may be waived, in writing, by EOCE. Include the cost of all such bonds as a separate line item within the bid forms provided in Attachment A.

3. LICENSES

Vendors shall maintain in status all federal, state, and local licenses and permits required for the operation of business conducted by the Vendor.

4. PERMITS

Each Vendor shall secure permits and inspections required by applicable authorities and pay all cost in connection with the work. The Vendor shall provide written notification to EOCE when permits are not required.

V. INSPECTIONS

1. EOCE INSPECTION

Each Vendor is required to be present at the EOCE final inspection of each specified energy efficiency measure to ensure compliance with weatherization rules, materials, and agreed upon bid specifications. EOCE will give the selected Vendor five (5) days notice of the scheduled inspection.

2. CEO INSPECTION

Each Vendor is required to be present at the CEO final inspection of each specified energy efficiency measure to ensure compliance with weatherization rules, materials, and agreed upon bid specifications. EOCE will give the selected Vendor five (5) days notice of the scheduled inspection.

VI. ENVIRONMENTAL SAFETY COMPLIANCE

1. AHERA – ASBESTOS CERTIFICATION

The Colorado Department of Public Health and Environment requires certification for personnel intending to provide asbestos abatement services. Properly trained weatherization personnel or appointed representatives may remove samples of material for laboratory testing to determine if the sample is, in fact, an ACM (asbestos containing material). A certified asbestos worker or organization may be hired by the housing provider to remedy hazards that represent any imminent threat. Any and all asbestos work shall be paid for by the Housing Provider and will require a contract separate from the EOCE/Housing Provider/Vendor(s) contract; EOCE is not able to pay for asbestos testing/work.

2. LEAD-BASED PAINT

For improvements constructed before 1978, Vendor shall:

- a. Obtain certification in Lead-Based Paint Renovation
- b. Meet or exceed all EPA Lead-Safe Renovation requirements and processes according to Lead-Safe weatherization regulations 40 CFR 745 Subpart D & E.

3. RECYCLING

Vendor shall appropriately recycle all appliances, and provide an official certificate of recycling or receipt for specified energy efficiency measures which include refrigerators, air conditioning units, fluorescent lamps and magnetic ballasts.

VII. SUBCONTRACTORS & PAYROLL REQUIREMENTS

1. SUBCONTRACTORS

If the Vendor seeks to hire sub-contractors to perform the weatherization services, the Vendor shall comply with the Weatherization Assistance Program procurement regulations. Subcontractors will be held to all terms, conditions and requirements outlined within the text of this RFP.

VIII. PROPOSALS EVALUATION AND AWARD(S)

1. EVALUATION PROCESS

Energy Outreach Colorado Efficiency LLC will determine the most suitable Vendor(s) to complete the services described in the bid specifications. Proposals must be complete according to Attachment A in order for the proposals to be evaluated. Vendors will be evaluated based on the content of the proposal package with considerations made for solid financial responsibility, integrity, experience and quality of work, record of completing projects on time, and the capacity and ability to do the work according to the plans and specifications. Preference will be given to the following: a) minority firms; b) Women Business Enterprises; and c) Labor Surplus Area Firms.

Proposals that are incomplete or contain significant inconsistencies or inaccuracies may be rejected by Energy Outreach Colorado Efficiency LLC without further discussion. Energy Outreach Colorado Efficiency LLC reserves the right to accept or reject any part of any proposals, and to accept or reject any or all proposals without penalty. Energy Outreach Colorado Efficiency LLC reserves the right to waive minor deficiencies and informalities if, in the judgment of Energy Outreach Colorado Efficiency LLC, the best interests of EOCE shall be served.

Selection cannot be made based on local geographic preferences, except where applicable Federal statutes expressly mandate or encourage geographic preference. Only responsible contractors possessing the ability to perform successfully under the terms and conditions of the RFP will be awarded the work.

In addition bids may be re-evaluated against the DOE Audit software to evaluate cost effective benefit. Bids exceeding this benefit may be rejected by EOCE without further discussion.

2. APPEAL OF AWARD

Solicitations are awarded based on several conditions, price being just one of the elements. Please check the Proposal Evaluation criteria to see what elements the award will be based on. Vendors may appeal the Proposal Award Notice decision by submitting, in writing, to Energy Outreach Colorado Efficiency LLC, a request for reconsideration within 5 days of the Proposal Award Notice being sent to all participating vendors via email. Vendors who were deemed non-responsive are ineligible to participate in the appeal of award process.

IX. PAYMENT FOR SERVICES

1. CONDITION PRECEDENT FOR PAYMENT

Passing the EOCE inspection is a condition precedent for payment. Accordingly, no payment shall be made to Vendor if Vendor fails to pass the EOCE inspection. Further, EOCE may withhold payment until corrections in Vendor's performance are satisfactorily made and completed, and no payment shall be made to Vendor if Vendor cannot satisfactorily perform the work.

2. PAYMENT

EOCE will review payment requests upon receipt. If Vendor has satisfied all conditions for service and inspections, and if payment request complies with this agreement, subject to amounts retained, as described below, EOCE shall issue payment to Vendor within 30 days of the day EOCE determines the payment request complies with this agreement.

3. PAYMENT AMOUNT

In accordance with this section, EOCE shall pay Vendor an amount equal to the cost of the work per Exhibit A-1 of the final contract. Profit will be negotiated as a separate element of the price (1) for each contract in which there is no price competition and (2) in all cases where cost analysis is performed.

4. MAXIMUM PAYMENT AMOUNT

Regardless of the cost of the work, total payments made to Vendor shall not exceed the funding amount, unless amended by change order. Further, Vendor shall not be entitled to any additional compensation for repairs performed as a result of failed inspection, Vendor's negligence, or defects in the work.

5. INTERIM FUNDING

EOCE shall have no obligation to fund the energy efficiency measures prior to final completion and inspection of the requested EEMs. However, if the Vendor is obligated to pay for the specified energy efficiency measures prior to payment, and has insufficient funds to do so, EOCE may, in certain circumstances, but is not obligated at any point to, negotiate progress payments with specific conditional and unconditional lien waiver requirements (**Attachment E**).

6. RETAINAGE

EOCE will withhold from Vendor's payment retainage of ten percent (10%) until Vendor passes the CEO inspection. If Vendor passes the CEO inspection prior to submitting the payment request, EOCE shall not withhold retainage. EOCE shall pay Vendor the retainage amount within 15 days of Vendor passing the CEO inspection.

7. TAXES & FEES

If not included in bid submission, Vendor shall be responsible for costs associated with taxes and duties however designated, including all sales, use, rental, receipt, value added, personal property, and other taxes, that may be levied or assessed in connection with the Vendor's possession, receipt, or use of the specified construction services.

8. CHANGE ORDERS

Notwithstanding the foregoing, the parties may agree that additional funding, above the funding amount, is necessary to complete the energy efficiency measure. Change orders may be

negotiated and approved upon Vendor's notice, but only when due to unforeseen circumstances, concealed conditions, or acts of nature. The parties shall negotiate change order amounts, and EOCE shall make final determinations, in its sole discretion, of whether and how much additional funding is necessary to complete the work. EOCE's decision regarding change orders shall be at its sole discretion and is final. If approved, EOCE may fund change orders pursuant to this section. Vendor expressly waives all other rights and claims regarding change orders. If a change order request is a result of an egregious bid, then a change order will not be issued and the difference in cost will be the Vendor's responsibility.

9. PAYMENT REQUEST AND LIEN WAIVER

Once Vendor has passed the EOCE inspection, Vendor may submit to EOCE a payment request.

a. Payment Request Submission

- i. ALL INVOICES MUST INCLUDE: reference to the property's address; unit numbers/floors/buildings served; an itemized list of all labor and materials; labor hours; Vendors zip code + 4 digit extension; and a current W-9.
- ii. EOCE may request documentation necessary to demonstrate Vendor's cost of the work, which may include invoices, statements, receipts, subcontractor contracts or payments and timecards.
- iii. When the Vendor has completed the requested weatherization service(s), the Vendor shall submit payment request to EOCE.

b. Lien Waivers

- i. Conditional and unconditional lien waivers (Attachment E), when deemed necessary from Vendor, subcontractor, supplier, and any other person who has supplied materials or labor to the property/project.

X. SCHEDULE KEY DATES

Following are the key dates in the schedule for this procurement:

- | | |
|---|------------|
| • Request for Proposals Issued | 01-25-2021 |
| • Proposals Bidders Meeting- <u>TERRY ST APARTMENTS</u> | 02-03-2021 |
| • Proposal Question Submission Deadline | 02-08-2021 |
| • Proposal Answers/Amendment Distribution | 02-10-2021 |
| • Proposals due by 5pm | 02-18-2021 |
| • Anticipated Date - Contract(s) Signed | 07-01-2021 |
| • Anticipated Project Start Date | 07-01-2021 |
| • Anticipated Completion Date | 05-31-2022 |

Energy Outreach Colorado Efficiency LLC reserves the right to proceed under a revised version of this schedule.

XI. RFP MODIFICATIONS

Energy Outreach Colorado Efficiency LLC shall prepare written Modifications(s) if needed. All modifications to this RFP shall be prepared by Energy Outreach Colorado Efficiency LLC and formally issued to all holders of RFP documents on record and verified as “in attendance” at the mandatory bidder’s conference. Addenda shall be issued not later than the date specified in the schedule. Written addenda shall serve to amend the RFP documents accordingly.

TERRY STREET APARTMENTS

Energy Outreach Colorado Multi-Family Audit

January 4, 2021

PREPARED BY:

Erik Swanton

PE

eswanton@group14eng.com



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1 EXECUTIVE SUMMARY

Group14 has completed an energy audit of Terry Street Apartments, a 7100 ft², two-story wood frame building consisting of 10 units.

The Terry Street Apartments have individual furnaces controlled by in-unit thermostats to provide heating for each unit. Cooling is provided by tenant-owned window AC units. In-unit ventilation is provided by exhaust fans ducted to bathrooms that vent individually to the outdoors. The only common space is the laundry room, which is attached to the main building and has its own baseboard heating system.

Building and utility data shall be compiled and entered into DOE-2 modeling software at a later date.

| Fuel | Annual Use | Annual Cost |
|----------------|--------------|-------------|
| Electric (kWh) | TBD | TBD |
| Gas (Therms) | TBD | TBD |
| | Total | TBD |

Table 1 - Historical Energy Use Summary

Building envelope, HVAC, lighting, potable water, and control systems were analyzed for opportunities to improve efficiency and address health and safety issues. The energy efficiency measures (EEMs) and health and safety measures (H&S) that passed the Department of Energy's criteria for weatherization funding are presented in the tables below. Specific details of savings calculations will be provided at a later date.

| Energy Efficiency Measure | 1 st Year Savings | SIR |
|----------------------------------|------------------------------|------------|
| Replace In-Unit Lighting | TBD | TBD |
| Replace Common Area Lighting | TBD | TBD |
| Low Flow Fixtures | TBD | TBD |
| Furnace Upgrade | TBD | TBD |
| DHW Upgrade | TBD | TBD |
| DHW and Space Heating in Laundry | TBD | TBD |
| Refrigerator Upgrade | TBD | TBD |
| Programmable Thermostat | TBD | TBD |
| Increase Attic Insulation | TBD | TBD |
| Package | TBD | TBD |

Table 2 - EEM Summary

| Energy Efficiency Measure | 1 st Year Savings | SIR |
|------------------------------------|------------------------------|-----|
| Replace Exterior Lighting Fixtures | TBD | TBD |
| Replace Windows | TBD | TBD |
| Install Solar | TBD | TBD |

Table 3 - Measures Not Recommended

All energy efficiency measures are detailed in the DOE-2 model outputs (Appendix C) and Scope of Work Specifications (Appendix A).

In addition to the EEMs presented above, four health and safety measures were documented.

| Existing Condition | Health and Safety Measure |
|---|--|
| Some bathroom exhaust flow rates are below code minimum. | Clean exhaust ducting and install new exhaust fans where necessary to meet ventilation requirements. |
| Each unit has a separate battery powered smoke and CO alarms. | Replace battery operated alarms with a hardwired smoke and CO combination alarm. |
| Laundry room has an atmospherically vented water heater and no makeup air. | Consider installing louver on door to provide makeup air and prevent back drafting exhaust gases into the laundry room. |
| DHW heaters are currently set to 120°F and there is no thermostatic mixing valve installed. | Raise temperature to 140°F to prevent Legionnaire's Disease and install thermostatic mixing valve to temper the hot water. |

Table 4 - Health and Safety Measures

The existing building conditions of The Terry Street Apartments are also documented in this report.

Note that all existing equipment types, quantities, and costs listed in this report are for purposes of this analysis and should not be used as a basis for contractor bids or construction estimates.

2 EXISTING BUILDING CONDITIONS

2.1 Building Description

| | | | |
|-----------------------|-------|-------------------------|--|
| Square Footage | 8,000 | Lot Description | Parking lot wraps around entryways at south and west elevations with laundry room at the front and maintenance shed on the northwest corner. |
| Building(s) | 1 | Unit Description | (4) 1-Bedroom units, (6) 2-Bedroom units |
| Stories | 2 | Common Spaces | Exterior laundry room |

Table 5 - Building Description

The Google Earth image below provides an overhead view of the site.



Figure 1 - Overhead view of The Terry Street Apartments

2.2 Building Envelope

The building has a pitched composite shingle roof with a continuous vented attic.

The exterior envelope consists a mix of brick veneer and lap siding, over gypsum sheathing with 2x4 wood studs and R-11 fiberglass insulation.

The windows are double pane with vinyl frames. The floor construction consists of wood joists over a continuous crawl space with insulated rims and vents dispersed throughout the perimeter of the building.

The attic space has a single access point, which was obstructed at the time of the site visit. Attic was inaccessible and inspection of attic insulation was not completed during this round.

Images of the east, north, south, and west façades are presented below.



Figure 2 - East Facade



Figure 3 - West Facade



Figure 4 - South Facade



Figure 5 - North Facade

2.2.1 Wall Insulation

The exterior walls have R-11 batt insulation according to construction drawings. Samples taken from the wall cavity showed 3.5” of insulation.

Wall cavity and insulation depths were measured on site in each cardinal direction:

| Orientation | Cavity Depth | Insulation Depth | Location |
|-------------|--------------|------------------|----------|
| South | 3.5” | 3.5” | Unit 201 |

| | | | |
|-------|------|------|----------|
| North | 3.5" | 3.5" | Unit 206 |
| West | 3.5" | 3.5" | Unit 209 |
| East | 3.5" | 3.5" | Unit 201 |



Figure 6 - 3.5" depth of batt insulation



Figure 7 - Typical batt insulation of exterior wall

2.2.2 Crawl Space

The Terry Street Apartment building has a passively vented, unconditioned crawl space that extends under the entire building. The crawl space was 32" high with 3.5" of fiberglass batt at the rim joists. There was no floor insulation or vapor barrier. Rim insulation appeared to be in fair condition.



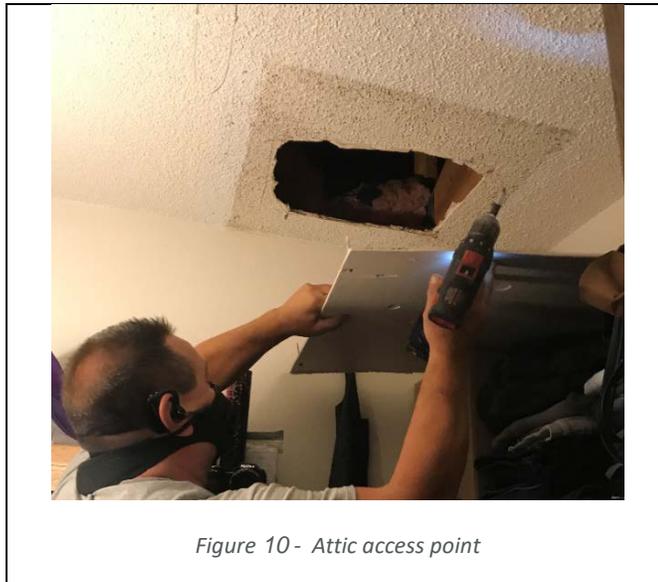
Figure 8 - Crawl space access point



Figure 9 - Crawl space

2.2.3 Attic Insulation

The attic to the building had a single access point, which was obstructed by additional shelving installed by the tenant. There is no insulation or air sealing on the ¼" wood sheathing that served as the access door.



2.2.4 Envelope Energy Modeling

To be included in Final Report.

2.2.5 Thermal Boundary

To be included in Final Report.

2.2.6 Infrared Photos

To be included in Final Report.

2.3 Lighting

The lighting at Terry Street Apartments is a varying assortment of technologies. With limited exterior and common area space, most lighting is within the individual units.

Building common area consists of a laundry room accessible through an exterior entrance. The only light fixtures present in this space are T12 Linear Fluorescent tubes.

Exterior site lighting is provided by all wall mounted LED floodlights with individual photocells.

Residential units have a variety of lighting configurations ranging from linear fluorescents to ceiling mounted screw bulb fixtures. Technologies include halogen, incandescent, CFL, and LED fixtures all controlled by wall mounted switches.

A full lighting inventory has been included below in **Table 6**.

Table 6 - Lighting Inventory

| Tag | Fixture Type | Lamp/ Ballast Type | Lamps /Fixture | # Fixtures | Lamp Watts | Spaces Served | Replace |
|-----------------------------|--|---|----------------|------------|------------|---|---------|
| COMMON AREA LIGHTING | | | | | | | |
| T12M4SM | Surface Mount | 4' T12 Fluorescent/ Magnetic Ballast | 2 | 1 | 40 | Laundry Room | Y |
| EXTERIOR LIGHTING | | | | | | | |
| LFL | Wall Mounted Flood Light | LED Bulb | 2 | 4 | 7.5 | Exterior East, West, and North | N |
| IN-UNIT LIGHTING | | | | | | | |
| AA | Ceiling Surface Mount Fixture | T12 Linear Fluorescents | 2 | 4 | 40 | Kitchen | Y |
| BB | Ceiling Surface Mount Fixture | T12 Linear Fluorescents | 4 | 4 | 40 | Kitchen | Y |
| CC | Ceiling Surface Mount Fixture | LED Tubes | 2 | 2 | 18 | Kitchen | N |
| DD | Ceiling Surface Mount Round/Square Fixture | Screw-Base LED Bulb | 2 | 7 | 9 | Kitchen, Bedroom | N |
| EE | Ceiling Surface Mount Round/Square Fixture | Screw-Base Incandescent Bulbs | 2 | 2 | 38 | Kitchen, Bedroom | Y |
| FF | Screw Base LED Porch Light, Exhaust, Ceiling Mounted | Screw-Base LED Bulb | 1 | 12 | 9 | Front Porch, Kitchen Exhaust, Hallway, Closets | N |
| GG | Front Porch Light, Exhaust Fan, Ceiling Mount | Screw-Base CFL Bulb | 1 | 6 | 13 | Front Porch, Kitchen Exhaust, Hallways, Closets | Y |
| HH | Kitchen Exhaust | Screw-Base Incandescent Bulb | 1 | 1 | 40 | Kitchen | Y |
| II | Kitchen Exhaust | Screw Base Halogen | 1 | 1 | 72 | Kitchen | Y |
| JJ | Ceiling Mounted Screw Base | Screw-Base Incandescent Bulb | 1 | 2 | 29 | Mechanical Closets | Y |
| KK | Ceiling Mounted Screw Base | Screw-Base Incandescent Bulb | 1 | 2 | 38 | Mechanical Closets | Y |
| LL | Vanity | Screw-Base LED Bulb | 4 | 6 | 9 | Bathroom | N |
| MM | Vanity | Screw-Base CFL Bulb | 4 | 2 | 13 | Bathroom | Y |
| NN | Vanity | Screw-Base Incandescent Bulb | 4 | 2 | 29 | Bathroom | Y |
| OO | Square Semi Flush Ceiling Mount | Screw-Base CFL Bulb | 2 | 1 | 13 | Bedroom | Y |
| PP | Square Semi Flush Ceiling Mount | Screw-Base Halogen Bulb | 2 | 1 | 72 | Bedroom | Y |

A sample of lighting photos and a lighting inventory for the building are presented below. Additional fixture photos can be found in Appendix E.

Common Area Lighting



Figure 11 – 4' T12 Fluorescent / Magnetic Ballast (T12M4SM)

Exterior Lighting



Figure 12 - LED Wall Mounted Flood Light (LFL)

In-Unit Lighting



Figure 13– Surface Mount 4' T12 Linear Fluorescent 2-Bulb Fixture (AA)



Figure 14– Surface Mount 4' T12 Linear Fluorescent 4-Bulb Fixture (BB)



Figure 15 -- Ceiling Surface Mount Round Fixture, Incandescent Bulbs (EE)



Figure 16 – Front Porch Light, LED (FF)



Figure 17 – Front Porch Light, CFL (GG)



Figure 18 – Kitchen Exhaust, Incandescent 40W (HH)



Figure 19 – Kitchen Exhaust, Halogen 72W (II)



Figure 20 – Typical Surface Mount Globe Fixture, LED Bulb (FF)



Figure 21 – Typical Vanity Fixture, Screw Base LED Bulbs (LL)



Figure 22 – Typical Square Semi Flush Ceiling Mount, Screw Base CFL Bulbs (OO)

2.4 HVAC System

In-Unit: Heating for each unit at Terry Street Apartments is provided by forced air, natural draft gas furnaces located in the mechanical closet of each unit. Installation of furnaces range from approximately 1983 to 2006. Exhaust vent ducting for the furnace ties into a common vent shared by the water heater that pipes through the wall or ceiling of the mechanical closet. Heating is controlled by a mix of analog and digital thermostats. Cooling is provided by tenant-installed window AC units. For further mechanical details, please see **Table 7** Sampled Furnace Details.

Laundry Area: There is an exterior section attached to the main building that serves as a common laundry room. The space is conditioned by baseboard heating served by a naturally drafted packaged water heater tank, which also provides hot water for the washers. Space heating is controlled by a wall-mounted thermostat that enables a circulating pump to the baseboard. There is no cooling or ventilation.

Gas combustion analysis and operation of furnaces and DHW are scheduled to be tested at a later date during cold weather months.

Ventilation: Each unit has an exhaust fan ducted to a bathroom.

Table 7 - Sampled Furnace Details

| Furnace #1 | | | |
|------------------------|---------------|--------------|---------------|
| Furnace Information | | Fuel | |
| Manufacturer | Magic Chef | Fuel Type | Natural Gas |
| Model | EG6A40D-7 | Combustion | Natural Draft |
| Input Capacity (MBH): | 40 | Year | 1983 |
| Output Capacity (MBH): | 32 | Furnace Type | Forced Air |
| Furnace #2 | | | |
| Furnace Information | | Fuel | |
| Manufacturer | HEIL | Fuel Type | Natural Gas |
| Model | GMH80704BNCB | Combustion | Natural Draft |
| Input Capacity (MBH): | 70 | Year | 2006 |
| Output Capacity (MBH): | 56 | Furnace Type | Forced Air |
| Furnace #3 | | | |
| Furnace Information | | Fuel | |
| Manufacturer | Frigidaire | Fuel Type | Natural Gas |
| Model | L1RA 054C-12A | Combustion | Natural Draft |
| Input Capacity (MBH): | 54 | Year | 2002 |
| Output Capacity (MBH): | 43 | Furnace Type | Forced Air |
| Furnace #4 | | | |
| Furnace Information | | Fuel | |
| Manufacturer | Trane | Fuel Type | Natural Gas |
| Model | TUD040R924J1 | Combustion | Natural Draft |
| Input Capacity (MBH): | 36 | Year | 1993 |
| Output Capacity (MBH): | 22 | Furnace Type | Forced Air |

2.4.1 Domestic Hot Water

Domestic hot water is provided by a natural gas fired water heaters ranging from 2006 (possible there could be older ones) to 2019. All sampled units had manual dial controls set between a range of 120°F (Setting “Hot”) to 150°F (Setting “C”) and a storage capacity of 40 gallons. Exhaust vent ducting for the water heater ties into a common vent shared by the furnace that pipes through the wall or ceiling of the mechanical closet. For further mechanical details, please see **Table 8 Sampled DHW Details**.

In the laundry room, there is a wall-mounted thermostat enabling a 1/40 HP recirculation pump to cycle water from the baseboard back to the DHW tank. The DHW tank in the laundry room provides hot water for both the baseboard and the washers. The temperature setpoint was 150°F and the storage capacity was 50 gallons. The DHW vents directly through the ceiling and discharges at the roof of the main building.

Generally, domestic hot water tanks appeared to be more recently replaced than furnaces. All piping was uninsulated and within conditioned space.

Table 8 - Sampled DHW Details

| Domestic Hot Water #1 | | | |
|------------------------|----------------|------------------------|---------------|
| DHW Type | Packaged | Fuel Type | Natural Gas |
| Manufacturer | Rheem | Temperature Setpoint | 140 |
| Model | XG40T06EC36U1 | Control Type | Manual Dial |
| Thermal Efficiency | 80% | Storage Capacity (Gal) | 40 |
| Input Capacity (MBH): | 36 | Combustion | Natural Draft |
| Output Capacity (MBH): | 29 | Year | 2019 |
| Domestic Hot Water #2 | | | |
| DHW Type | Packaged | Fuel Type | Natural Gas |
| Manufacturer | Bradford White | Temperature Setpoint | 130 |
| Model | RG240T6N | Control Type | Manual Dial |
| Thermal Efficiency | 80% | Storage Capacity (Gal) | 40 |
| Input Capacity (MBH): | 40 | Combustion | Natural Draft |
| Output Capacity (MBH): | 32 | Year | 2014 |
| Domestic Hot Water #3 | | | |
| DHW Type | Packaged | Fuel Type | Natural Gas |
| Manufacturer | Rheem | Temperature Setpoint | 140 |
| Model | XG40T06EC36U1 | Control Type | Manual Dial |
| Thermal Efficiency | 80% | Storage Capacity (Gal) | 40 |
| Input Capacity (MBH): | 36 | Combustion | Natural Draft |
| Output Capacity (MBH): | 29 | Year | 2019 |
| Domestic Hot Water #4 | | | |
| DHW Type | Packaged | Fuel Type | Natural Gas |
| Manufacturer | Whirlpool | Temperature Setpoint | 120 |
| Model | N40T91-403 | Control Type | Manual Dial |
| Thermal Efficiency | 80% | Storage Capacity (Gal) | 40 |
| Input Capacity (MBH): | 40 | Combustion | Natural Draft |
| Output Capacity (MBH): | 32 | Year | 2006 |

| Domestic Hot Water - Laundry Room | | | |
|-----------------------------------|----------------|------------------------|---------------|
| DHW Type | Packaged | Fuel Type | Natural Gas |
| Manufacturer | Bradford White | Temperature Setpoint | 150 |
| Model | RG250T6N | Control Type | Manual Dial |
| Thermal Efficiency | 80% | Storage Capacity (Gal) | 50 |
| Input Capacity (MBH): | 40 | Combustion | Natural Draft |
| Output Capacity (MBH): | 32 | Year | 2014 |

Photos of the major mechanical equipment are shown on the next page. Additional photos are included in Appendix E (separate file).

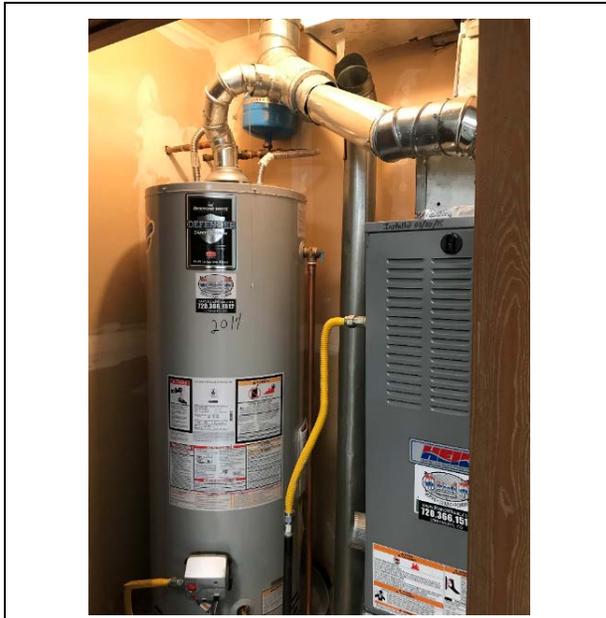


Figure 23 – Typical Mechanical Closet

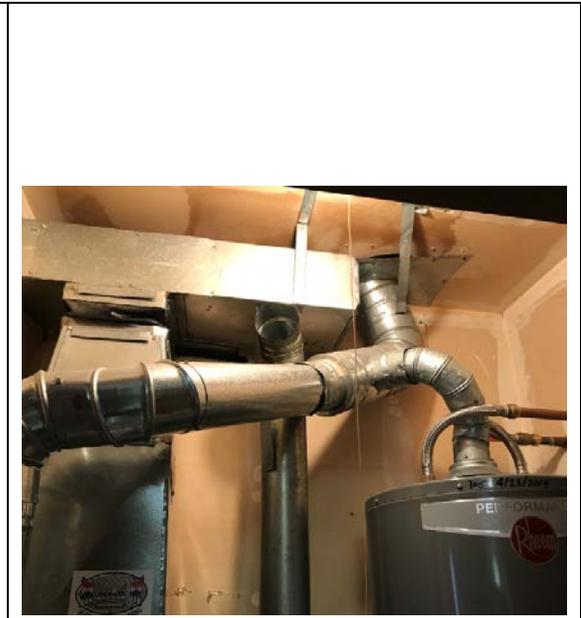


Figure 24 – Common Vent Ducting

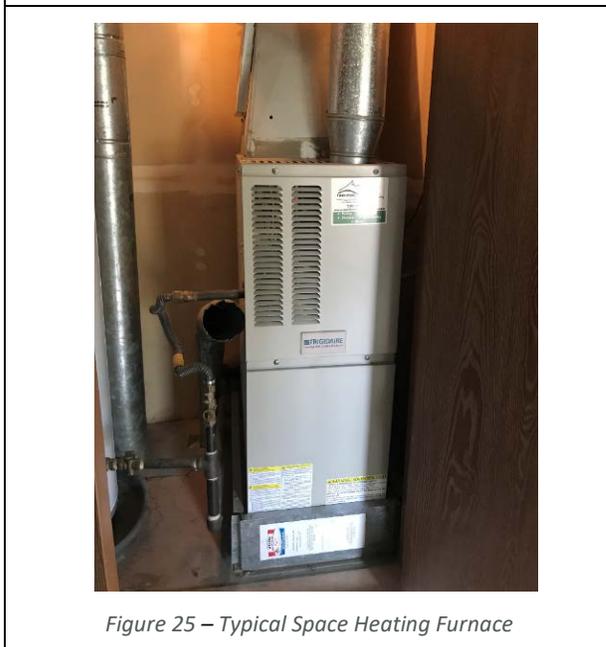


Figure 25 – Typical Space Heating Furnace



Figure 26 – Typical Space Heating Furnace



Figure 27 – Typical Packaged Water Heater



Figure 28 – Typical Packaged Water Heater



Figure 29 – Packaged Water Heater (Laundry)



Figure 30 – DHW recirculation pump (Laundry)

2.5 Equipment Testing and Records

Combustion gas analysis will be completed at a later date. Full results of the combustion analysis of all equipment are to be provided in Appendix D.

2.6 Mold Inspection

A visual mold inspection was conducted in 100% of the units at the Terry Street Apartments.

No signs of mold or mildew were detected in any of the 10 units.

3 RECOMMENDED ENERGY EFFICIENCY MEASURES

A short narrative of each energy efficiency and health and safety measure that meets DOE weatherization funding criteria is provided below. More detailed guidance for measure implementation is included in the bid specifications (Appendix A).

3.1 In-Unit Lighting

3.1.1 Halogen, Incandescent and CFL Bulbs to LEDs

The replacement of all hardwired screw-in fixtures with LED lamps has been evaluated. It is recommended that an LED be used to replace bulbs in all screw-in fixtures.

Bulb replacements are shown in the table below.

| Lighting Inventory Tag | Fixture | Replacement Fixture | Replacement Fixture Code | Estimated Number To Be Replaced |
|--|--|---------------------|--------------------------|---------------------------------|
| EE, GG, HH, II, JJ, KK, MM, NN, OO, PP | Hardwired Screw-in Typical Base Incandescent, CFL, and Halogen Bulbs | 9.5W LED Bulb | L1-B | 36 Bulbs |

Table 9 - In Unit Lighting Replacements, Screw-In Fixtures

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.1.2 T12 Linear Fluorescents to LEDs

The replacement of all hardwired Linear Fluorescent fixtures with LED tubes has been evaluated. It is recommended that an LED tube be used to replace all remaining T12 linear fluorescents. A combination of electronic and magnetic ballasts was identified. All remaining magnetic ballasts should be replaced with electronic ballasts.

| Lighting Inventory Tag | Fixture | Replacement Fixture | Replacement Fixture Code | Estimated Number To Be Replaced |
|------------------------|---|--|--------------------------|---------------------------------|
| AA, BB | 4' T12 Linear Fluorescent Bulbs, Magnetic and Electronic Ballast (2-lamp & 4-lamp fixtures) | Type C 15W LED Tube with Remote Driver | RL3 | 24 Bulbs |

Table 10 - In Unit Lighting Replacements, Non screw-in Fixtures

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.2 Common Area Lighting Fixtures

The only community space at Terry Street Apartments is a laundry room on the West end of the building. This space has (1) 4' T12 fixture with magnetic ballast lamped with (2) 40W bulbs. Ballast should also be replaced with an electronic ballast.

Fixture replacement is shown in the table below.

| Lighting Inventory Tag | Fixture | Replacement Fixture | Replacement Fixture Code | Number To Be Replaced |
|------------------------|---|--|--------------------------|-----------------------|
| T12M4SM | 4' Surface Mount T12 Linear Fluorescent with Magnetic Ballast (2-Lamp Fixtures) | Type C 15W LED Tube with Remote Driver | RL3 | 2 Bulbs |

Table 11 - Common Area Lighting Replacements

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.3 Low-Flow Fixtures

The majority of kitchen faucets and showerheads had conventional flow fixtures. Fixtures should be replaced as needed to meet the Recommended Minimum Performance indicated in the table below.

Please note that the number of replacement fixtures to be verified in the field by installing contractor due to significant variability in unit configurations.

| Fixture | EPA Requirements (GPM) | Recommended Minimum Performance (GPM) | Anticipated Number to Be Replaced |
|-----------------|------------------------|---------------------------------------|-----------------------------------|
| Bathroom Faucet | 2.0 | 1.0 | 10 |
| Shower | 2.5 | 1.5 | 10 |
| Kitchen Faucet | 2.2 | 1.5 | 10 |

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.4 Furnace Upgrade

Existing Condition:

In-unit heating is provided by individual forced air, natural gas furnaces. There is one outdoor air intake pipe in some units and two in a high-low configuration in others. Combustion air is provided for both the DHW and the furnace.

Efficiency Measure:

Some of the furnaces are more than 30 years old. The replacement of furnaces with new 94%+ AFUE condensing 2-stage models is recommended in units where inefficient non-condensing models more than 7 years old are currently in place. A new thermostat shall be installed that takes full advantage of the staging and efficiency performance of the new furnace.

General Requirements

Please consider the following while pricing:

1. The Contractor shall be responsible for the design and construction of the installation in its entirety, and shall secure the services of qualified professionals as required to complete this scope of work. Additional wires may need to be run between the furnace and new thermostat. This cost must be included in the bid.
2. Provide a programmable thermostat with the ability to take advantage of the staging and the ability to operate in fan only mode.
3. Furnaces need to be installed per code. This includes meeting any dedicated power requirements. Any costs associated with code requirements of the Authority Having Jurisdiction must be included in the bid.
4. A Manual J compliant load calculation and Manual S compliant sizing must be performed to properly size the new furnaces. The load calculation should assume the infiltration reduction and attic insulation measures listed in this report have been performed. All load and sizing calculations shall be submitted to the owner and commissioning agent for approval before any equipment is ordered. It was noted during the audit that most units were oversized. **Do NOT bid like for like capacities with existing equipment before evaluating loads.**
5. Include a detailed description of the proposed flue routing for the new condensing furnace with the bid that meets code and manufacturer requirements. Exterior flue penetrations should be capped with a bird screen and be out of reach of any residents. The proposed flue route will need to be approved by the commissioning agent and owner.
6. Verify that gas piping and pressure meet manufacturer requirements. Any cost for modifications must be included in bid.
7. All visible and accessible ducts shall be sealed with a SMACNA approved material.
8. All equipment shall be started per manufacturer requirements. Also include documentation of proper airflow, filtration, gas pressure, temperature rise, and controls configuration. Start-up documentation shall be left on site and submitted to the owner and commissioning agent. A sample start up report shall be included in the bid specifications.
9. The following performance-based specification sections are related to this scope of work (note: some information in the specifications may relate to other scopes of work and may not be germane to this scope of work):
 - 235416 – GAS-FIRED FURNACES

Improvements to Operations and Maintenance:

New furnaces will push back the date at which the unit furnaces would have to be replaced due to reaching end of life cycle, and will reduce the number of heating-related calls experienced. Additionally, all furnaces will be provided by the same manufacturer, improving the ease of maintenance and repair.

Impacts to Residents:

The new furnaces will likely be capable of more heating output than the current equipment, keeping the residents more comfortable. Installation of digital thermostats will allow for more accurate thermal control. Any sites that see airflow rebalancing will improve thermal comfort.

Pricing and Site Specific Installation Notes to Contractor:

Size furnaces at 30 btu/SF for pricing purposes. Before final equipment selection, contractor shall be responsible for load calculation and equipment sizing per specifications. **It should be noted that the contractor is ultimately responsible for verifying site conditions.**

3.5 Domestic Hot Water Upgrade

Existing Condition:

Domestic water heating is provided by individual packaged tank water heaters in each unit. The water heaters were atmospherically vented units with 80% thermal efficiency, and temperature setpoints ranged from 120°F to 150°F. Age of water heaters ranged from over 15 years old to less than one year old. There is one outdoor air intake pipe in some units and two in a high-low configuration in others. Combustion air is provided for both the DHW and the furnace.

Efficiency Measure:

The replacement of atmospheric water heaters with a condensing water heater is recommended in dwelling units where inefficient non-condensing models more than 7 years old are currently in place. New water heaters can be either tank type condensing or a domestic hot water boiler with separate storage tanks. Calculations shall be performed to determine the necessary domestic hot water capacity for the current connected hot water loads. Loads may be reduced as new low flow water fixtures are installed.

The combustion air intake and flues for the new water heaters will depend on the manufacturer selected. Ducted combustion air (direct vent) is preferred so there are no openings in the mechanical closet that allow cold air to enter. Some condensing water heaters have a concentric vent/flue option that may allow both the combustion air and flue to go to the existing combustion air location. Common venting between the furnace and water heater for combustion air may be necessary for some units depending on existing vent configurations.

General Requirements

Please consider the following while pricing:

1. The Contractor shall be responsible for the design and construction of the installation in its entirety, and shall secure the services of qualified professionals as required to complete this scope of work.

2. The capacity of the domestic water heating plant shall be engineered to match the anticipated domestic hot water loads, considering that all conventional flow fixtures will be replaced with low-flow fixtures. A load calculation, piping layout and drawings are part of the design scope of work. The Design/Build installer shall submit all engineering calculations for Owner review and acceptance prior to ordering equipment.
3. The contractor shall provide a fully operational hot water system including but not limited to the electrical work, flues, combustion air, natural gas piping, equipment and piping supports, anchors, pumps, boilers, acid neutralization for condensing equipment drainage, and associated controls. Follow manufacturer's guidelines for proper installation and venting.
4. The Contractor shall be responsible for the demolition, removal and proper disposal of all of the existing equipment to be replaced. This includes but is not limited to any regulated materials such as asbestos, lead, etc. Regulated materials shall be disposed of in accordance with local and federal regulations.
5. The Contractor shall secure all permits and inspections required for demolition and installation.
6. Piping and pumping shall meet the following requirements:
 - a. One line piping diagram shall be provided to owner prior to ordering any equipment.
 - b. Insulate all exposed piping.
7. Provide proper venting for water heaters. The combustion air and flues shall be engineered to meet manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation.
8. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
9. One full hard copy of O&M's shall be present at the site and electronic O&M's presented to the owner upon completion of the project.

The following specifications apply.

- o 15514 – DOMESTIC WATER HEATERS

Improvements to Operations and Maintenance:

New water heaters will extend the lifecycle of the plant, and will reduce the number of maintenance and repair work orders.

Pricing and Site Specific Installation Notes to Contractor:

Before final equipment selection, contractor shall be responsible for load calculation and equipment sizing per specifications for domestic hot water plant. It should be noted that the contractor is ultimately responsible for verifying site conditions. Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.6 Space Heating and DHW Upgrade in Laundry Room

Existing Condition:

An individual packaged tank water heater provides both space heating for the laundry room and hot water for the clothes washers. Heating is provided by pumping domestic hot water directly to the baseboard using a small circulation pump controlled by a wall mounted thermostat. The heater is atmospherically vented, and there are no combustion air openings in the room.

Efficiency Measure:

The replacement of the atmospheric water heater with a high efficiency condensing water heater is recommended. The water heater shall provide heating to the hydronic baseboard via a small heat exchanger (brazed plate or similar) with ECM circulation pumps controlled by a programmable thermostat. Calculations shall be performed to determine the necessary hot water capacity for the current connected hot water loads. A small combi-boiler could be used as a design alternative.

The combustion air intake and flues for the new water heater will depend on the manufacturer selected. Ducted combustion air (direct vent) is preferred so there are no openings in the laundry room that allow cold air to enter. Some condensing water heaters have a concentric vent/flue option that may allow both the combustion air and flue to go to the existing combustion air location.

General Requirements

Please consider the following while pricing:

1. The Contractor shall be responsible for the design and construction of the installation in its entirety and shall secure the services of qualified professionals as required to complete this scope of work.
2. The capacity of the domestic water heating plant shall be engineered to match the anticipated domestic hot water and space heating. A load calculation, piping layout and drawings are part of the design scope of work. The Design/Build installer shall submit all engineering calculations for Owner review and acceptance prior to ordering equipment.
3. The contractor shall provide a fully operational hot water system including but not limited to the electrical work, flues, combustion air, natural gas piping, equipment and piping supports, anchors, pumps, boilers, acid neutralization for condensing equipment drainage, and associated controls. Follow manufacturer's guidelines for proper installation and venting.
4. The Contractor shall be responsible for the demolition, removal and proper disposal of all of the existing equipment to be replaced. This includes but is not limited to any regulated materials such as asbestos, lead, etc. Regulated materials shall be disposed of in accordance with local and federal regulations.
5. The Contractor shall secure all permits and inspections required for demolition and installation.
6. Piping and pumping shall meet the following requirements:
 - a. One line piping diagram shall be provided to owner prior to ordering any equipment.
 - b. Insulate all exposed piping.

7. Provide proper venting for condensing water heater. The combustion air and flues shall be engineered to meet manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation.
8. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
9. One full hard copy of O&M's shall be present at the site and electronic O&M's presented to the owner upon completion of the project.
10. Provide a programmable thermostat.

The following specifications apply.

- o 15514 – DOMESTIC WATER HEATERS
- o 220513 – COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

Improvements to Operations and Maintenance:

The new water heater will extend the lifecycle of the plant, and will reduce the number of maintenance and repair work orders.

Pricing and Site Specific Installation Notes to Contractor:

Before final equipment selection, contractor shall be responsible for load calculation and equipment sizing per specifications for domestic hot water plant. It should be noted that the contractor is ultimately responsible for verifying site conditions. Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.7 Replace Inefficient Refrigerators

Generally, it is cost effective to replace older, inefficient refrigerators, determined by an annual energy consumption of 650 kWh/year or greater for full sized units. The kWh limit is generally based on the range of rated energy use of the existing refrigerators, to allow the highest number of refrigerators to be replaced while maintaining an SIR greater than 1. The kWh limit may change slightly with additional anticipated refrigerator data. It is recommended that these units be replaced with new Energy Star refrigerators rated at an annual energy consumption of 330 kWh or less.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.8 Programmable Wall Mounted Thermostats

Existing Condition:

Forced air furnaces throughout the building are controlled by a mix of programmable and non-programmable analog thermostats.

Efficiency Measure:

Replace an estimated 10 wall mounted non-programmable thermostats with programmable thermostats. The contractor should verify thermostat counts prior to ordering any equipment.

The contractor shall provide simplified training materials to teach management and residents how to operate and program their new thermostat.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

3.9 Add Attic Insulation and Accessible Attic Panel

Existing Condition:

There is only one access panel to the attic located in a tenant closet, which consists of a rough cut hole in the ceiling drywall covered by ¼” wood sheathing screwed into the ceiling. Attic was not accessible during site visit due to tenant installed shelving and other obstructions in the closet. Group14 recommends adding an attic panel that is properly air-sealed, insulated, and easily accessible.

This efficiency measure typically considers the impact of increasing the insulation level of the attic to R-49. Since depth of insulation in the attic was not verified, this measure will be revisited at a later date.

Efficiency Measure:

A completed and signed “Certificate of Insulation” must be posted if insulation is installed. Certificate must include: insulation type, coverage area, R-value, installed thickness, settled thickness, number of bags installed. Insulation must be installed in such a manner that ensures complete coverage at the thermal boundary and a consistent R-value, except where physical constraints may exist. Installation must be within 10% of the estimate. Lesser or greater percentages must be documented and must be reasonable or practicable.

Any recessed can lights that penetrate the attic space should be covered to reduce the fire hazard from direct contact with the insulation. A minimum re-blow of the attic should be performed after all other work is completed.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

4 EFFICIENCY MEASURES NOT RECOMMENDED

4.1 Exterior Lighting Improvements

Efficiency Measure:

Replace exterior lighting with LED fixture replacements.

Reason Not Recommended:

High efficiency LED fixtures are already installed for exterior lighting. Further improvements would not have any significant savings.

4.2 Replace Windows

Existing Condition:

Existing windows have double pane glazing with vinyl frames in fair condition.

Efficiency Measure:

Replace windows with new ENERGY STAR rated double pane windows.

Reason Not Recommended:

The building windows currently have double pane glazing installed with vinyl framing, and there would not be any significant savings to replace them.

4.3 Install Solar Photovoltaics

Existing Condition:

Terry Street Apartments does not have any solar photovoltaics (PV) or any other electrical generation on site. There are exhaust vent penetrations scattered throughout the roof area, and no mechanical ventilation equipment. There is no significant shading from trees. This leaves some sections of roof available for solar photovoltaics if panels are installed over the venting without interference.

Efficiency Measure:

Terry Street Apartments is pitched roof with small gable sections on either side. Excluding roof penetrations, approximately one third of the total roof area is available for PV (1,300 sf). The potential area can be seen in the photos below as shaded green areas.

The total area was multiplied by 18 W/ft² to come to an estimated system size of 23 kW. Typical parameters were applied in PVWatts to determine a potential energy production of nearly 37,000 kWh.

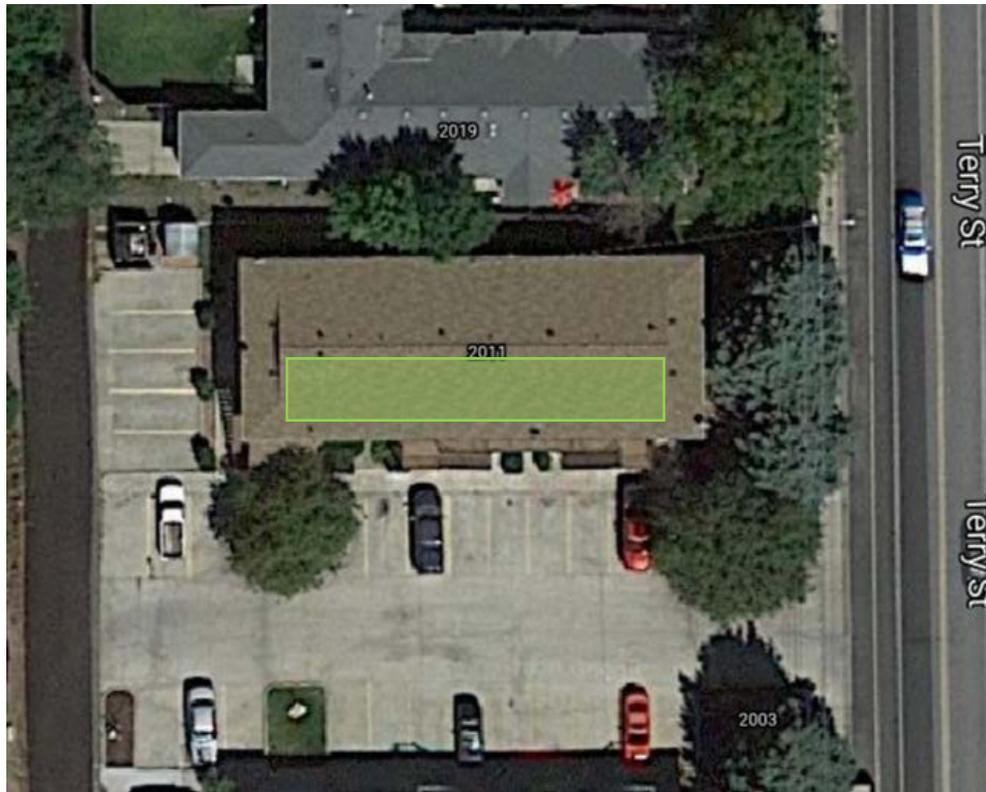


Figure 31 - Roof layout with potential PV areas

Reason Not Recommended:

Because this building is sub metered for each unit, separate solar PV installations would need to be added for each utility meter. Large numbers of smaller systems will substantially drive up the costs and fees associated with operating a PV system.

The contractor may want to consider a single smaller system tied to the house meter to offset the electrical cost of common area lighting and central mechanical systems.

| | | | |
|---------------------------|------------|-------------|------------|
| Predicted Savings: | TBD | SIR: | TBD |
|---------------------------|------------|-------------|------------|

5 RECOMMENDED HEALTH AND SAFETY MEASURES

5.1 Replace Non-Functional or Low Flow Exhaust Fans

Bathroom exhaust in the units are provided by individually ducted exhaust fans. As part of the audit, all the exhaust intakes at the units were tested for exhaust air flow. There were five locations where the exhaust flow rate was so low that they were unreadable. However, even where fans were operating, a significant amount (70%) of the exhaust fan terminals were drawing less than 20 cfm, the code minimum bathroom exhaust airflow for constant operation. None of the fans were drawing more than 50 CFM which is the code minimum for switch operated exhaust fans. This can create mold and air quality health and safety issues.

It is recommended that all exhaust ducting be cleaned, and inoperable exhaust fans should be replaced. The remaining exhaust fans should be tested for airflow by a certified test and balance contractor. If the fans are not drawing adequate air from the building, then the exhaust fans should be replaced. All new fan flow rates should be measured to verify they are removing an appropriate amount of air from the space.

Please reference Appendix D for a listing of the measured exhaust rates in each unit and restroom.

The new equipment should include the following:

- ENERGY STAR® rated exhaust fans
- In general, fans should be rated at 75 CFM. If the selected product varies from this, secure approval from the commissioning agent.
- Properly seal the fan with caulk or other similar material to inhibit air leakage to the exterior of the thermal envelope of the building.
- Always reuse existing duct work. If instances are found where existing duct infrastructure is not code compliant, bring to the attention of the owner.
- All new ductwork routing shall be approved by the Owner for locations and enclosure finishes.

Replacing the exhaust fans with Energy Star qualified fans can save \$2-5/fan each year. While this measure would only have an SIR of 0.1, it would produce some energy savings.

5.2 Install Thermostatic Mixing Valve (TMV) & Temperature Gauge

Currently, there is no functioning thermostatic mixing valve on the domestic hot water systems, presenting a scald risk to residents. The Contractor shall install, test, and balance a new TMV to temper the domestic hot water to 120°F. The domestic hot water tanks should be maintained at 140°F to prevent the risk of Legionella.

All temperature gauges should be tested to ensure proper operation or replaced as part of this measure. A temperature gauge downstream of the TMV and on the storage tank will be required.

5.3 Install Hardwired Combination Smoke/Carbon Monoxide Alarms

Existing Condition:

All units at the Terry Street Apartments have a combined battery-powered carbon monoxide and smoke alarm. Alarms were not hardwired.

Efficiency Measure:

Verify that every unit has hardwired combination smoke and carbon monoxide detectors and add one where it is not currently installed. The contractor should verify the operation of existing equipment and replace existing detectors that are not operational or beyond their recommended useful life. If it is not possible to provide a hardwired connection, then battery operated combination detectors with long life batteries should be installed (10-year minimum battery life).

5.4 Install Combustion Air Openings in Laundry Room

Existing Condition:

The laundry room has an atmospherically vented water heater with no makeup air provided to the room.

Efficiency Measure:

Install louvered combustion air openings on the entry door to provide makeup air and prevent back drafting exhaust gases into the laundry room. Combustion air openings should be properly sized to meet the requirements of the existing DHW system.

If the DHW system is replaced or upgraded, direct venting rather than louvered openings is recommended to prevent cold air from entering the laundry room.

-

APPENDIX A – SPECIFICATIONS (PROVIDED SEPARATELY)

APPENDIX B – EXISTING PIPING DIAGRAMS

APPENDIX C – DOE-2 DOCUMENTATION (PROVIDED SEPARATELY)

**APPENDIX D – AUDITOR NOTES
(PROVIDED SEPARATELY)**

APPENDIX E – SITE PHOTOS (PROVIDED SEPARATELY)

APPENDIX A - SPECIFICATIONS

SECTION 072100 - THERMAL INSULATION

Part 1 - GENERAL

1.01 Cellulose Insulation

- A. Pneumatically blown dry into attics and floor assemblies.
- B. Install over existing insulation

1.02 Insulation Intent:

- A. Provide apartments with improved energy performance:

1.03 References: Design and installation shall comply with the following standards, codes and guidelines.

- A. ASTM C 739 – Standard Specification for Cellulosic Fiber Loose-Fill Thermal Insulation.
- B. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. ASTM E 119 – Standard Test Methods for Fire Tests of Building Construction and Materials.
- D. CPSC Standard 16 CFR Parts 1209 and 1404.
- E. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 Submittals

- A. Product Data: Submit manufacturer's product data, including installation instructions.
- B. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- C. Warranty Documentation: Submit manufacturer's standard warranty.

1.05 Quality Assurance:

- A. Manufacturer's Qualifications: Manufacturer regularly engaged, for past 10 years, in manufacture of cellulose insulation of similar type to that specified
- B. Installer's Qualifications:
 - 1. Installer regularly engaged, for past 1 year, in installation of cellulose insulation of similar type to that specified.
 - 2. Employ persons trained for installation of cellulose insulation.

3. Installer: Certified by cellulose insulation
4. Installer's Equipment: Approved by cellulose insulation manufacturer.

1.06 Delivery, Storage, and Handling

- A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage and Handling Requirements:
 1. Store and handle materials in accordance with manufacturer's instructions.
 2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
 3. Store materials in clean, dry area indoors.
 4. Protect materials during storage, handling, and installation to prevent damage.

Part 2 - PRODUCTS

2.01 Thermal Insulation

A. Cellulose Insulation

1. Pneumatically Blown Dry into Attics

B. Material Description

1. Manufactured from recycled newspapers.
2. Post-Consumer Recycled Content: 85 percent minimum.
3. Fibers: Treated with boric acid and sodium polyborate additives to create permanent flame resistance
4. Fungicide Additive:
 - a. EPA registered
 - b. Makes insulation resistant to mold growth
5. Additives
 - a. Non-toxic
 - b. Non-corrosive
 - c. Does not irritate normal skin
 - d. Does not give off odor during or after insulation
 - e. Does not attract vermin or insects
 - f. Does not adversely affect other building materials

C. Compliance

1. UL classified R-8078.
2. CPSC Standard 16 CFR Parts 1209 and 1404.
3. ASTM C 739.
4. ASTM E 119: Firewalls U382, U369a, U369b, U360.
5. ES Report ESR-2217.
6. ASTM C177
7. ASTM C518
8. ASTM C976
9. CFR Title 16, Part 460
10. Foam sealants - ASTM C1642

11. Acrylic, silicone, and urethane caulk - ASTM C-920
12. Water based duct sealant - UL 181A-M, UL 181B-M
13. Fire Rated Sealant - ASTM 814 and UL1479

D. Test Results

1. Settled Density:
 - a. For Attic: Maximum density after long-term settling of dry installation: 1.6 lbs per cu ft.
 - b. For Sidewall: 3.25 pounds per cubic foot density, and in such a manner that does not allow settling of the material to occur.
2. Thermal Insulation
 - a. Average thermal resistance (R-value) per inch: 3.8.
3. Flammability Characteristics:
 - a. Critical Radiant Flux: 0.12 W/cm² minimum
 - b. Smolder Combustion: NO evidence of flaming and weight loss of 15.0 percent maximum
4. Moisture Vapor Sorption:
 - a. Moisture Gain in Insulation: 15 percent maximum by weight
5. Environmental Characteristics:
 - a. When in contact with steel, copper, aluminum, or galvanized materials: Non-corrosive.
 - b. Does not support fungal growth
6. Surface Burning Characteristics, ASTM E 84 and UL 723
 - a. Flame Spread Index: 15.
 - b. Smoke Developed Index: 5.

Part 3 - EXECUTION

3.01 Examination

- A. Examine areas to receive cellulose insulation
- B. Notify project manager of conditions that would adversely affect installation, subsequent use, or pose health and safety concerns. This includes, but is not limited to, active knob and tube wiring, the presence of vermiculite insulation, bathroom fans vented into the attic instead of to the outside, a leaking roof, or an unvented kerosene heater or gas fireplace.
- C. Do not begin installation until unacceptable conditions are corrected.

3.02 Preparation

- A. Protection of In-Place Conditions:
 1. Protect adjacent surfaces, electrical boxes, open pipes, and register openings in accordance with manufacturer's instructions.
 2. Protect adjacent surfaces from contact with pneumatically blown dry or pneumatically sprayed damp cellulose insulation.
 3. Prevent cellulose insulation from plugging soffit vents in attics.
- B. Preparation: Ensure mechanical, plumbing, electrical, and other utility installations and repairs have been completed before installation of cellulose insulation.
- C. Air-sealing: Ensure or perform proper air sealing of attic hatch and access panel, mechanical, electrical, and other penetrations.

3.03 Installation

- A. Install cellulose insulation in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Install cellulose insulation to uniform density without voids, gaps, or air pockets.
- C. Install cellulose insulation to density and depth to achieve required R-values
- D. Pneumatically Blown Dry Cellulose Insulation:
 - 1. Pneumatically blow cellulose insulation dry into attics and floor assemblies after mechanical, plumbing, electrical, and other utility installations and repairs have been completed.
 - 2. Ensure heat-producing devices in attics have barriers constructed around them to prevent contact with cellulose insulation.
 - 3. For attics, install cellulose insulation to a density of 1.6 lbs. per cu. ft. For side wall, install insulation to a density of 3.25 pounds per cubic foot density, and in such a manner that does not allow settling of the material to occur.

3.04 Protection

- A. Protect installed cellulose insulation from damage during construction

END OF SECTION 072100

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

Part 1 - GENERAL

1.01 Summary

- A. Section includes general requirements for single-phase and polyphase, general-purpose, small and medium, squirrel-cage induction and electronically commutated motors (ECM) 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.

1.02 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

2.01 General Motor Requirements

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 Motor Characteristics

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 5280 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.

2.03 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.
 - 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. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. 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.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 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.

2.05 Single-Phase Motors

- A. All single phase motors shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Electronically Commutated Motor (ECM)
 - 2. Permanent Split Capacitors (PSC) motors will only be accepted on special request.
- B. Multispeed Motors: Variable-torque, ECM.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

- D. 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 220513

SECTION 224200 – COMMERCIAL PLUMBING FIXTURES

PART 1 – PRODUCTS

Use the following products:

1. Kitchen Aerator
 - a. Brand: Delta VP / 1.5gpm
2. Restroom Aerator
 - a. Brand: Neoperl / 1.0gpm
3. Shower Head
 - a. Brand: Danze 250C / 1.5gpm
 - b. When replacing handheld: Delta Personal Hand Held Shower No Mount / 1.5 gpm
<http://s1.img-b.com/build.com/mediabase/specifications/delta/882530/delta-59462-b15-bg-specsheet-1799.pdf>

END OF SECTION 224200

SECTION 232123 - HYDRONIC PUMPS

Part 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Separately coupled, horizontally mounted, in-line centrifugal pumps.
2. Separately coupled, vertically mounted, in-line centrifugal pumps.
3. Separately coupled, base-mounted, end-suction centrifugal pumps.
4. Variable speed wet rotor pumps

B. Basis-of-design: Grundfos Magna 3

1.02 Closeout Submittals

- A. Operation and maintenance data.**

Part 2 - PRODUCTS

2.01 Separately Coupled, Horizontally Mounted, In-Line Centrifugal Pumps

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps Inc.
 2. Aurora Pump; Division of Pentair Pump Group.
 3. Flowserve Corporation.
 4. Grundfos Pumps Corporation.
 5. ITT Corporation; Bell & Gossett.
 6. Mepco, LLC.
 7. PACO Pumps.
 8. Scot Pump; Div. of Ardox Corp.
 9. TACO Incorporated.
 10. Thrush Company Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or union-end connections.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
- D. Motor: Single speed and resiliently mounted to pump casing.
1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Efficiency: Premium efficient.

2.02 Separately Coupled, Vertically Mounted, In-Line Centrifugal Pumps

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong Pumps Inc.
 2. Aurora Pump; Division of Pentair Pump Group.
 3. Crane Pumps & Systems.
 4. Flowserve Corporation.
 5. ITT Corporation; Bell & Gossett.
 6. Mepco, LLC.
 7. PACO Pumps.
 8. Peerless Pump Company.

9. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
 10. TACO Incorporated.
 11. Thrush Company Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.
- C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange or union-end connections.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
- D. Shaft Coupling: Axially split spacer coupling.
- E. Motor: Single speed and rigidly mounted to pump casing with lifting eyebolt and supporting lugs in motor enclosure.
1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Efficiency: Premium efficient.

2.03 Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American-Marsh Pumps.
 2. Armstrong Pumps Inc.
 3. Aurora Pump; Division of Pentair Pump Group.
 4. Buffalo Pumps, Inc.
 5. Crane Pumps & Systems.
 6. Flowserve Corporation.
 7. ITT Corporation; Bell & Gossett.
 8. Mepco, LLC.
 9. PACO Pumps.
 10. Peerless Pump Company.
 11. Scot Pump; Div. of Ardox Corp.
 12. TACO Incorporated.
 13. Thrush Company Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

2.04 Variable Speed Wet Rotor Pumps

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

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Flowserve Corporation.
4. Grundfos Pumps Corporation.
5. ITT Corporation; Bell & Gossett.
6. Mepco, LLC.
7. PACO Pumps.
8. Scot Pump; Div. of Ardox Corp.
9. TACO Incorporated.
10. Thrush Company Inc.

B. Description: Factory-assembled and -tested, centrifugal, in-line wet rotor pump, with variable speed drive an integral product designed and built by the same manufacturer. The pump shall be labeled on the nameplate as having an Energy Efficiency Index (EEI) of no greater than 0.20.

C. Pump Construction:

1. Casing: Circulating pumps shall be constructed with either cast iron or stainless steel housings.
2. Impeller: Impellers will be constructed of a 30% glass-filled PES composite.
3. Pump Shaft: Stainless steel.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 5. Pump Bearings: Carbon graphite or Alumina ceramic.
- D. Motor: Variable speed motor, cooled by pumped fluid, with Variable Frequency Drive (VFD).
1. 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. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Efficiency: Premium efficient.
 3. The integrated VFD control shall utilize an energy optimization algorithm to minimize energy consumption by reducing the factory-set setpoint and adjust to system characteristics. This shall be accomplished without the need of any external sensors or input.
- E. Control and Operation

The pump shall have the following control modes and operating modes:

1. During operation, the pump automatically reduces the factory-set setpoint and adjusts it to the actual system characteristic. Manual setting of the setpoint is not possible.
2. It shall be possible for the user to select a maximum flow that the pump shall not exceed in order to eliminate the need for additional throttling valves. The pump shall operate per selected control mode but will limit speed to not exceed the user specified flow limit.
3. The pump shall operate in the automatically adapting setpoint control mode with flow limit enabled.
4. Proportional Pressure – The head delivered shall be reduced from a manual setpoint linearly in accordance with decrease in flow demand in the system.
5. Constant Pressure – A manual set, constant head is maintained, irrespective of flow up to the maximum speed of the pump.

2.05 Pump Specialty Fittings

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Not Allowed.

Part 3 - EXECUTION

3.01 Pump Installation

- A. Comply with HI 1.4.

- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment base(s).
- E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.

3.02 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.03 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and throttling valve with memory stop or triple-duty valve with memory stop on discharge side of pumps.
- F. Install Y-type strainer, suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

END OF SECTION 232123

SECTION 235216 - CONDENSING BOILERS

Part 4 - GENERAL

1.01 Summary

- A. Section includes packaged, factory-fabricated and -assembled, gas-fired; fire-tube, water-tube or water-jacketed condensing boilers, trim, and accessories for generating hot water.

1.02 Action Submittals

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include diagrams for power, signal, and control wiring.
 - 2. Include schematic of existing and proposed piping.

1.03 Closeout Submittals

- A. Operation and maintenance data.
- B. Factory start-up reports
- C. Combustion analysis of any tuned or repaired boilers

1.04 Quality Assurance

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

Part 2 - PRODUCTS

2.01 Fire-Tube Condensing Boilers

- A. Manufacturers: Subject to compliance with requirements. Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience.
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent;

combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

- C. Combustion Chamber: Stainless steel, sealed.
- D. Burner: Natural gas, forced draft, minimum 5:1 turndown.
- E. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber. **No primary/secondary heat exchanger arrangements will be considered.**
- F. Pressure Vessel: Carbon steel with welded heads and tube connections.
- G. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. 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.
- H. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- I. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- J. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Baked-enamel or Powder-coated protective finish.
 - 4. Insulation: Minimum 2-inch- thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
 - 6. Mounting base to secure boiler.

2.02 WATER-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements. Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience.
- B. Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Heat Exchanger: Stainless steel single heat exchanger. **No primary/secondary heat exchanger arrangements will be considered. No aluminum heat exchangers.**
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve, minimum 5:1 turndown.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. 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.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
 4. Combustion-Air Connections: Inlet and vent duct collars.

2.03 Water-Jacketed Condensing Boilers

- A. Manufacturers: Subject to compliance with requirements. Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience.
- B. Description: Factory-fabricated, -assembled, and -tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Heat Exchanger: Stainless-steel combustion chamber.
- D. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.
- E. Burner: Natural gas, forced draft; swing-open front and burner observation port, minimum 5:1 turndown.
- F. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.
 1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. 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.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.
- H. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Powder-coated protective finish.
4. Insulation: Minimum 4-inch- thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

2.04 Trim

- A. Include devices sized to comply with ANSI B31.1, "Power Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- G. Circulation Pump (Optional): Non-overloading, in-line pump with ECM motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.05 Sizing: The capacity of the boiler plant shall be engineered to match the anticipated space heating loads. The Design/Build installer shall submit all engineering calculations (including heat loads) for Owner and Commissioning Agent review and acceptance prior to ordering equipment.

- A. Provide a minimum of two boilers for plants over 200 MBH (if there are significant cost savings, a single boiler can be proposed for plant sizes over 200 MBH.), each sized at 60% of anticipated space heating load. If more than two boilers are provided, the sum of the boiler plant shall always be 120% of the anticipated space heating load (i.e. three boilers at 40% each, four boilers at 30% each).

2.06 Controls

A. Controls:

1. New boiler plant controls shall be installed capable of the following suggested sequence of operation. Final programming, operation, and optimization are the responsibility of the installing contractor.
 - a. Boiler Plant Enable: The boiler plant shall be disabled when the Outside Air Temperature (OAT) is greater than 65F (Adj.).
 - b. Boiler Cascade Control:
 - 1) Single Boiler Operation: The boiler plant controller shall modulate the firing rate of the lead boiler to achieve the Heating Water Supply Temperature (HWS) Setpoint. The boiler plant controller shall have a short cycle prevention sequences and it shall be enabled (approaches vary by manufacturer) to ensure a minimum burn time of 20 minutes (Adj.) with one boiler firing at minimum fire. The controller shall have

- provisions to limit the firing rate of the lead boiler for 10 minutes (Adj.) before the firing rate is increased.
- 2) Parallel Modulation: If multiple new condensing boilers are installed the next/"lag" boiler in sequence shall only be enabled if the lead boiler's firing rate is above 60% (Adj.). When the next boiler is enabled, all operating boiler's firing rates shall be reduced to 30% (Adj.), and the firing rate of all operating boilers shall be modulated in parallel to maintain the HWS Setpoint. Appropriate firing rate dead-bands and/or short cycle timers shall be in place to prevent short-cycling of the recently enabled boiler. The lag boiler shall only be disabled if all operating boilers are at minimum firing rate for 10 minutes (Adj.).
 - c. Heating Water Supply Temperature Setpoint Control
 - 1) The HWS Setpoint shall be reset according to a linear outdoor air reset schedule in which the design hot water temperature, 180F (Adj.), is delivered at the design outdoor air condition, 0F (Adj.), and a lower, 90F (Adj.) HWS is delivered at the high outdoor air temperature, 55F (Adj.) The contractor shall be responsible for tuning these setpoints to provide the minimum HWS while still meeting the loads.
 - d. The boiler plant controller shall be equipped with an outdoor air temperature sensor located in an appropriate shaded located on the North Side of the building that ensures accurate outdoor air temperature measurement.
 2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - a. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 - b. Water Flow Switch: Automatic-reset paddle-switch shall prevent burner operation on low water flow.
 - c. Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.
 - d. Rollout Safety Switch: Factory mounted on boiler combustion chamber.
 - e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

2.07 Electrical Power

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color-coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.

2.08 Venting Kits

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
 1. Other materials appropriate as approved by the authority having jurisdiction and the manufacturer.
 2. If allowed by manufacturer and the authority having jurisdiction, the following materials are also approved: CPVC, PVC, and Polypro for Condensing Boilers; CPVC and PVC for Condensing DHW Heaters

- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.
 1. Other materials appropriate as approved by the authority having jurisdiction and the manufacturer.
 2. If allowed by manufacturer and the authority having jurisdiction, the following materials are also approved: CPVC, PVC, and Polypro for Condensing Boilers; CPVC and PVC for Condensing DHW Heaters
 3. Combustion air only need be directly vented to boiler if existing equipment to remain is not forced draft. The installation of new boilers shall in no way interfere with the combustion of existing gas-fired equipment.

2.09 Source Quality Control

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

2.10 PIPE INSULATION

- A. ***All piping in the boiler room shall be insulated per the requirements of all applicable codes.*** In particular, all heating water piping in the boiler room shall be insulated with a preformed fiber glass pipe insulation, complying with ASTM C 547, Class 3 (to 850°F), rigid, molded pipe insulation, noncombustible.
 1. Thermal Conductivity (“k”): 0.23 Btu•in/(hr•ft²•°F) at 75°F mean temperature (0.033 W/m•°C at 24°C) per ASTM C 518.
 2. Maximum Service Temperature: 850°F.
 3. Rated 25/50 per ASTM E 84, UL 723 and NFPA 255.
- B. Pipes shall be spaced to allow for full insulation and to permit access for operation and servicing of valves and equipment.
- C. Minimum Heating Water Pipe Insulation Schedule:

| Fluid Design Operating Temperature Range °F | Mean Rating Temperature | Nominal Pipe Diameter (in.) | | | | |
|---|-------------------------|-----------------------------|-------------|-------------|---------|---------------|
| | | 1” and Less | 1-1/2” - 2” | 2-1/2” - 3” | 4” - 8” | 8” and Larger |
| 141-200°F | 125 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 105-140°F | 100 | 1.0 | 1.0 | 1.5 | 1.5 | 1.0 |

2.11 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- 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, 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 inches high.
- E. Locate pipe labels in mechanical rooms:
 - 1. Near each valve and control device.
 - 2. Near each branch connection. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. Near major equipment items and other points of origination and termination.
 - 5. Spaced at maximum intervals of 15 feet along each run in mechanical rooms.

Part 3 - EXECUTION

3.01 Boiler Installation

- A. Equipment Mounting:
 - 1. Install boilers on cast-in-place concrete equipment base(s).
 - 2. Wall mounted boilers will be approved only with written permission and shall be mounted according to manufacturer's requirements.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.02 Connections

- A. Piping installation requirements are specified in other Sections.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.

H. Condensate drains shall always be routed through a manufacturer provided or approved neutralization kit and neutralized condensate shall be piped or pumped, if necessary, to the nearest drain. Coordinate condensate location with the owner prior install.

I. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
 - a. Combustion air only need be directly vented to boiler if existing equipment to remain is not forced draft. The installation of new boilers shall in no way interfere with the combustion of existing gas-fired equipment.
2. Connect full size to boiler connections.

3.03 Field Quality Control

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting and optimizing system to suit actual occupied conditions. Provide up to six visits to Project for this purpose.

3.04 Demonstration

- A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers

END OF SECTION 235216

SECTION 15514 - DOMESTIC WATER HEATERS

Part 5 - GENERAL

1.01 Summary

This section includes condensing gas-fired storage water heaters for potable water.

1.02 References

- A. ASME Boiler and Pressure vessel code, section IV, Part HLW
- B. UL 795 "Industrial Gas Heating Equipment"
- C. ANSI Z21.10.3 -2004/CSA 4.3-2004 "Gas Water Heaters"
- D. ASHRAE/IES 90.1-2010
- E. ISO 9001 Quality Management System
- F. CSD-1-2009 "Controls and Safety Devices for Automatically Fired Boilers"

- G. NFPA 70- National Electric Code
- H. NFPA 54- National Fuel Gas Code
- I. NSF/ANSI Standard 61- Drinking Water System Components
- J. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

1.03 Submittals

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, components, and size of each field connection
- C. Wiring Diagrams: Detail for wiring power signal, differentiate between manufacture- installed and field-installed wiring
- D. Field Test Reports: Indicate and interpret test reports for compliance with performance requirements. A copy will be furnished to the owner.
- E. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include maintenance guide and wiring diagrams.

1.04 Regulatory Requirements

- A. Conform to applicable code for internal wiring of factory wired equipment
- B. Units: ETL, UL or CSA Certified as a Complete Gas Fired Water Heater Assembly.
- C. Gas Train shall comply with ANSI Z.21.10.3 or UL 795

1.05 Quality Assurance

- A. Listing: The water heater will be listed ETL listed to UL 795 or ANSI Z21.10.3 -2004/CSA 4.3-2004 “Gas Water Heaters”
- B. ASME Compliance: Water heater shall bear the ASME HLW stamp and be National Board listed
- C. The water heater will operate at a minimum 98% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol.
- D. The water heater will comply with current ASHRAE 90.1 requirements.
- E. Water heater manufacturer certified to the ISO 9001 International Quality System.

1.06 Coordination

Coordinate size and location of concrete bases

1.07 Warranty

- A. Storage tank, heating surfaces, and combustion chamber will have a five-year warranty covering manufacturing or material defects, leaks, and/or the production of rusty water.
- B. Stress Corrosion Cracking Warranty –5-year, non-prorated coverage for failure of tank or heat exchanger due to chloride-induced stress corrosion cracking with no limit to the level of dissolved chlorides in the potable water supply and no exclusion for scale build up.
- C. Tank and heating surfaces will have a three-year warranty against failure due to scale buildup with no provisions for periodic cleaning.
- D. The heater shall have a first year service policy, which shall cover labor and freight costs under certain conditions for warranty covered services.
- E. Burner and all heater parts: 1 year

Part 2 - PRODUCTS

2.01 Manufacturers

- A. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience.
- B. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters incorporating storage tanks.
- C. Manufacturers: AO Smith – Cyclone is the basis of design. Other manufacturers will be considered for approval.

2.02 Construction

- A. The water heater will be a vertical fire tube design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure.
- B. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems.
- C. Water contacting tank surfaces will be non-porous.
- D. All tank connections/fittings will be non-ferrous.
- E. Combustion will be provided by a fan-assisted burner with a gas train meeting CSD-1/GE-GAP/MASS and/or ANSI and FM requirements for the input specified.
- F. Burner will be stainless steel
- G. Burner will employ non-linkage modulation utilizing only a variable speed fan to vary gas and air.
- H. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.
- I. Water heater will be a category IV, condensing appliance and vent through CPVC, or PVC, as required by manufacturer or Authority Having Local Jurisdiction.

1. Storage-Tank Construction: Non-ASME-code steel with 150-psig working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
2. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: maintenance-free powered anode.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - d. Jacket: Steel with enameled finish.
 - e. For Power Direct Venting: Water heater shall be suitable for power direct venting using PVC pipe, sized and routed per all applicable codes, for vent piping and intake air piping.
 - f. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - g. Temperature Control: The control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and shall have digital temperature readout.
 - 1) When the install site has a DDC building automation system the water heater shall be selected with an appropriate communications card (LON, BACnet, or other) to enable the local building automation system to read and write to the available digital control points.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
3. Thermostatic Mixing Valve (TMV):
 - a. The existing TMV must be tested for reliable operation, and if found faulty or missing, replaced.
 - b. Wax/Paraffin or Bi-metal valves appropriate
 - c. TMV must be sized for flow characteristics of the load
 - d. Manufacturer's piping diagrams must be followed.
4. Re-circulation pumps
 - a. If reusing the existing domestic hot water recirculation pump, ensure that an aquastat is present. The aquastat should maintain return water temperatures of 110° F with a 5° F dead band.
 - b. Re-circulation flows shall be balanced to the minimum flow possible to ensure the most distant load receives adequately warm water.
5. Non-packaged burners
 - a. For installations where existing storage tanks are to be reused section 235216 – CONDENSING BOILERS shall apply to the heating appliance with the following exceptions related to controls & piping:
 - 1) The boilers circulator shall be interlocked with the boiler and shall only run for a brief (5 min or less) post-purge period.

- 2) The boiler's on-board controls shall have a tank temperature sensor located ~ 1/3rd of the height of the tank.
- 3) The boiler's on-board controls shall modulate the firing rate to maintain the tank temperature setpoint.
 - a) Minimum on and minimum off timers shall be available to prevent boiler short cycling
 - b) Boiler staging delay timers shall be available to control regulate firing rate.
 - c) Controls shall generally be tuned to provide long burns at near minimum firing rates.
- 4) The boiler manufacturer's suggested piping diagrams shall be followed.

2.03 Performance

- A. When tested to the ANSI Z21.10.3 standard, the water heater shall operate at 90% thermal efficiency at full firing rate.
- B. When modulated to low fire, water heater will be capable of 95% thermal efficiency.
- C. Water heater will meet the thermal efficiency and standby heat loss requirements of ASHRAE 90.1 – 2010.
- D. Hot-Water Storage-Tank and Firing Rate Capacity: The capacity of the domestic water heating plant shall be engineered to match the anticipated domestic hot water loads. These loads need to take the existing and proposed low flow fixtures into account, as any existing hot water storage tanks. The Design/Build installer shall submit all engineering calculations for Owner review and acceptance prior to ordering equipment.
- E. Temperature Setting: Building distribution temps (downstream of the thermostatic mixing valve) shall be 120F. The tanks shall store DHW at 140F.
 1. A tank storage temperature schedule may be applied (when controls capability permits) that stores DHW at 125F for 18 Hrs/day, and 140F for the remaining 6 hours each day.

2.04 Water Heater Trim

- A. As a minimum, the heater will be equipped with the following:
 1. electronic flame monitoring
 2. an immersion operating control
 3. an immersion temperature limiting device
 4. an ASME- or AGA-rated temperature and pressure relief valve
- B. Operating and safety controls shall meet the requirements of UL 795 and FM, or ANSI Z21.10.3.
- C. The water heater shall employ an electronic operating control with digital temperature readout.

Part 3 - EXECUTION

3.01 Installation

Install water heaters level and plumb in accordance with manufacturers written instructions and referenced standards.

3.02 Finishing

The storage and heating sections shall be completely factory packaged on a single skid, requiring only job site hookup to utilities, venting, and plumbing. The heater shall be insulated to ASHRAE 90.1-2010 requirements, jacketed with coated steel panels. Pressure vessel shall include a drain valve. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

3.03 Start-Up

Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.

3.04 Controls Tuning

The contractor is responsible for setting the thermostatic mixing valve to deliver no hotter than 120°F domestic hot water. This controls tuning shall include an investigation of DHW delivery temperatures under extended periods of low/no load. DHW recirculation flow shall be balanced to ensure the hot water stacking does not occur and that delivery temperatures at the point of use never exceed 120°F.

3.05 Pipe Insulation

A. **All piping in the boiler room shall be insulated per the requirements of all applicable codes.** In particular, all DHW water piping in the boiler room shall be insulated with a preformed fiber glass pipe insulation, complying with ASTM C 547, Class 3 (to 850°F), rigid, molded pipe insulation, noncombustible.

1. Thermal Conductivity (“k”): 0.23 Btu•in/(hr•ft²•°F) at 75°F mean temperature (0.033 W/m•°C at 24°C) per ASTM C 518.
2. Maximum Service Temperature: 850°F.
3. Rated 25/50 per ASTM E 84, UL 723 and NFPA 255.

B. Pipes shall be spaced to allow for full insulation and to permit access for operation and servicing of valves and equipment.

C. Minimum DHW Water Pipe Insulation Schedule:

| Fluid Design Operating Temperature Range °F | Mean Rating Temperature | Nominal Pipe Diameter (in.) | | | | |
|---|-------------------------|-----------------------------|-------------|-------------|---------|---------------|
| | | 1” and Less | 1-1/2” - 2” | 2-1/2” - 3” | 4” - 8” | 8” and Larger |
| 105-140°F | 100 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |

END OF SECTION 15514

SECTION 262923 - VARIABLE FREQUENCY DRIVES

Part 1 - GENERAL

1.01 Summary

A. This specification is to cover a complete Variable Frequency Drive consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.

- B. The drive manufacturer shall supply the drive and all necessary options as herein specified. VFDs that are manufactured by a third party and “brand labeled” shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

1.02 Quality Assurance

A. Referenced Standards and Guidelines:

1. IEEE 519-1992, Guide for Harmonic Content and Control.
2. UL508(A)(C)
3. ICS 7.0, AC Adjustable Speed Drives
4. EN/IEC 61800-3
5. NEC 430.120, Adjustable-Speed Drive Systems
6. IBC 2012 Seismic – referencing ASC 7-05 and ICC AC-156

B. Qualifications:

1. VFDs and options shall be UL508 listed as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR without the need for external input fuses.

1.03 Submittals

A. Submittals shall include the following information:

1. Outline dimensions, conduit entry locations and weight.
2. Customer connection and power wiring diagrams.
3. Complete technical product description include a complete list of options provided.

Part 2 - PRODUCTS

2.01 Variable Frequency Drives

A. Available 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. Yaskawa America, Inc.
2. Danfoss
3. ABB

B. The VFD package as specified herein and defined on the VFD schedule shall be enclosed in a UL Type enclosure (enclosures with only NEMA ratings are not acceptable).

1. Environmental operating conditions: -15 to 40° C (5 to 104° F) continuous. Altitude 0 to 3300 feet above sea level, less than 95%, non-condensing All circuit boards shall be coated to protect against corrosion.

C. All VFDs shall have the following standard features.

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” functions available via the keypad.
3. VFDs through 200 HP shall have internal chokes (reactors) providing 5% impedance to reduce the harmonics to the power line and to add protection from AC line transients.

4. The input current rating of the VFD shall not be greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.122
 5. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, relay output, and / or over the serial communications bus.
- D. All VFDs to have the following adjustments:
1. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active.
 2. The VFD shall include a fireman's override input. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.
- E. Serial Communications
1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, LONworks, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet).
- F. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level (Category C2).
- G. DRIVE OPTIONS – Options shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
- H. BYPASS – All drives provides shall have a bypass. Bypasses shall be furnished and mounted by the drive manufacturer. All VFD with bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses. UL Listed motor overload protection shall be provided in both drive and bypass modes.
 2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
 3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 Amps and this rating shall be indicated on the UL data label.
 4. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.

5. The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement.
6. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User’s Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.

Part 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor.
- B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current.
- C. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.02 Start-Up

- A. Factory start-up shall be provided for each drive by a factory authorized service center.

3.03 Product Support

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A technical support line connected to factory support personnel shall be available.

3.04 Warranty

- A. The VFD Product Warranty shall be 24 months from the date of factory shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

END OF SECTION 262923

SECTION 237433 - DEDICATED OUTDOOR-AIR CORRIDOR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.2 GENERAL REQUIREMENTS

- A. The Contractor shall examine the site and existing make-up air systems and associated components to understand the full scope of work required.
- B. The audit report and accompanying documentation of existing conditions are intended to show the general arrangement of existing components and indicate the approximate energy performance of the existing facility. The Contractor shall review the existing corridor make-up air units, existing facility and the audit report in their entirety.
- C. The existing make-up air unit shall be demolished.
- D. Provide new 100% OA make-up air units with a natural gas furnace and DX cooling. Contractor can propose a hot water coil instead of a natural gas furnace if deemed feasible. If so, freeze protection must be provided for.
- E. The new make-up air unit maximum airflow volume shall be set by the contractor's design professional, based on 62.1 code ventilation requirements, building pressurization, and odor control. All ventilation rate calculations shall be submitted to the Owner and Commissioning Agent for review. The unit shall be equipped with a VFD to modulate the supply fan speed.
- F. The new MAUs locations shall be coordinated with the existing structure, and equipment.
- G. The MAU duct system shall be tested, adjusted and balanced at 75% of the maximum design airflow. All grilles, registers and diffusers shall be provided a balancing damper or new GRDs shall be provided with integral opposed blade dampers. The intent is to provide a proportional air balance.
- H. The Make-up air unit shall be sized to provide the greater of the following:
 - 1. Code minimum ventilation airflow.
 - 2. 0.5cfm/sf for odor and pressure control (Using just common area and corridor square footages.)
 - 3. Airflow required for temperature control of the conditioned spaces.
- I. It is not anticipated that engineered drawings and specifications will be required. However, the Contractor shall confirm the permitting requirements with the Authorities Having Jurisdiction, and be responsible for all steps necessary to obtain a permit.
- J. Installation of the make-up air unit. Including electrical and sheet-metal connections from the existing systems to the new equipment.
- K. Verify all existing electrical connections and capacities are sufficient to meet the loads and demands of the new MAU. Where existing electrical connection and capacities are found to be insufficient, upgrade electrical components and equipment as required.
- L. Unit weights shall be less than or equal to the existing equipment or the Contractor shall confirm the equipment of increased weight does not exceed the limitations of the structural system.

- M. Installation of the Make-up Air Unit Automatic Temperature Controls.
- N. Assessment to establish any code required modifications to the MEP systems and/or architectural components for a complete code-compliant design and installation.

1.3 BID SUBMITTALS

- A. Product Data: For each type of product.
- B. Plans, elevations, sections and detail drawings or detailed narratives indicating how all MEP services will be modified to accommodate the new units.
- C. Design calculations of required ventilation airflow and the heating and cooling loads.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof-curb mounting details, drawn to scale, and coordinated with each other, using input from installers of the items involved:
- B. Startup service reports.
- C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Executed startup service report(s).

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Five years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Wind-Restraint Performance:
 - 1. Provide wind-restraints, if required by the Authority Having Jurisdiction. Meet or exceed all minimum requirements.
- C. Cabinet Thermal Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1-2010.
 2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- D. Cabinet Surface Condensation:
1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- E. 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.
- F. Capacities and Characteristics:
1. Refrigerant Cooling:
 - a. Full-Load Efficiency (EER): EER must meet or exceed CEE Tier 2 standard.
 - b. Minimum Design Condenser Ambient-Air Temperature: 95°F.
 2. Gas-Fired Furnace Heating:
 - a. Efficiency: 85 percent.
 - b. Fuel: Natural gas.

2.2 CABINET

- A. Construction: double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
 1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
 2. Insulation Adhesive: Comply with ASTM C 916, Type I.

3. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:

1. Shape: Rectangular, with slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
3. Configuration: Single wall.
4. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
5. Material: Galvanized-steel sheet with asphaltic waterproofing compound coating on pan top surface.
6. Material: Stainless-steel sheet.
7. Drain Connection:
 - a. Located on one end of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

L. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

1. Comply with requirements in "The NRCA Roofing Manual."

2.3 SUPPLY FAN

A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.

1. Fan Wheel Material: Galvanized Painted steel, mounted on solid-steel shaft.
2. Bearings: Pillow-block bearings rated L₅₀ for 200,000 hours and having external grease fittings.

B. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Efficiency: Premium efficient.

C. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.4 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- I. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.5 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- D. Refrigerant: R-134a, R-407C or R-410A.
 - 1. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Provide unit with operating charge of refrigerant.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.
 - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 - 6. Brass service valves installed in discharge and liquid lines.
- F. Capacity Control:
 - 1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
 - 2. Digital scroll compressor.
- G. Refrigerant condenser coils:
 - 1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.

2. Tube Material: Copper.
3. Fin Material: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Phenolic epoxy corrosion-protection coating after assembly.

H. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
 - c. Built-in overcurrent and thermal-overload protection.
 - d. Efficiency: Premium efficient.
3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

2.6 INDIRECT-FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
3. AGA Approval: Designed and certified by and bearing label of AGA.

B. Burners:

1. Heat-Exchanger Material: Stainless steel with a minimum thermal efficiency of 80 percent.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.

C. Heat-Exchanger Drain Pan Material: Stainless steel.

D. Venting: Gravity vented.

E. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.

F. Safety Controls:

1. Gas Control Valve: Electronic modulating with minimum 20% (5:1 turndown)
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.7 HOT-WATER HEATING COIL

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.8 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1-2007.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.9 FILTERS

- A. Extended-Surface, Disposable Panel Filters:
 - 1. Comply with NFPA 90A.
 - 2. Factory-fabricated, dry, extended-surface type.
 - 3. Thickness: 1 inch or 2 inches.
 - 4. Minimum Merv: 7, according to ASHRAE 52.2.
 - 5. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
- B. Mounting Frames:
 - 1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
 - 2. Extended surface filters arranged for flat orientation, removable from access plenum.
 - 3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.10 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, Type 4, or Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to wire lugs or NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - 2. NEMA KS 1, heavy-duty, nonfusible switch.
 - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle. Receptacle shall not be powered with unit, but to separate 120v circuit.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

2.11 CONTROLS

- A. The Unit shall be furnished with all necessary operating and safety controls provided, mounted and pre-wired by the unit manufacturer.
- B. Provide corridor mounted temperature sensor hard-wired to unit. Coordinate final location of sensor with owner.
- C. Control Wiring: Factory wire connection for controls' power supply.
- D. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- E. Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.
 - d. Heating operating.
 - e. Smoke alarm.
 - f. General alarm.
3. Digital Numeric Display:
 - a. Outdoor dry-bulb temperature.
 - b. Space temperature.
 - c. Supply temperature.

F. Control Dampers:

1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
4. Damper Label: Bear the AMCA seal for both air leakage and performance.
5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
6. Damper Frame Material: Extruded aluminum, galvanized steel, or stainless steel.
7. Blade Type: Single-thickness metal reinforced with multiple V-grooves.
8. Blade Material: Extruded aluminum, galvanized steel, or stainless steel.
9. Maximum Blade Width: 6 inches.
10. Maximum Blade Length: 48 inches.
11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
12. Bearings: Thrust bearings for vertical blade axles.

G. Damper Operators:

1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
3. Maximum Operating Time: Open or close damper 90 degrees in 90 seconds.
4. Adjustable Stops: For both maximum and minimum positions.
5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
6. Spring-return operator to fail-safe; either closed or open as required by application.
7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
8. Position feedback Signal: For remote monitoring of damper position.
9. Coupling: V-bolt and V-shaped, toothed cradle.

10. Circuitry: Electronic overload or digital rotation-sensing circuitry.
- H. Temperature Controls: Wall-mounted, space-temperature sensor with unit-mounted temperature adjustment to modulate gas furnace burner or hot water coil control valve to maintain space temperature. This same wall-mounted, space temperature sensor shall also be used for cooling control.
- I. Outdoor Air Damper Control: When the unit is enabled, the outdoor air damper shall modulate full open. When the unit is disabled, the outdoor air damper shall be closed.
- J. Integral Smoke Alarm: Smoke detector installed in supply air.
- K. Minimum DAT Control: A DAT low limit control shall not allow discharge air temperatures to drop below a setpoint of 65F in heating mode, to avoid blowing frigid air into the corridors.
- L. Supply Fan Control:
1. The Testing, Adjusting and Balancing contractor shall simulate dirty filters (1.5 x clean filter pressure drop) and then set the supply fan VFD minimum speed such that the code minimum required ventilation airflow is provided. Exception: If the gas furnace, DX Cooling or fan motor (to prevent motor over-heating or surging) requires more airflow, then set the minimum VFD speed accordingly.
 2. The Testing, Adjusting and Balancing contractor shall simulate dirty filters (1.5 x clean filter pressure drop) and then set the supply fan VFD maximum speed such that the design make-up airflow is provided to the spaces served.
 3. The minimum and maximum supply fan VFD speeds shall be programmed within the VFD.
 4. During daytime periods (Contractor to coordinate with Owner hours that are considered “daytime”) the supply fan shall operate between 0.3 and 0.5cfm/sf (adj.) for odor and pressure control.
 5. Daytime Heating and Cooling: During daytime operation the supply fan VFD shall modulate to 0.3cfm/sf if the zone temperature sensor is satisfied. Upon a call for heating or cooling, the VFD shall remain at the 0.3 cfm/sf speed until the cooling or heating demand exceeds 50% of the unit’s heating/cooling capacity. The supply fan VFD shall then ramp up to the 0.5 cfm/sf speed. As heating or cooling demand decreases, reverse the supply fan speed operation.
 6. Nighttime Heating and Cooling: Ventilation during nighttime shall be setback to provide ventilation rate at the code minimum as described above. Upon a call for heating or cooling, the VFD shall modulate up to the 0.3 cfm/sf speed. The VFD shall remain at 0.3 cfm/sf until the cooling or heating demand exceeds 50% of the unit’s heating/cooling capacity. The supply fan VFD shall then ramp up to the 0.5 cfm/sf speed. As heating or cooling demand decreases, reverse the supply fan speed operation.

2.12 ACCESSORIES

- A. Service Lights and Switch: Factory installed in fan and coil sections with weatherproof cover. Factory wire lights to a single-point field connection.
- B. Duplex Receptacle: Factory mounted in unit supply-fan section, with 20 amp 120 V GFI duplex receptacle and weatherproof cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Curb Support: Install roof curb on roof structure according to "The NRCA Roofing Manual."
 - 1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
 - 2. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.
 - 3. Unit weights shall be less than or equal to the existing equipment or the Contractor shall confirm the equipment of increased weight does not exceed the limitations of the structural system.
- C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."
- E. Install separate devices furnished by manufacturer and not factory installed.
- F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- G. Install drain pipes from unit drain pans to sanitary drain.
 - 1. Drain Piping: Schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
 - a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - c. Solvent cement and adhesive primer 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. Pipe Size: Same size as condensate drain pan connection.

3.2 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Gas Piping Connections:
 - 1. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
 - 2. Install AGA-approved flexible connectors.
- C. Hydronic Piping Connections:

1. Install shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.

D. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

E. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.3 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
7. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
 9. Verify that clearances have been provided for servicing.
 10. Verify that controls are connected and operable.
 11. Verify that filters are installed.
 12. Clean coils and inspect for construction debris.
 13. Clean furnace flue and inspect for construction debris.
 14. Inspect operation of power vents.
 15. Purge gas line.
 16. Inspect and adjust vibration isolators and seismic restraints.
 17. Verify bearing lubrication.
 18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 19. Adjust fan belts to proper alignment and tension.
 20. Start unit.
 21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 22. Operate unit for run-in period.
 23. Calibrate controls.
 24. Adjust and inspect high-temperature limits.
 25. Inspect outdoor-air dampers for proper stroke.
 26. Verify operational sequence of controls.
 27. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

END OF SECTION 237433

SECTION 238126 – SPLIT SYSTEMS AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications describe requirements for air cooled split-DX air conditioning systems for the indoor make up air units.

1.2 GENERAL REQUIREMENTS

- A. The Contractor shall examine the site and existing make-up air systems and associated components to understand the full scope of work required.
- B. The audit report and accompanying documentation of existing conditions are intended to show the general arrangement of existing components and indicate the approximate energy performance of the existing facility. The Contractor shall review the existing corridor make-up air units, existing facility and the audit report in their entirety.
- C. The split-DX system shall be factory assembled units as scheduled. The direct expansion model's refrigeration system shall be split, with the compressor located in a remote condensing unit.
- D. Verify all existing electrical connections and capacities are sufficient to meet the loads and demands of the new units. Where existing electrical connection and capacities are found to be insufficient, upgrade electrical components and equipment as required.
- E. Assessment to establish any code required modifications to the MEP systems and/or architectural components for a complete code-compliant design and installation.

1.3 BID SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit product data including rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressure, sound power characteristics, motor requirements, and electrical characteristics.
- C. Design calculations of cooling loads.
- D. Submit shop drawings including power, signal, and control wiring diagrams differentiating between manufacturer-installed and field-installed wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Mounting details, drawn to scale, and coordinated with each other, using input from installers of the items involved:
- B. Startup service reports.
- C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
- B. Executed startup service report(s).

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Five years from date of Substantial Completion.
 - 2. Warranty Period for Heat Exchangers: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Capacities and Characteristics:
 - 1. Refrigerant Cooling:
 - a. Full-Load Efficiency (EER): EER must meet or exceed CEE Tier 2 standard.
 - b. Minimum Design Condenser Ambient-Air Temperature: 95°F.

2.2 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- D. Refrigerant: R-134a, R-407C or R-410A.
 - 1. Classified as Safety Group A1 according to ASHRAE 34.
 - 2. Provide unit with operating charge of refrigerant.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.
 - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 - 6. Brass service valves installed in discharge and liquid lines.
- F. Capacity Control:

1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
2. Digital scroll compressor.

G. Refrigerant condenser coils:

1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410 and coil bearing the ARI label.
2. Tube Material: Copper.
3. Fin Material: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Phenolic epoxy corrosion-protection coating after assembly.

H. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
 - c. Built-in overcurrent and thermal-overload protection.
 - d. Efficiency: Premium efficient.
3. Fan Safety Guards: Steel with corrosion-resistant coating.

I. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

2.3 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, Type 4, or Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to wire lugs or NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Lights: Factory wire unit-mounted lights.
- K. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle. Receptacle shall not be powered with unit, but to separate 120v circuit.
- L. Control Relays: Auxiliary and adjustable time-delay relays.

2.4 CONTROLS

- A. The Unit shall be furnished with all necessary operating and safety controls provided, mounted and pre-wired by the unit manufacturer.
- B. Control Wiring: Factory wire connection for controls' power supply.
- C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- D. Minimum DAT Control: A DAT low limit control shall not allow discharge air temperatures to drop below a setpoint of 65F in heating mode, to avoid blowing frigid air into the corridors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

3.2 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.3 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 - 3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 - 4. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 - 5. Verify that controls are connected and operable.
 - 6. Clean coils and inspect for construction debris.
 - 7. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
- B. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- C. Prepare written report of the results of startup services.

END OF SECTION 238126

SECTION 265100 - INTERIOR LIGHTING

Part 1 - GENERAL

1.01 Related Documents

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

1.02 Summary

- A. This Section includes the following:
 - 1. Lighting Control Devices.
 - 2. Interior lighting fixtures, lamps, and ballasts.
 - 3. Lighting fixture supports.
 - 4. Retrofit kits for fluorescent lighting fixtures.

1.03 Definitions

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.04 Submittals

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Ballast.
 - 3. Energy-efficiency data.
 - 4. Life, output, and energy-efficiency data for lamps.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.05 Quality Assurance

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

1.06 Coordination

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 Extra Materials

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. LED replacement modules/boards: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

4. Battery and Charger Data: One for each emergency lighting unit.
5. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
6. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
7. Interior fixtures: 1 for every 100 of each type. Furnish at least one extra fixture of each interior fixture type (in addition to other extra materials described above).

Part 2 - PRODUCTS

2.01 Manufacturers

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 1. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. Where another manufacturer is not specifically listed for a given fixture type, and alternate product that complies with all listed requirements for that fixture type shall be considered as comparable.

2.02 Lighting Fixtures and Components, General Requirements

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metalized Film: 90 percent.
- I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.
- K. Surface mounted conduit wiring: Conduit covers/molding are to be metal and not plastic. Color will be the standard white or almond.

2.03 Ballasts for Linear Fluorescent Lamps

- A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 10 percent.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Operating Frequency: 20 kHz or higher.
 5. Lamp Current Crest Factor: 1.7 or less.
 6. BF: 0.85 or higher
 7. Power Factor: 0.95 or higher.
 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- C. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- D. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
 2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.
- E. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- F. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 50 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.04 Fluorescent Lamps

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 instant-start low-mercury lamps, rated 28 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- C. Compact Fluorescent Lamps: standard screw-in base, low mercury, CRI 80 (minimum), color temperature 2700K, minimum 5 year or 7000 hour warranty, energy star rated.

2.05 LED Lamps and Retrofits

- A. LED retrofit kit for linear fluorescent fixtures, rated >100 lumens/watt, nominal length of 48 inches, CRI 80 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- B. LED Lamps: standard screw-in base, rated 11 W maximum, mercury free, CRI 80 (minimum), color temperature 2700K, minimum 5 year or 7000 hour warranty, energy star rated.

Part 3 - EXECUTION

3.01 Installation

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

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END OF SECTION 26510

REFRIGERATOR REPLACEMENT-MINIMUM PERFORMANCE REQUIREMENTS

Part 1- GENERAL

1.01 Submittals

1.02 Warranty: The Contractor shall provide the appliance manufacturer’s warranty information on all products, and shall agree to pay for the replacement of all defective appliances.

1.03 Quality Assurance

- A. Product manufacturer must have three years of documented experience specializing in manufacturing the products specified.
- B. Products must be listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. All products and installations must comply with Appendix A-Standards for Weatherization Materials.

Part 2- PRODUCTS

- D. All proposed models must be an Energy Star rated appliance that consumes at or below 386 KWH/yr annually.
- E. All proposed models must be white with top mounted freezer compartment unless _____ located in a handi-cap unit where side-by-side or bottom freezer models are acceptable.

Part 3- EXECUTION

- F. The vendor will notify EOC’s project manager within five (5) working days after the receipt of any incorrectly delivered or defective material. The vendor will pick up the material and return it to their facility within three (3) working days. No service charge or restocking fees for items returned as a result of error by the vendor, including but not limited to, damage, incorrect deliveries, or material overages, shall be invoiced to or paid for by EOC.
- G. Hinge must be located on the same side as existing refrigerator

- H. Both the freezer and main compartment door must be able to open 90 degree from the unhinged side and not damage drywall or existing cabinets adjacent to the designed refrigerator space.
- I. Each installed refrigerator must be level and installers will be responsible for setting adjustment screws located on the base of the refrigerator
- J. Each refrigerator shall be of the capacity indicated, and shall have a frost-free freezer and freezer compartments.
- K. Refrigerator to be Energy-Star rated. Vendor must furnish and install, meeting Energy Star requirements.
- L. Sizes of Refrigerator to be priced on the provided *Refrigerator Proposal* form.

Part 4 – Demolition

- M. Contractors shall provide all parts, labor, equipment, transportation and supervision necessary for the demilling refrigerators.
- N. Recover Freon from each refrigerator. Disposal of Freon in accordance with EPA: Regulations at 40 CFR 82.156
- O. Remove compressors from unit. Drain compressor of oil and stack compressor. Disposal of compressor oil in accordance with EPA Regulation at 40 CFR 82.156.
- P. Cut electrical plug off of electrical cable of the refrigerator.

Attain model/serial number information from data plate, complete and provide a Refrigerant Removal Verification Statement (DRMS Form 2016) for each unit.

END OF SECTION

SECTION 260500 - ELECTRICAL POWER AND LIGHTING SYSTEMS

PART 4 - GENERAL

4.1 RELATED DOCUMENTS

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

4.2 SUMMARY

- A. This Section includes the following:
 1. Low voltage power conductors and cables.
 2. Raceway for electrical systems.
 3. Lighting Control Devices.
 4. Interior lighting fixtures, lamps, and drivers/ballasts.

- 5. Lighting fixture supports.
- 6. Retrofit kits for fluorescent lighting fixtures.
- 7. Exit signs.
- 8. Emergency lighting units.

4.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CCT: Correlated color temperature.
- D. CU: Coefficient of utilization.
- E. Driver: Electronics components that couple to Light engine to convert power from line voltage AC to light engine operating mA output and voltage.
- F. HID: High-intensity discharge.
- G. LED: Light Emitting Diode
- H. LER: Luminaire efficacy rating.
- I. Light Engine: One or more LEDs coupled to a circuit board with or without on board optics.
- J. Lumen: Measured output of lamp and luminaire; or both.
- K. Luminaire: Complete lighting fixture, including driver/ballast housing if provided.
- L. RCR: Room cavity ratio.
- M. SPD: Surge Protection Device.
- N. SVR: Suppressed Voltage Range.

4.4 SUBMITTALS

- A. Surge Protection Device Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Low Voltage Power Conductors Product Data: For each type of product indicated.
- C. Raceway for electrical systems Product Data: For each type of product indicated.
- D. Lighting Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Ballast.
 - 3. Energy-efficiency data.

- 4. Life, output, and energy-efficiency data for lamps.
- 5. If LED source is provided, include in addition to the above:
 - a. LED light engines for each type used. Provide compatibility information for LED light engines used in conjunction with dimming systems.
 - b. Life, output (lumens, CCT, and CRI), of each light engine, and energy-efficiency data for light engines.
 - c. Power supplies, including energy-efficiency data.
 - d. LED engines, including life based on IES LM-80, output based on IES LM-79 testing methods, CCT, CRI, lumens, operating current in milliamps (mA), and energy-efficiency data.

- E. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

- F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

- G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all LED light engine and driver types used on Project; use manufacturers' codes.
 - 2. Provide recommended LED light engine and driver replacement schedule for each lamp type based on manufacturer's listed lamp life ratings.
 - 3. Provide manufacturer's maintenance and trouble-shooting information for all luminaire.

4.5 QUALITY ASSURANCE

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

4.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

4.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Fluorescent and/or LED and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion

4.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. SPD Replaceable Protection Modules: One of each size and type installed.
 - 2. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. LED replacement modules/boards: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 5. Battery and Charger Data: One for each emergency lighting unit.
 - 6. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 7. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 - 8. Interior fixtures: 1 for every 100 of each type. Furnish at least one extra fixture of each interior fixture type (in addition to other extra materials described above).

PART 5 - PRODUCTS

5.1 LOW VOLTAGE POWER CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC70.
- B. Conductor Insulation: Comply with NEMA WC70 for Types THHN-THWN.
- C. Connectors and Splices: Provide factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- D. Conductor Materials: Copper, Type THHN-TWVN, single conductors in raceway. Solid for No. 10AWG and smaller, stranded for No. 8AWG and larger.

5.2 RACEWAYS FOR ELECTRICAL SYSTEMS

- A. RNC: NEMA TC2, Type EPC-80-PVC.

5.3 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Manufacturers: In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified. Where another manufacturer is not specifically listed for a given fixture type, and alternate product that complies with all listed requirements for that fixture type shall be considered as comparable.
- B. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. LED Fixtures: 120-277VAC, 60hz driver power supply with 0-10V dimming capability, overload and short circuit protected. Test in accordance with IES LM79 and LM80.
- F. Metal Parts: Free of burrs and sharp corners and edges.
- G. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- H. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.
- I. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metalized Film: 90 percent.
- J. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.
- K. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.
- L. Factory-Applied Labels: Comply with UL 1598. Include recommended replacement LED light engines and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following LED light engine and driver characteristics:
 - a. "USE ONLY" and include specific LED light engine type.
 - b. Driver info including operating mA output and wattage.
 - c. CCT and CRI for all luminaires.

5.4 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 10 percent.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Operating Frequency: 20 kHz or higher.
 5. Lamp Current Crest Factor: 1.7 or less.
 6. BF: 0.78 or similar.
 7. Power Factor: 0.95 or higher.
 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.78, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
- C. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
1. Ballast Manufacturer Certification: Indicated by label.
- D. Single Ballasts for Multiple Lighting Fixtures: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- E. Ballasts for Low-Temperature Environments:
1. Temperatures 0 Degrees F and Higher: Electronic type rated for 0 Degrees F (minus 17 Degrees C) starting and operating temperature with indicated lamp types.
 2. Temperatures Minus 20 Degrees F and Higher: Electromagnetic type designed for use with indicated lamp types.
- F. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- G. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 50 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

5.5 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher, unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
 10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 11. Ballast Case Temperature: 75 Degrees C, maximum.
- B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

5.6 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

5.7 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 instant-start low-mercury lamps, rated 28 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- C. T8 instant-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. T5 low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life of 20,000 hours, unless otherwise indicated.
- E. T5HO high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life of 20,000 hours, unless otherwise indicated.
- F. Pin-base Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 2700K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
 - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
 - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
 - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
 - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
 - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
 - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).
- G. Screw-in Compact Fluorescent Lamps: Medium base, low mercury, CRI 80 (minimum), color temperature 2700K, average rated life of 10,000 hours at 3 hours operation per start.
 - 1. 13 W: rated 900 initial lumens (minimum).
 - 2. 18 W: rated 1200 initial lumens (minimum).
 - 3. 26 W: rated 1800 initial lumens (minimum).
 - 4. 32 W: rated 2400 initial lumens (minimum).
 - 5. 42 W: rated 3200 initial lumens (minimum).
 - 6. 55 W: rated 4300 initial lumens (minimum).

5.8 LED LAMPS REPLACEMENT REQUIREMENTS

- A. Solid State Lighting (LED) Sources must meet the following requirements:
 - 1. Lamp Efficacy: ≥ 85 lumens/watt
 - 2. CRI: ≥ 80
 - 3. CCT: 2700K for in-unit applications, 3500K for common area applications, and 4000K for exterior applications

4. Lumen Maintenance: 50,000+ hours, unless otherwise indicated. Details provided in “Requirements for Individual Lighting Fixtures”
5. LED Lamps: standard screw-in base, rated 11 W maximum, mercury free, CRI 80 (minimum), color temperature 2700K, minimum 5 year or 50,000 hour warranty, Energy Star labeled.
 - a. 9W maximum for the replacement of CFLs with a wattage of 26W or lower, and for the replacement of incandescent bulbs with a wattage of 75W or lower.
 - b. 14W maximum for the replacement of any CFLs higher than 26W and incandescent higher than 75W

5.9 LED FIXTURE REPLACEMENT REQUIREMENTS

- A. Solid State Lighting (LED) Sources must meet the following requirements:
 1. Fixture Efficacy: ≥ 90 lumens/watt.
 2. CRI: ≥ 80
 3. CCT: 2700K for in-unit applications, 3500K for common area applications, and 4000K for exterior applications
 4. Lumen Maintenance: 50,000+ hours, unless otherwise indicated. Details provided in “Requirements for Individual Lighting Fixtures”
 5. Warranty: 5+ years.
- B. Power Supply Units (PSU) including drivers must meet the following requirements:
 1. Must have a minimum efficiency of 85 percent
 2. Must be rated to operate between -40°C to $+50^{\circ}\text{C}$
 3. Input Voltage: capable of 120 to 277 ($\pm 10\%$) volt, single phase as required by the site.
 4. Power supplies can be UL Class I or II output.
 5. Operating frequency must be 60 Hz.
 6. Drivers must have a Power Factor (PF) of: ≥ 0.90 .
 7. Drivers must have a Total Harmonic Distortion (THD) of: $\leq 20\%$.
 8. Drivers must comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards
 9. Drivers must be Reduction of Hazardous Substances (RoHS) compliant.
 10. Drivers for fixtures connected to dimmers must be compatible with specified dimming controls.
 11. Driver Current Operation: Driver current to the LEDs shall range from 350mA to 1A (or per manufacturer's recommendation).

5.10 INDOOR OCCUPANCY SENSORS

- A. **Timer Switch T-1:**
 1. Basis of Design Product: Lutron MA-T530G or similar product with the following requirements:
 2. General Description: Wall mounted, UL listed, single relay, 10 amp dial timer switch
 3. Mounting: Wall mounted on single gang back box.
 4. Operation: Dial ON / Automatic OFF after preset time.
 5. Time Out Adjustments: Adjustable time out adjustments range from 5 to 30 minutes
- B. **Ceiling Mount Occupancy/Vacancy Sensor Type OS1:**
 1. Basis of Design Product: Subject to compliance with requirements, provide Watt Stopper #DT-355 series or a comparable product by one of the following:
 - a. Leviton Mfg. Company, Inc.
 - b. Lithonia Lighting; Acuity Lighting Group, Inc.

- c. Eaton Cooper Lighting
 - d. Lutron Industries
2. General Description: Ceiling mounted, UL listed, line voltage, dual technology unit.
 3. Mounting: Ceiling mounted on single 4-inch octagonal back box.
 4. Dual Technology Sensing: Detect occupancy by using a combination of Passive Infrared (PIR) and Ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on/off function shall be selectable in the field by operating controls on the unit.
 5. Area of Coverage: Approx. 1000 square foot. Installing contractor to ensure appropriate quantities of sensor is provided for space size. For spaces that require more than ONE sensor device, ensure an approx. 10% overlap of sensor coverage between sensor installation locations.
 6. Operation: Automatic ON/Automatic OFF or Manual ON/Automatic OFF.
 - a. Installing contractor to ensure that for vacancy operation, low voltage override switches are installed in lieu of line voltage override switches. This will ensure that the ceiling mount sensor operates in true vacancy (manual ON/Automatic OFF) mode.
 7. Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door or operable panel. Adjustable time delay of 5, 10, 15, or 30 minutes. Allow for high/low adjustment of PIR and fully variable adjustment of ultrasonic systems.
 8. Indicator: LED lamping to indicate detection type with separate color for each type.
 9. Walk Thru Mode: Provide selectable walk-through mode to turn lights off three minutes after the room is initially occupied if no motion is detected after the first 30 seconds. Use walk-through mode ONLY for sensors connected to fixtures with programmed-start electronic ballasts or LED source.
 10. Power Supply: Required to power sensor and operate light fixtures as required. Reference the Power Supply section for more information.

C. Wall Switch Mount Occupancy/Vacancy Sensor Type OS2:

1. Basis of Design Product: Subject to compliance with requirements, provide Watt Stopper #DW-100 series or a comparable product by one of the following:
 - a. Leviton Mfg. Company, Inc.
 - b. Lithonia Lighting; Acuity Lighting Group, Inc.
 - c. Eaton Cooper Lighting
 - d. Lutron Industries
2. General Description: Switch mounted, UL listed, line voltage, single relay, dual technology unit.
3. Mounting: Switch Mounted
4. Dual Technology Sensing: Detect occupancy by using a combination of Passive Infrared (PIR) and Ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on/off function shall be selectable in the field by operating controls on the unit.
5. Operation: Manual ON / Automatic OFF.
 - a. Device shall also have the ability to allow for a change of operation from Vacancy to Occupancy (Automatic ON/Automatic OFF) operation for spaces that require Occupancy operation as allowed by the governing Energy Code.
6. Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door or operable panel. Adjustable time delay of 5, 10, 15, or 30 minutes. Allow for high/low adjustment of PIR and fully variable adjustment of ultrasonic systems.
7. Indicator: LED lamping to indicate detection type with separate color for each type.
Walk Thru Mode: Provide selectable walk-through mode to turn lights off three minutes after the room is initially occupied if no motion is detected after the first 30 seconds. Use walk-through mode ONLY for sensors connected to fixtures with programmed-start electronic ballasts or LED source.

D. Power Supply Type PS:

1. Basis of Design Product: Subject to compliance with requirements, provide Watt Stopper #BZ-50 series or a comparable product by one of the following:
 - a. Leviton Mfg. Company, Inc.
 - b. Lithonia Lighting; Acuity Lighting Group, Inc.
 - c. Eaton Cooper Lighting
 - d. Lutron Industries
2. General Description: Universal Voltage Power Pack provides 24 VDC operating voltage to low-voltage occupancy sensors.
3. Mounting: UL2043 rated for installation in plenums.
4. Voltage: 120-277 VAC input and 24 VDC output.
5. Load Rating: 20 AMP

5.11 EXTERIOR SENSORS

A. Astronomical Time Clock Type AT:

1. Basis of Design Product: Subject to compliance with requirements, provide Intermatic #ET8015C series or a comparable product complying with the following requirements:
2. General Description: Wall mounted, UL listed, astronomic clock providing sunset ON and sunrise OFF settings.
3. Mounting: Wall mounted on single gang back box.
4. Features: Automatic Daylight Saving Time adjustment

B. Photocell Lighting Control PC:

1. General Description: UL listed photocell lighting dusk-to-dawn control with delay action
2. Mounting: Wall or roof mounted
3. Features: Lens to seal out moisture, capable of controlling multiple fixtures

5.12 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

A. Fixture Type FL1:

1. Basis-of-Design Product: Cooper MSS11315LES Motion LED single head flood or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 21 W, LED, 5000K, 1350 lumens at 65 lumens/watt, 70 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Special Conditions: Integrated motion sensor, preference for Energy Star qualified products.

B. Fixture Type FL2:

1. Basis-of-Design Product: Cooper MST18920LES Motion LED twin head flood or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 31 W, LED, 5000K, 2240 lumens at 73 lumens/watt, 70 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.

6. Special Conditions: Integrated motion sensor, preference for Energy Star qualified products.

C. Fixture Type CL1:

1. Basis-of-Design Product: Eaton Cooper Lighting SLD6 LED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Lamps: 14.8W, LED, 4000K, 1,215 lumens at 82 lumens/watt, 80 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Size: Contractor must verify diameter sizes for all the downlights to ensure the retrofits will fit.
7. Special Conditions: Preference for Energy Star qualified products.

D. Fixture Type L1-a:

1. Basis-of-Design Product: CREE A19 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 5.5 W, LED, 465 lumens, 85 CRI, 2700 K.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for A19 dimensions.
7. Special Conditions: Preference for Energy Star qualified products.

E. Fixture Type L1-b:

1. Basis-of-Design Product: CREE A19 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 9.5 W, LED, 815 lumens, 80 CRI, 2700 K.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for A19 dimensions.
7. Special Conditions: Preference for Energy Star qualified products.

F. Fixture Type L1-c:

1. Basis-of-Design Product: CREE A21 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 16.5 W, LED, 1,700 lumens, 85 CRI, 5000 K.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for A21 dimensions.
7. Special Conditions: Preference for Energy Star qualified products.

G. Fixture Type L2-a:

1. Basis-of-Design Product: CREE BR30 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 8.5 W, LED, 680 lumens, 85 CRI, 2700 K.
4. Driver Type: Integral, high efficiency.

- 5. PF: Greater than 0.9 nominal.
- 6. Meets ANSI standards for A19 dimensions.
- 7. Special Conditions: Preference for Energy Star qualified products.

H. Fixture Type L2-b:

- 1. Basis-of-Design Product: CREE BR30 LED Series or a comparable product complying with the following requirements:
- 2. Voltage: 120V
- 3. Lamps: 16 W, LED, 85 CRI, 2700 K.
- 4. Driver Type: Integral, high efficiency.
- 5. PF: Greater than 0.9 nominal.
- 6. Meets ANSI standards for BR40 dimensions.
- 7. Special Conditions: Preference for Energy Star qualified products.

I. Fixture Type L3:

- 1. Basis-of-Design Product: Philips 2 PIN LED lamps Series or a comparable product complying with the following requirements:
- 2. Voltage: 120V
- 3. Lamps: 5.5 W, LED, 80 CRI, 3000 K.
- 4. 2-pin base (replaces 2-pin CFL bulbs)
- 5. Driver Type: Integral, high efficiency.
- 6. PF: Greater than 0.9 nominal.
- 7. Meets ANSI standards for 2 Pin bulb dimensions.
- 8. Special Conditions: Preference for Energy Star qualified products.

J. Fixture Type L4-a:

- 1. Basis-of-Design Product: Philips 4 PIN LED lamps Series or a comparable product complying with the following requirements:
- 2. Voltage: 120V
- 3. Lamps: 5.5 W, LED, 85 CRI, 3000 K.
- 4. 4-pin base (replaces 4-pin CFL bulbs)
- 5. Driver Type: Integral, high efficiency.
- 6. PF: Greater than 0.9 nominal.
- 7. Meets ANSI standards for 4 Pin bulb dimensions.
- 8. Special Conditions: Preference for Energy Star qualified products.

K. Fixture Type L4-b:

- 1. Basis-of-Design Product: Philips 4 PIN LED lamps Series or a comparable product complying with the following requirements:
- 2. Voltage: 120V
- 3. Lamps: 8.5 W, LED, 85 CRI, 3000 K.
- 4. 4-pin base (replaces 4-pin CFL bulbs)
- 5. Driver Type: Integral, high efficiency.
- 6. PF: Greater than 0.9 nominal.
- 7. Meets ANSI standards for 4 Pin bulb dimensions.
- 8. Special Conditions: Preference for Energy Star qualified products.

L. Fixture Type L4-c:

1. Basis-of-Design Product: Philips 4 PIN LED lamps Series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 10.5 W, LED, 85 CRI, 3000 K.
4. 4-pin base (replaces 4-pin CFL bulbs)
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Meets ANSI standards for 4 Pin bulb dimensions.
8. Special Conditions: Preference for Energy Star qualified products.

M. Fixture Type L5-a:

1. Basis-of-Design Product: Cree B13 LED candelabra lamps or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 5 W, LED, 85 CRI, 2700 K
4. Candelabra bulb replacement
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Meets ANSI standards for B13 dimensions.
8. Special Conditions: Preference for Energy Star qualified products.

N. Fixture Type L5-b:

1. Basis-of-Design Product: Cree B13 LED candelabra lamps or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 7 W, LED, 85 CRI, 2700 K
4. Candelabra bulb replacement
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Meets ANSI standards for B13 dimensions.
8. Special Conditions: Preference for Energy Star qualified products.

O. Fixture Type L6-a:

1. Basis-of-Design Product: Philips 17PAR38 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 17 W, LED, 815 lumens, 80 CRI, 2700 K
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for PAR38 dimensions.
7. Special Conditions: Preference for Energy Star qualified products

P. Fixture Type L6-b:

1. Basis-of-Design Product: Philips 32PAR38 LED series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 32W, LED, 2,800 lumens at 88 lumens per watt, 80 CRI, 815 lumens, 3000 K

4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Meets ANSI standards for PAR38 dimensions.
7. Special Conditions: Preference for Energy Star qualified products

Q. Fixture Type L7:

1. Basis-of-Design Product: Truly Green Solutions Universal Light or a comparable product complying with the following requirements:
2. Voltage: 100-277V
3. Lamps: 36W LED, 3000K, 3,800 lumens, 80+ CRI
4. Bulb should be designed to replace HID/HPS bulb
5. Driver Type: Integral, high efficiency. Contractor to remove or bypass existing ballast.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products

R. Fixture Type L8:

1. Voltage: 120V
2. Lamps: 23 W, LED, 85 CRI, 3000 K.
3. 4-pin 2G11 base
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Special Conditions: Preference for Energy Star qualified products.

S. Fixture Type LB1:

1. Basis-of-Design Product: SLV Quadrasyl SL 75 bollard lamped with GX53 LED bulb or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Lamps: 11 W minimum, 15 W maximum, 3,000K
4. Driver Type: Weather tight, class 1
5. External Finish: Manufacturer's standard finish option per site.
6. Special Conditions: Preference for Energy Star qualified product

T. Fixture Type LC1:

1. Basis-of-Design Product: Lumark CLCSLED-40-SM-UNV canopy LED fixture or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Surface Ceiling/Canopy
4. Lamps: 4000K, LED unit, 36W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 36W input driver.
7. Lumens: Minimum of 4,800 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified product.

U. Fixture Type LW1:

1. Basis-of-Design Product: Seasons LED Saturn Wall Sconce (model # 39110000)

1. Voltage: Universal (120-277V)
2. Lamps: 10W, LED, 3000K, 790 lumens at 79 lumens/watt, 80 CRI.
3. Driver Type: Integral, high efficiency.
4. PF: Greater than 0.9 nominal.
5. Trim and Finish: Brushed Nickel
6. Special Conditions: Preference for Energy Star qualified products.

V. Fixture Type LW2:

1. Basis-of-Design Product: Cooper Industries BCLED 2' Metalux Wall Mount (model # 2BCLED-LD4-8SL)
2. Voltage: Universal (120-277V)
3. Lamps: 10W, LED, 3500K, 800 lumens at 80 lumens/watt, 80 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Trim and Finish: Brushed Nickel
7. Special Conditions: Preference for Energy Star qualified products.

W. Fixture Type LW3:

1. Basis-of-Design Product: Columbia Lighting Contemporary 4' LED Wall Mount (model # CWM4-35XW SMFR)
2. Voltage: Universal (120-277V)
3. Lamps: 18W, LED, 3500K, 2490 lumens at 135 lumens/watt, 80 CRI.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.
6. Trim and Finish: Brushed Nickel
7. Special Conditions: Preference for Energy Star qualified products.

X. Fixture Type LW4:

1. Basis-of-Design Product: Cerno Via Sconce Light
2. Voltage: 120V
3. Lamps: 7 W, LED, 90+ CRI, 500 Lumens, 2700 K.
4. Driver Type: Integral, high efficiency.
5. PF: Greater than 0.9 nominal.

Y. Fixture Type P1-a:

1. Basis-of-Design Product: Cooper PMM Mesa LED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Pole – contractor to determine width of existing pole
4. Lamps: 4,000K, 52W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1
6. Lumens: 4,900 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

Z. Fixture Type P1-b:

1. Basis-of-Design Product: Eaton Cooper Lighting PRV Prevail or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 10'-15' pole height, replacing 100-400W HPS or MH). Verify pole type and shape (square vs round).
4. Lamps: 4,000K, 87W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1, THD less than 20 percent.
6. Lumens: 10,204 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell. Preference for Energy Star qualified products.

AA. Fixture Type P1-c:

1. Basis-of-Design Product: Eaton Cooper Lighting PRV Prevail or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 20'-25' pole height, replacing 200-400W HPS or MH). Verify pole type and shape (square vs round).
4. Lamps: 4,000K, 163W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1, THD less than 20 percent.
6. Lumens: 18,830 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell. Preference for Energy Star qualified products.

BB. Fixture Type P1-d:

1. Basis-of-Design Product: Eaton Cooper Lighting PMM Mesa or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Mounted at top of existing pole (estimate 10'-12' pole height, replacing 50-100W HPS or MH). Verify pole type and shape (square vs round).
4. Lamps: 4,000K, 25W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1, THD less than 20 percent.
6. Lumens: 2,400 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell. Preference for Energy Star qualified products.

CC. Fixture Type P2-a:

1. Basis-of-Design Product: Eaton Cooper Lighting PRV Prevail or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 10'-15' pole height, replacing 100-400W HPS or MH). Verify pole type and shape (square vs round). **Compatible for mounting multiple heads on same pole.**

4. Lamps: 4,000K, 87W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1, THD less than 20 percent.
6. Lumens: 10,204 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell. Preference for Energy Star qualified products.

DD. Fixture Type P2-b:

1. Basis-of-Design Product: Eaton Cooper Lighting PRV Prevail or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: Versatile mount arm. Arm mounted at top of existing pole (estimate 20'-25' pole height, replacing 200-400W HPS or MH). Verify pole type and shape (square vs round). **Compatible for mounting multiple heads on same pole.**
4. Lamps: 4,000K, 163W, contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
5. Driver Type: Weather tight, class 1, THD less than 20 percent.
6. Lumens: 18,830 minimum (lumens will depend on distribution type)
7. External Finish: Manufacturer's standard finish option per site.
8. Trim and Hardware: Cast aluminum.
9. Special Conditions: Integral photocell. Preference for Energy Star qualified products.

EE. Fixture Type RL1:

1. Basis-of-Design Product: MaxLite LED T8 Linear Replacement Lamp or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 2' T8 replacement lamps
4. Lamps: LED, 10 W, CRI >80, 3500K
5. Driver Type: Internal, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

FF. Fixture Type RL2:

1. Basis-of-Design Product: MaxLite LED T8 Linear Replacement Lamp or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 3' T8 replacement lamps
4. Lamps: LED, 10 W, CRI >80, 3500K
5. Driver Type: Internal, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

GG. Fixture Type RL3:

1. Basis-of-Design Product: MaxLite LED T8 Linear Replacement Lamp or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)

3. 4' T8 replacement lamps
4. Lamps: LED, 15 W, CRI >80, 3500K
5. Driver Type: Internal, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

HH. Fixture Type RL4:

1. Basis-of-Design Product: GE Type C LED Tubes with remote dedicated LED driver, or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 2' T8 replacement lamps
4. Lamps: LED, 8 W, CRI >80, 3500K
5. Driver Type: Remote, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

II. Fixture Type RL5:

1. Basis-of-Design Product: GE Type C LED Tubes with remote dedicated LED driver, or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 3' T8 replacement lamps
4. Lamps: LED, 16 W, CRI >80, 3500K
5. Driver Type: Remote, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

JJ. Fixture Type RL6:

1. Basis-of-Design Product: GE Type C LED Tubes with remote dedicated LED driver, or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 4' T8 replacement lamps
4. Lamps: LED, 18 W, CRI >80, 3500K
5. Driver Type: Remote, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Ensure bulb compatibility with existing fixture. Preference for Energy Star qualified products.

KK. Fixture Type RL7:

1. Basis-of-Design Product: ESPEN RetroFlex LED T8 lamp with an LED emergency ballast or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. 4' T8 replacement lamps
4. Lamps: LED, 15 W, CRI >80, 3500K
5. Driver Type: High efficiency
6. Ballast: LED emergency ballast
7. PF: Greater than 0.9 nominal.

8. Special Conditions: Ensure bulb compatibility with existing fixture and that emergency backup lighting functionality is preserved. Preference for Energy Star qualified products.

LL. Fixture Type RO1:

1. Basis-of-Design Product: Commercial Electric 11” LED flush round mount or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Mounting: flush, round – contractor should confirm diameter is equal to or greater than existing fixture if being installed as a retrofit
4. Lamps: LED, 15 W, 920 lumens, 80+ CRI
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

MM. Fixture Type RO2:

1. Basis-of-Design Product: Commercial Electric 13” LED flush round mount or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Mounting: flush, round – contractor should confirm diameter is equal to or greater than existing fixture if being installed as a retrofit
4. Lamps: LED, 23 W, 1690 lumens, 80+ CRI
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

NN. Fixture Type RR1:

1. Basis-of-Design Product: Philips FluxGrid LED 1FG-G-30L-835-4-STANDARD LENS-UNV-DIM or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: 1’ x 4’ recessed
4. Lamps: LED, 24 W, 3000 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

OO. Fixture Type RR2:

1. Basis-of-Design Product: Philips FluxGrid LED 1FG-G-38L-835-4-STANDARD LENS-UNV-DIM or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277V)
3. Mounting: 1’ x 4’ recessed
4. Lamps: LED, 32 W, 3800 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

PP. Fixture Type RR3:

1. Basis-of-Design Product: Philips 2FG-G-43L-835-4-STANDARD LENS-UNV-DIM or a comparable product complying with the following requirements:

2. Voltage: 120V
3. Mounting: 2' x 4' recessed
4. Lamps: 36 W, 4300 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

QQ. Fixture Type RR4:

1. Basis-of-Design Product: Philips 2FG-G-54L-835-4-STANDARD LENS-UNV-DIM or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Mounting: 2' x 4' recessed
4. Lamps: LED, 49 W, 5400 lumens, 80 CRI, 3500K
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

RR. Fixture Type RR5:

1. Basis-of-Design Product: Metalux 22CZ Cruze Series 22CZ-LD5-34-UNV-L830-CD1-U or a comparable product complying with the following requirements:
2. Voltage: Universal (120-227V)
3. Mounting: 2' x 2' recessed ceiling troffer
4. Lamps: LED, 30 W, CRI >80, 3000K, 3292 lumens
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

SS. Fixture Type RR6:

1. Basis-of-Design Product: Metalux 22SP3435 LED or a comparable product complying with the following requirements:
2. Voltage: Universal (120-227V)
3. Mounting: 2' x 2' surface flush mount
4. Lamps: LED, 32 W, CRI >80, 3500K, 3400 lumens
5. Driver Type: Integral, high efficiency.
6. PF: Greater than 0.9 nominal.
7. Special Conditions: Preference for Energy Star qualified products.

TT. Fixture Type RS1:

1. Basis-of-Design Product: Eaton Cooper HU1024D930P + HU109P series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Fixture type: 18" under-cabinet fixture
4. Mounting: Under-cabinet
5. Lamps: LED, 8 W, CRI > 80, 2700K
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.

UU. Fixture Type RS1b:

1. Basis-of-Design Product: Eaton Cooper HU1024D930P + HU109P series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Fixture type: 24" under-cabinet fixture
4. Mounting: Under-cabinet
5. Lamps: LED, 11 W, CRI > 80, 2700K
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.

VV. Fixture Type RS2:

1. Basis-of-Design Product: Eaton Cooper 2SNLED LENSED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 2' strip light
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 22 W, CRI > 80, 3500 K, 2000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Contractor should check with owner for preference of clear or frosted lens.

WW. Fixture Type RS3:

1. Basis-of-Design Product: Eaton Cooper 4SNLED LENSED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4' strip light
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 22 W, CRI > 80, 3500 K, 2300 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Contractor should check with owner for preference of clear or frosted lens.

XX. Fixture Type RS4:

1. Basis-of-Design Product: Eaton Cooper 4SNLED LENSED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4' strip light
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 32 W, CRI > 80, 3500 K, 3400 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Contractor should check with owner for preference of clear or frosted lens.

YY. Fixture Type RS5:

1. Basis-of-Design Product: Eaton Cooper 8TSNLED LENSED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 8' strip light
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 50 W, CRI > 80, 3500 K, 5400 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Contractor should check with owner for preference of clear or frosted lens.

ZZ. Fixture Type RS6:

1. Basis-of-Design Product: Eaton Cooper 8TSNLED LENSED series or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 8' strip light
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 57 W, CRI > 80, 3500 K, 6100 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Contractor should check with owner for preference of clear or frosted lens.

AAA. Fixture Type RS7:

1. Basis-of-Design Product: Philips FluxStream FSS220L835-UNV-DIM-DAYOCC or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 2' surface mount strip fixture with integral daylight and occupancy sensor
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 17 W, 80 CRI, 3500 K, 2000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products. Fixture should be set up with daylight/occupancy sensor based on space requirements.

BBB. Fixture Type RS8:

1. Basis-of-Design Product: Philips FluxStream FSS440L835-UNV-DIM-DAYOC or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4' surface mount strip fixture with integral daylight and occupancy sensor
4. Mounting: Contractor should verify that existing mounting equipment is sufficient for replacement LED fixture, or contractor should provide new mounting.
5. Lamps: LED, 31 W, 80 CRI, 3500 K, 4000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.

8. Special Conditions: Preference for Energy Star qualified products. Fixture should be set up with daylight/occupancy sensor based on space requirements.

CCC. Fixture Type RW1:

1. Basis-of-Design Product: Eaton Cooper 4WNLED-LD4-40SL-F-UNV-L835 or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4' surface mount wrap fixture
4. Mounting: Contractor should ensure that if new fixture is narrower than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, 36 W, 80 CRI, 3500 K, 4000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.

DDD. Fixture Type RW2:

1. Basis-of-Design Product: Eaton Cooper 4WNLED-LD4-50SL-F-UNV-L835 or a comparable product complying with the following requirements:
2. Voltage: Universal (120-277 V)
3. Fixture type: 4' surface mount wrap fixture
4. Mounting: Contractor should ensure that if new fixture is narrower than existing fixture, space around the mounted new fixture is cleaned up (spackled, painted, etc)
5. Lamps: LED, 47 W, 80 CRI, 3500 K, 5000 lumens or greater
6. Driver Type: Integral, high efficiency.
7. PF: Greater than 0.9 nominal.
8. Special Conditions: Preference for Energy Star qualified products.

EEE. Fixture Type WL1:

1. Basis-of-Design Product: Cooper Lighting Lumark NFFLD-S series or a comparable product complying with the following requirements:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 4000K, LED unit, 51W, 73 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 51W input driver.
7. Lumens: Minimum of 1,884 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

FFF. Fixture Type WL2:

1. Basis-of-Design Product: RAB FFLED18 series or a comparable product complying with the following requirements:
2. Voltage: Universal 120-227V
3. Mounting: Ground
4. Lamps: 4000K, LED unit, 23W, 82 CRI.

5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 2, 18W input driver.
7. Lumens: Minimum of 2,000 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

GGG. Fixture Type WP1:

1. Basis-of-Design Product: Cooper Lighting Lumark XTOR LED series or a comparable product complying with the following requirements:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 4000K, LED unit, 18W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 18W input driver.
7. Lumens: Minimum of 1,400 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

HHH. Fixture Type WP2:

1. Basis-of-Design Product: Cooper Lighting Lumark Wal-Pak (WP) series or a comparable product complying with the following requirements:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 4000K, LED unit, 27W, 73 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 27W input driver.
7. Lumens: Minimum of 1,884 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

III. Fixture Type WP3:

1. Basis-of-Design Product: Cooper Lighting Lumark Wal-Pak (WP) series or a comparable product complying with the following requirements:
2. Voltage: Universal 120-227V
3. Mounting: Surface Wall
4. Lamps: 4000K, LED unit, 46W, 73 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 46W input driver.
7. Lumens: Minimum of 5,828 lumens for glass door or 3,100 for full cutoff door

8. External Finish: Manufacturer's standard finish option per site.
9. Trim and Hardware: Cast Aluminum.
10. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

JJJ. Fixture Type WP4:

1. Basis-of-Design Product: Lithonia TWS Mini Wall Pack LED Outdoor or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Mounting: Surface Wall
4. Lamps: minimum of 4000K (5000K is acceptable), LED unit, 25W, 70 CRI.
5. Distribution: Contractor needs to verify appropriate distribution type for fixture locations, taking local city guidelines in to consideration.
6. Driver Type: Weather tight, class 1, 25W input driver.
7. Lumens: Minimum of 1,476 lumens
8. External Finish: Manufacturer's standard finish option per site.
9. Special Conditions: Integral photocell unless site is receiving central exterior lighting controls (to be verified by contractor). Preference for Energy Star qualified products.

KKK. Fixture Type X1 (exit sign):

1. Basis of design product: TCP Lighting Exit Sign series or a comparable product complying with the following requirements:
2. Voltage: 120V
3. Mounting: By application
4. Lamping: Internally lit LED, 4W max
5. Battery backup: Internal
6. Driver Type: Integral, high efficiency.
7. Special conditions: Choose mounting, arrows, colors, and single/double face to match existing applications. Preference for Energy Star qualified products.

5.13 INSTALLATION

- A. Surge Protection Device: Install devices at service entrance on the load side, with ground lead bonded to service entrance ground. Install devices with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 1. Provide multi-pole, 100A, circuit breaker as a dedicated disconnect for suppressor.
- B. Low-voltage power conductors and cables: Copper, Type THHN-TWVN, single conductors in raceway. Solid for No. 10AWG and smaller, stranded for No. 8AWG and larger.
 1. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 2. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

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3. The Contractor shall increase branch circuit conductors, as required, to limit voltage drop in each branch circuit to 3%.
 4. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 5. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connectors.
- C. Raceway Application: Intercept the existing site lighting conduits within 5ft of the exterior building wall. Apply new raceway products as specified below, unless otherwise noted:
1. Outdoors; Underground Conduit exposed to vehicular traffic areas: RNC, Type EPC-80-PVC, direct buried.
 2. Minimum Raceway Size: 3/4-inch trade size.
 3. Raceway Fittings: Compatible with raceways and suitable for use an location.
 4. Complete raceway installation before starting conductor installation.
 5. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
 6. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
 7. Minimum burial depth for underground conduit shall be 24".
 8. Direct Buried Conduit:
 - a. Excavation: Excavate utility trench to uniform widths to bottom to provide firm and uniform support for conduit.
 1. Slope sides of trenches of provide shoulders in accordance with OSHA requirements and as required by local AHJ.
 2. Continuously monitor cut slopes and trenches for distress or movement. Provide all necessary shoring and bracing required to protect the life and safety of workmen performing excavation or installation of conduit.
 3. Excavate trenches a minimum of 3 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of conduit.
 4. After completion of trench excavation and before installation of conduit, install not less than 3" of approved bedding material in trench bottom for support of conduit.
 - b. Utility Trench Backfill: After installation of conduit has been completed, locations recorded, debris removed, and bedding placed, backfill promptly as work and weather conditions permit.
 1. Do not backfill trenches until all required conduit system tests and inspections have been made. Use care in backfilling to avoid damage or displacement of pipe systems.

- 2. Place backfill on sub-grades free of mud, frost, snow, or ice.
 - 3. Before compaction, moisten or aerate each layer of backfill. Compact each layer to not less than 95% of maximum standard Proctor density (ASTM D698).
 - c. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
 - d. Install manufactured rigid steel conduit elbows for stub-ups at poles. For stub-ups at concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 - e. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.
- D. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- 1. Patch and paint to ensure fixture retrofit maintains professional appearance.
- E. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
- 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- F. Suspended Lighting Fixture Support:
- 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structures.
- G. Adjust aimed lighting fixtures to provide required light intensities.

5.14 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

END OF SECTION 260500