REQUEST FOR PROPOSALS (RFP) FOR WEATHERIZATION CONSTRUCTION SERVICES

SILVERCREST Colorado Springs 1

904 Yuma St

Colorado Springs, CO 80909

Mandatory Bidders Meeting

October 20, 2016

ALL TRADES: 9 am

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I. INTRODUCTION

1. OVERVIEW

Energy Outreach Colorado Efficiency, LLC (EOC) 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.

EOC has conducted an energy audit and has identified energy efficiency measures using a DOE approved energy modeling software. EOC 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, EOC, 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:

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

SUBJECT: "Silvercrest CS 1"

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

SILVERCREST 1 CS 904 YUMA ST, COLORADO SPRINGS, CO 80909

Silvercrest CS I is a 38,088 square foot, three story building with elderly residents. There are 49 one bedroom units and a two bedroom staff unit on the first floor. Common spaces include a laundry room, trash rooms, hallways and elevator lobbies on each floor, two stairwells, and a large community room on the first floor.

2. ENERGY AUDIT SUMMARY AND BID SPECIFICATIONS

EOC is seeking weatherization construction services for the following energy efficiency measures for **SILVERCREST CS 1:**

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

Energy Efficiency and Health & Safety Measures				
HVAC	**Lighting**	**Appliances**	**Low Flow Fixtures**	**Insulation**
Condensing DHW	In-Unit (Screw-in LEDs)	Refrigerators	Kitchen Aerators	LED Can Covers
Condensing Space Heating Boiler	In-Unit (T12s to LEDs)		Bath Aerators	Knee Wall Insulation
MAU Replacement	Common Area		Shower Heads	
Bath Exhaust Fans	Exterior			
	LED Can Covers			

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. MANDTORY BIDDERS MEETING

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

SILVERCREST 1 CS 904 YUMA ST, COLORADO SPRINGS, CO 80909
October 20, 2016 ALL TRADES: 9:00 am

This meeting is **MANDATORY** for all Vendors planning to submit a proposal to EOC. 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 - 9:00 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 EOC in person or mailed to EOC; however, proposals (bid forms) shall be emailed only. Proposals must be emailed to:

Ashley Feiertag: afeiertag@energyoutreach.org and **Valerie Rick**: vrick@energyoutreach.org
SUBJECT: Request for Proposals: **Silvercrest CS 1**

Proposals Due Date/Time: **November 3, 2016 by 5 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 EOC 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 EOC. All policies evidencing the required insurance coverage shall be issued by insurance companies satisfactory to EOC 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, EOC 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, EOC 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 EOC, 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 EOC, CEO, and Property Owner. EOC 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 EOC's sole discretion and may be waived, in writing, by EOC. 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 EOC when permits are not required.

V. INSPECTIONS

1. EOC INSPECTION

Each Vendor is required to be present at the EOC final inspection of each specified energy efficiency measure to ensure compliance with weatherization rules, materials, and agreed upon bid specifications. EOC 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. EOC 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 EOC/Housing Provider/Vendor(s) contract; EOC 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 EOC shall be served.

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 EOC 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 EOC inspection is a condition precedent for payment. Accordingly, no payment shall be made to Vendor if Vendor fails to pass the EOC inspection. Further, EOC 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

EOC 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, EOC shall issue payment to Vendor within 30 days of the day EOC determines the payment request complies with this agreement.

3. PAYMENT AMOUNT

In accordance with this section, EOC shall pay Vendor an amount equal to the cost of the work per Exhibit A-1 of the final contract.

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

EOC 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, EOC

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

EOC 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, EOC shall not withhold retainage. EOC 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 EOC shall make final determinations, in its sole discretion, of whether and how much additional funding is necessary to complete the work. EOC's decision regarding change orders shall be at its sole discretion and is final. If approved, EOC 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 EOC inspection, Vendor may submit to EOC 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. EOC 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 EOC.

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 10-13-2016
- Proposals Bidders Meeting- SILVERCREST CS 1 10-20-2016
- Proposal Question Submission Deadline 10-24-2016
- Proposal Answers/Amendment Distribution 10-27-2016
- Proposals due by 5pm 11-03-2016
- Anticipated Date - Contract(s) Signed 01-31-2017
- Anticipated Project Start Date 02-01-2017

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.

Silvercrest Colorado Springs I

Energy Outreach Colorado Multi-Family Audit

This document contains the results of a multi-family audit and resulting recommendations.

10/12/2016

Version 1.0

Table of Contents

1 Executive Summary

Group14 has completed an energy audit of Silvercrest CS I, a 38,088 ft^2, three-story building, consisting of 50 units. Building and utility data were compiled and entered into DOE-2 modeling software.

Table 1 – Historical Energy Use Summary

Fuel	Annual Use	Annual Cost
Electric (kWh)	244,626	$33,932
Gas (Therms)	13,937	$6,664
	Total	**$40,596**

Silvercrest CS I has baseboard heating controlled by electronic thermostats and packaged terminal air conditioning (PTAC) units for cooling. Hot water is provided by 2 central boilers. There is a make-up air unit (MAU) that provides ventilation air to the corridors in each level.

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), prescriptive measures, and health and safety measures (H&S) that passed the Department of Energy's criteria for weatherization funding are presented in the tables below.

Table 2 – EEM Summary

Energy Efficiency Measure	1st Year Savings	SIR
In-Unit Lighting (Screw-in LEDs)	$ 1,837	2.6
Common Area Lighting	$ 4,319	10.7
In-Unit Lighting (T12s to LEDs)	$ 484	1.1
Exterior Lighting	$ 1,776	4.1
Low Flow Fixtures	$ 1,095	1.3
Condensing DHW Heater	$ 582	0.6
Space Heating Boiler – condensing	$ 1,608	0.7
Replace MAU	$ 593	0.8
Attic Improvements	$ 6	0.1
Energy Star Refrigerators	$ 1,140	2.2
Package	$ 12,807	1.8

Table 3 – Measures Not Recommended

Energy Efficiency Measure	1st Year Savings	SIR
R-58 Attic Insulation	$ 33	0.02
R-55 Attic Insulation	$ 22	0.02
R-52 Attic Insulation	$ 10	0.01

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, two health and safety measures were documented.

Table 4 – Health and Safety Measures

Existing Condition	Health and Safety Measure
Many Bathroom Exhaust Fan Flow Rates are Below Code Minimum	Install Energy Star Exhaust Fans
No anti-scald mixing valves	Installing an anti-scald mixing valve will protect against burns and the higher tank temperature will ward against legionella.
No covers on can lights that penetrate into attic space	Install covers on the lights to reduce fire hazard.

The existing building conditions of Silvercrest CS I 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

Silvercrest CS I is a 38,088 square foot, three story building with elderly residents. There are 49 one bedroom units and a two bedroom staff unit on the first floor. Common spaces include a laundry room, trash rooms, hallways and elevator lobbies on each floor, two stairwells, and a large community room on the first floor.

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

Figure 1 – Overhead View of Silvercrest CS I

2.1 Building Envelope

The building is constructed of 2x4 wood frames with a brick exterior. The exterior walls have a 3-1/2" cavity with 3" and 3-1/4" of fiberglass batt insulation. The building has an attic, which has an average depth of 18" of insulation. Windows are all double-pane with vinyl frames. Images of the east, north, south, and west façades are presented below.

Figure 2 - South Façade

Figure 3 - East Façade

Figure 4 – North Façade

Figure 5 – West Façade

2.1.1 Attic

The attic has blown fiberglass insulation, unevenly distributed with an average depth of 18” for an R-value of R-49. The access panel and elevator shaft knee walls are devoid of insulation, providing a discontinuous thermal boundary. The attic contains LED can lights without covers and without visible ICAT ratings, posing a potential fire hazard. There was also noticeable roof damage, and the area around the roof access hatch was littered with debris and construction materials, which could negatively affect the thermal boundary performance at this location.

Figure 6 – Attic Insulation Measurement

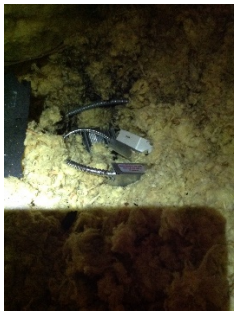


Figure 7 – Exposed Can Lights

Figure 8 – Roof Damage

2.1.2 Wall Insulation

Wall cavity and insulation depths were measured on site in each cardinal direction. Each direction has a wall cavity depth of 3 ½", and similar levels of batt insulation. The insulation on the south and west walls measured 3 ¼". The insulation on the east wall measured 3", and the insulation on the north wall measured 3 1/8".

Figure 9 –East Wall Insulation Test

Figure 10 – East Wall Insulation Test

2.1.3 Envelope Energy Modeling

Wall cavity and insulation depths were measured on site in each cardinal direction. The insulation was measured on average between 3" and 3-1/4", in a 3-1/2" cavity. This is consistent with the architectural drawings (see Figure 11 below). With a fiberglass batt R-value of R-3.4/inch, the total wall insulation is R-11.

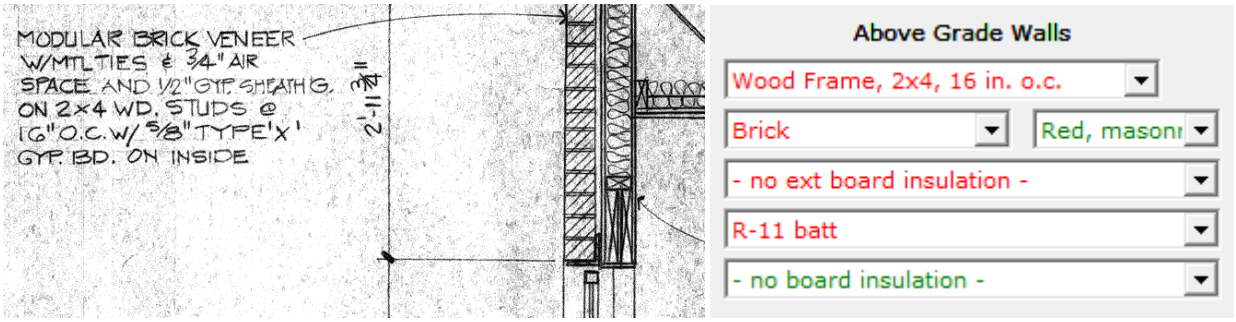


Figure 11 – The wall construction drawings show R-21 batt insulation filling the 2x4 wood cavity. This construction was modeled as such.

Attic insulation depths were measured in multiple sections of attic. The insulation was measured on average to be 18". With an R-value of R-2.8/inch, the total attic insulation is R-49. This is more than the original drawings (see Figure 12 below), as insulation was added to the attic. The model reflects the current situation.

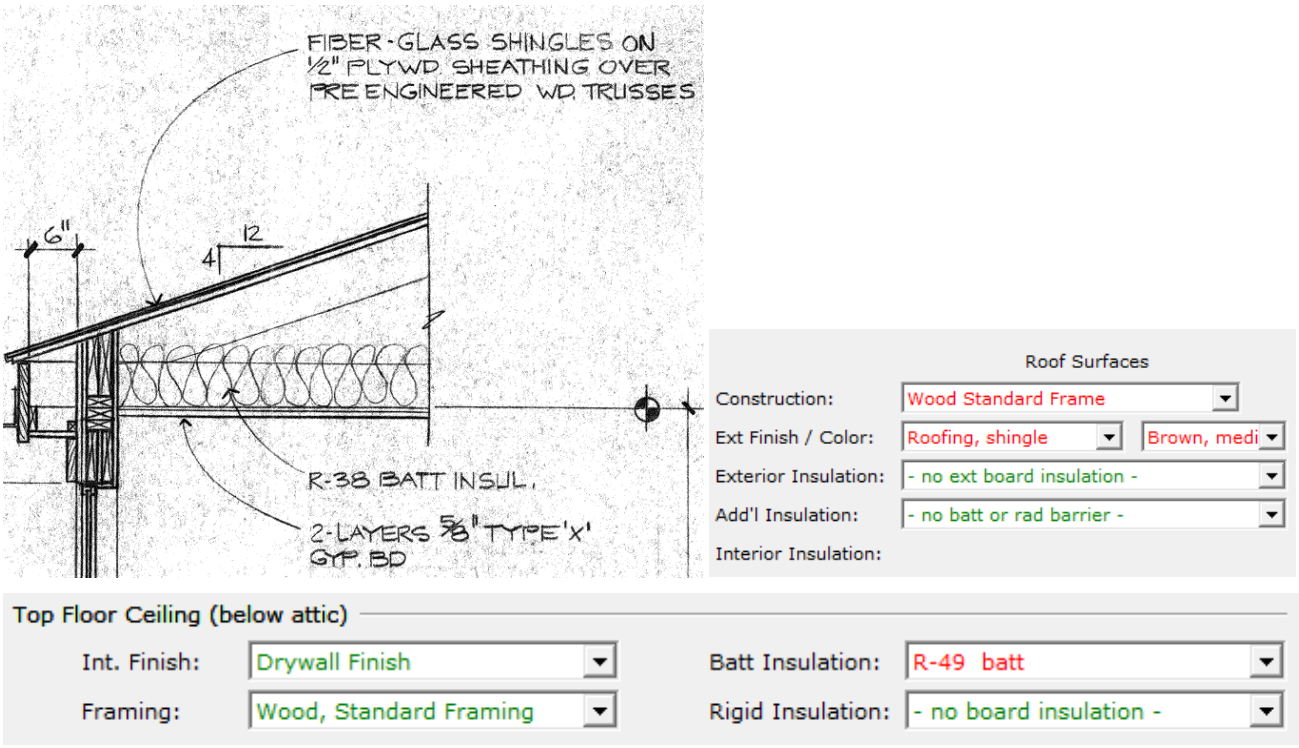


Figure 12 – The attic construction drawings show R-38 batt insulation. Field measurements put this value closer to R-49, which was modeled.

2.1.4 Thermal Boundary

In the figures below, the red lines denote the boundaries of the conditioned space of the building.

Figure 13 –South & East Thermal Boundaries

Figure 14 – North & East Thermal Boundaries

2.1.5 Infrared Photos

Infrared photographs were taken of the building to look for sources of air leakage in the building envelope.

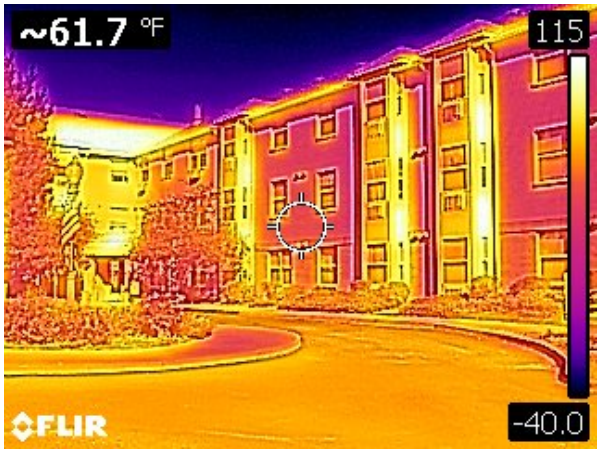


Figure 15 – Example IR Photo - Exterior

Figure 16 – Example IR Photo - Exterior

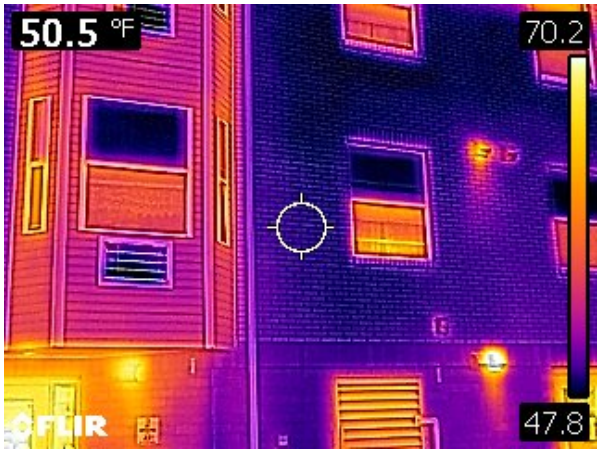


Figure 17 – Example IR Photo - Exterior

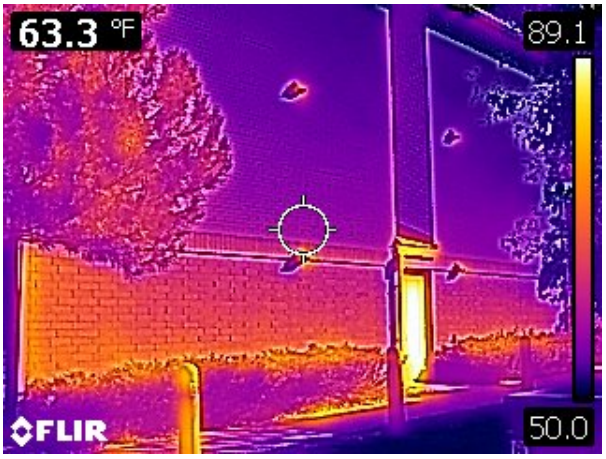


Figure 18 – Example IR Photo - Exterior

2.2 Lighting

Building common areas include interior hallways, two stairwells, an elevator, a laundry room, trash rooms, and a large community room on the first floor. The elevator, stairwells, laundry room, office, and part of the community room are served by ceiling mounted linear fluorescent T12 fixtures with magnetic ballasts. The rest of the community room is served by pin-based CFL can lights. The corridors are served by LED sconces and can lights. There are incandescent vanities in the common restrooms and incandescent tack lights in the first floor corridor.

Each unit has a number of ceiling mounted fixtures and a bathroom vanity fixture with a mixture of CFL and incandescent bulbs. Each unit also has a 4' ceiling mounted T12 fixture, with a magnetic ballast. Tenant lamps are common in living rooms and bedrooms, and contain a mixture of CFL and incandescent bulbs.

Exterior lighting is provided by 9W CFL cans near the entrance and a flood light with a 150W halogen bulb. There are wall packs, walkway and parking lot pole lights that all contain 175W metal halide bulbs. The bollards use 70W metal halide bulbs. All exterior lights for both Silvercrest CS I and II are controlled by a single 24 hour time clock.

Lighting photos and a lighting inventory for the building are presented below.

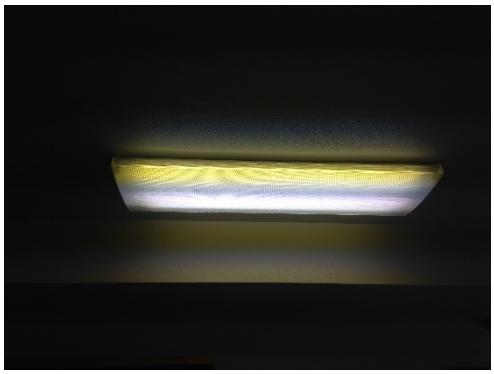


Figure 19 – Typical Ceiling Surface Linear Fluorescent (LF) Fixture

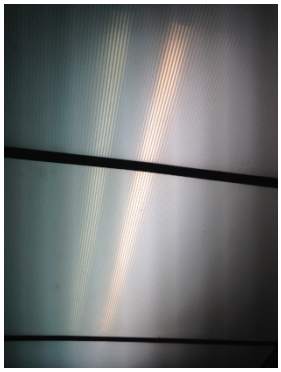


Figure 20 – Typical Recessed Ceiling LF Fixture

Figure 21 – Typical Wall Mounted LF Fixture

Figure 22 – Typical Ceiling Surface Mounted Fixture

Figure 23 – Typical Wall Sconce

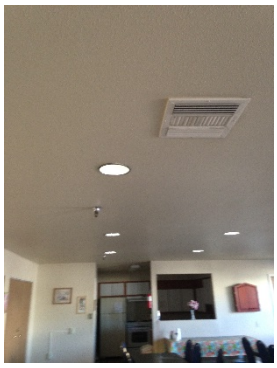


Figure 24 – Typical Ceiling Can Fixtures

Figure 25 – Typical Ceiling Surface Mounted Fixture

Figure 26 – Exterior Bollard

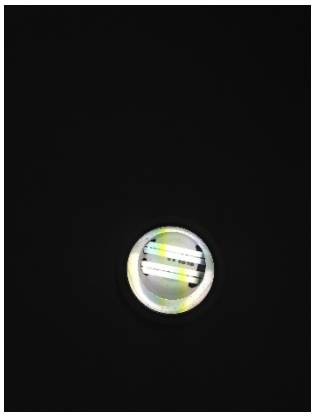


Figure 27 – Typical Exterior Recessed Fixture

Figure 28 – Halogen Flood Light

Figure 29 – Wall Pack

Figure 30 – 10' Pole Light

Figure 31 – 20' Pole Light

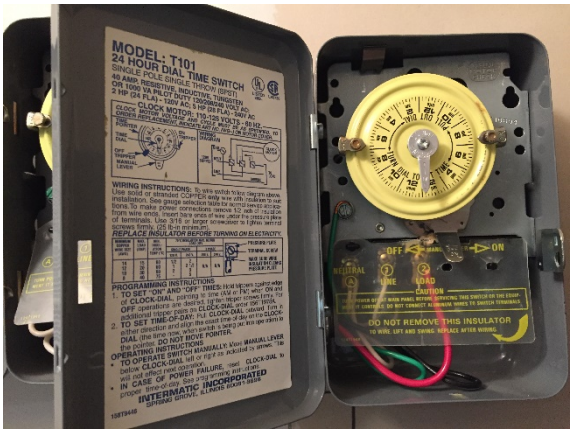


Figure 32 – 24hr Timeclock for Exterior Lighting

Figure 33 - Typical Dwelling Unit (DU) Ceiling Surface Fixture

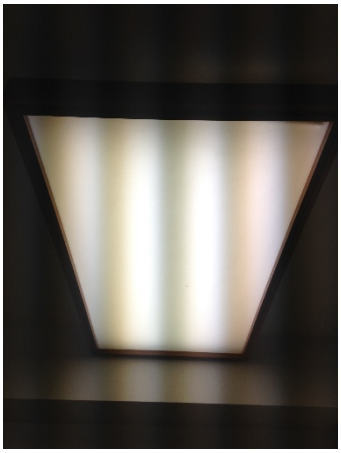


Figure 34 - Typical DU LF Fixture

Figure 35 - Typical DU Stove Light

Figure 36 - Typical DU Vanity Fixture

Figure 37 - Typical DU Exhaust Fan Light Fixture

Figure 38 - Typical DU Ceiling Fan

Table 5 – Lighting Inventory

Tag	Fixture Type	Lamp/Ballast Type	# Lamps /Fixture	# Fixtures	Lamps Watts	Spaces Served
C1	Recessed can	Pin-based CFL	1	12	22	Community room
C2	Recessed can	CFL	2	2	9	Trash rooms
C3	Recessed can	CFL	2	2	9	Storage rooms
C4	Ceiling mounted	CFL	2	1	14	Coordinator's office
C5	Recessed can	2-pin CFL	2	1	9	Exterior entrance
F1	4' ceiling surface mounted	T12, magnetic	2	2	40	Trash rooms
F2	4' ceiling surface mounted	T12, magnetic	2	17	40	Elevator machine room, community closets, mechanical room, office closet, coordinator's office, community room
F3	4' ceiling surface mounted	T12, magnetic	4	10	40	3rd & 2nd floor common rooms
F4	4' ceiling surface mounted	T12, magnetic	2	6	40	Laundry rooms
F5	4' ceiling surface mounted	T12, magnetic	2	10	40	Stairwells
F6	4' ceiling recessed	T12, magnetic	2	1	40	Elevator
H1	Flood light	Halogen	1	1	150	Exterior entrance
I1	Vanity	Incandescent	4	2	60	Restrooms
I2	Ceiling surface mounted	Incandescent	1	2	60	Electrical room, community room stove light
I3	Track flood lights	Incandescent	3	1	65	1st floor corridor
L1	Recessed can	LED	1	93	26	Corridors
L2	Wall sconce	LED	1	6	9.5	2nd floor corridor
L3	Exit sign	LED	1	16	2	Common areas
M1	10' pole light	Metal halide	1	2	175	Exterior
M2	15' pole light	Metal halide	1	5	175	Parking lot
M3	Bollard	Metal halide	1	11	70	Exterior
M4	Wall pack	Metal halide	1	5	175	Exterior

AA	4’ ceiling surface mounted	T12, magnetic	4	1x50 units	40	Dwelling Unit Kitchen
BB	Ceiling surface mounted	Incandescent	2	~100	60	Dwelling Unit Bedrooms, Hallways
CC	Ceiling surface mounted	CFL	2	~21	14	Dwelling Unit Bedrooms, Hallways
DD	Ceiling surface mounted	Incandescent	3	~30	60	Dwelling Unit Living Rooms
EE	Ceiling surface mounted	CFL	3	~10	14	Dwelling Unit Living Rooms
FF	Vanity	Incandescent	2	~29	60	Dwelling Unit Bathrooms
GG	Vanity	CFL	2	~20	14	Dwelling Unit Bathrooms
HH	Vanity	CFL	3	~1	14	Dwelling Unit Bathrooms
JJ	Ceiling exhaust fan, recessed	CFL	1	~1	14	Dwelling Unit Bathrooms
KK	Ceiling surface mounted	Incandescent	1	~6	60	Dwelling Unit Closets
MM	Stove light	Incandescent	1	~40	40	Dwelling Unit Kitchens
NN	Stove light	Incandescent	1	~10	60	Dwelling Unit Kitchens
OO	Ceiling fan	Incandescent	1	~2	60	Dwelling Unit Living Rooms, Bedrooms

2.3 HVAC System

Each unit at Silvercrest CS I has baseboard heating controlled by an electronic thermostat and a wall mounted packaged terminal air conditioning unit for cooling. There are two (2) large non-condensing boilers located in the first floor mechanical room that provide heating water to the baseboard radiators. A single wall mounted ductless split-system was installed in the first floor office to provide supplemental heating and cooling.

Of the two (2) natural draft space heating boilers, Boiler #1 did not have a nameplate or drawings with specifications, but it appears to be the same make and model as Boiler #2. Boiler #2 was manufactured in 1987 and has a rated output capacity of 549 MBH. Each boiler operates on an outside air temperature reset that increases loop system temperature linearly from 160 to 200 as the outside air temperature drops from 7°F to -20°F degrees. The controller enables the boilers when the outside air drops below 60°F. Piping in the mechanical room is uninsulated. Some oversizing and standby losses associated with the boilers necessitated assuming a boiler efficiency of 75% in the DOE-2 energy model to calibrate the model to historical utility data. Boilers are manually disabled by maintenance personnel seasonally.

There are two (2) parallel constant volume heating water pumps that circulate heating water through the boilers and to the equipment in the building. The pumps are controlled by a separate outside air temperature sensor that enables the pumps to run constantly when air temperature drops below 65°F. The pumps currently operate lead/standby with manual changeover and one pump operating at a time. Pumps are also manually disabled seasonally by maintenance personnel.

Ventilation is provided to the corridors by a makeshift make-up air unit equipped with an evaporative cooling unit and indirect gas-fired unit heater paired together. Ventilation is provided to the units via operable windows and intermittent exhaust. Bathroom exhaust fans varied in performance from 73 CFM down to nearly 0 CFM.

2.3.1 Domestic Hot Water

Domestic hot water is provided by two (2) gas fired water heaters plumbed in parallel and located in the same room as the heating boiler. The tank water heaters are 360 MBH (IN) and have 65 gallons of storage. The storage temperature is set to 125°F, and there is no anti-scald valve installed. There is a 1/8 HP Taco recirculation pump operated on a return temperature sensor. The enable temperature has been set to 205°F which causes the pump to run constantly.

Table 6 – Mechanical Equipment Inventory

Tag	Make	Model #	Capacity/HP	Age
Boiler-1 Boiler-2	Weil-McLain	LGB-7	780,000 MBH (IN) 631,800 MBH (OUT)	30 years
Heating Circulation Pump-1 Heating Circulation Pump-2	Bell & Gossett	Series 60	1 HP	Unknown
DHW Heater-1 DHW Heater-2	Rheem-Ruud	G65-360A-1	360 MBH (IN) 65 Gallon Storage	10 yrs 12 yrs
DHW Circulation Pump	Taco	0014-BF1-1	1/8 HP	10-15 years
Evap Cooler w/ Unit Heater (Makeup Air Unit - MAU)	Essick Air	400L2.014N	375 MBH (IN), 75% Therm Eff 2 HP Fan	16 yrs

Ductless Mini-Split	Carrier	38MAQB09--3	0.053 HP Outdoor 0.027 HP Indoor	< 10 years

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

Figure 39 – Space Heating Boilers

Figure 40 – Space Heating Circulation Pumps

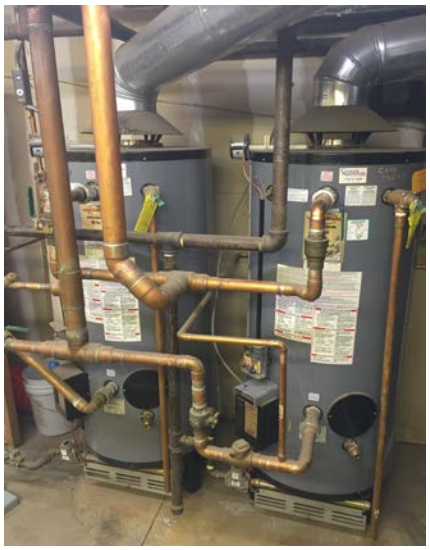


Figure 41 – Domestic Hot Water Heaters

Figure 42 – DHW Circulation Pump

Figure 43 – Evaporative Cooling w/ Unit Heater

Figure 44 – Ductless Split (Outdoor)

Figure 45 – Ductless Split (Indoor)

2.4 Equipment Testing and Records

Flue gasses were analyzed for the heating water boilers and domestic hot water heaters. During testing, Boiler #1 had a full fire efficiency of 83.5% and Boiler #2 had a full fire efficiency of 84.3%.

Both water heaters were operable during testing. There is not an anti-scald mixing valve in place for the domestic hot water. The domestic hot water heater set points are as follows:

- DHW-1 (2007) – 125°F
- DHW-2 (2004) – 125°F

Water heaters indicated an efficiency around 86%.

Full results of the combustion analysis of all equipment are provided in Appendix D.

2.5 Mold Inspection

A visual mold inspection was conducted in 100% of the units at Silvercrest CS I. Possible signs of mold were detected in the following units:

Unit #	Location
316	Around base of toilet

218	Shower

Figure 46 – Potential mold around base of toilet

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 Incandescents and CFLs to LEDs

The replacement of all hardwired screw-in fixtures with LED lamps has been evaluated. It is recommended that an 11 W LED be used to replace bulbs in all screw-in fixtures. Two LED lamps per unit should be left with maintenance to replace tenant-owned incandescents.

Fixtures should be replaced as needed to adhere to the table below.

Fixture	Replacement Fixture	Anticipated Number to Be Replaced
Hardwired Screw-in Incandescents and CFLs	11 W screw-in LED	523
Tenant-owned Screw-in Incandescents and CFLs	11 W screw-in LED	100

The LED retrofits are predicted to save $1,837 per year, giving this measure an SIR of 2.6.

3.1.2 Linear Fluorescents to LEDs

Each unit has a T12 fixture in the kitchen. There are surface-mounted 4’ T12 fixtures – with (4) 40 watt lamps, and magnetic ballasts. It is recommended that these fixtures be retrofit by removing the ballasts and tubes and installing Type C LED tubes and remote dedicated LED drivers. If the fluorescent sockets are more than 10 years old, it is recommended that the sockets be replaced.

The recommended actions are predicted to save $484 each year, giving this measure an SIR of 1.1.

3.2 Common Area Lighting Fixtures

There are (36) ceiling-mounted 4’ T12 fixtures lamped with (2) 40 W bulbs located in the stairwells, trash rooms, community room, laundry room, and elevator. There are also (10) ceiling-mounted 4’ T12 fixtures lamped with (4) 40 W bulbs located in the common rooms. It is recommended that these fixtures be retrofit by removing the ballasts and tubes and installing Type C LED tubes and remote dedicated LED drivers. If the fluorescent sockets are more than 10 years old, it is recommended that the sockets be replaced.

There is a 4-lamp incandescent vanity fixture in each of the 2 public restrooms. There is also an incandescent ceiling fixture in the electrical room and the community room stove. These all have 60W bulbs. There is a 3-lamp track light in the first floor corridor that has 65W bulbs. It is recommended that 11 W LED bulbs be used to replace these.

Fixture replacements are shown in the table below.

Fixture	Replacement Fixture	Anticipated Number to Be Replaced
4’ surface mounted 2-bulb 40W T12 fixture	42W 4’ LED Retrofit, Type C LED tubes and remote driver	36
4’ surface mounted 4-bulb 40W T12 fixture	84W 4’ LED Retrofit, Type C LED tubes and remote driver	10
Surface mounted 1-bulb circline 32W T9 fixture	28W LED fixture	13
Hardwired Screw-in Incandescents	11W screw-in LED bulbs	13

Table 7 - Common Area Lighting Replacements

The recommended actions are predicted to save $4,319 each year, giving this measure an SIR of 10.7.

3.3 Exterior Lighting Improvements

There are (5) 15’ pole lights in the parking areas, lamped with 175W metal halide bulbs. It is recommended that the pole light heads be replaced with 60 W LED parking lot fixture heads with type IV distribution, with integral multi-level motion sensing control. There are also (2) 10’ pole lights around the exterior of the building, lamped with 175W metal halide bulbs. It is recommended that the pole light heads be replaced with 45W LED lamps with retrofit kits. Electrical Contractor to provide sq. ft. coverage pattern for the multi-level motion sensor.

There are 5 wallpacks around the exterior of the buildings. They are lamped with 175 watt metal halides. It is recommended that these fixtures be replaced with 24 watt LED wall pack fixtures.

There is one halogen floodlight, with a 150 W bulb. It is recommended that this be relamped with a 27W LED. There are (11) bollard lights with 70W metal halide bulbs around the exterior of the building. It is recommended that these fixtures be replaced with 15W LED bollards.

Currently, the exterior lighting is controlled by a 24 hour timeclock. The new parking lot pole lights will have integral photocells, but an astronomical timeclock should be purchased to control the remaining exterior lighting.

Fixture replacements are shown in the table below.

Fixture	Replacement Fixture	Anticipated Number to Be Replaced
150W screw-in halogen bulbs	27W LED screw-in bulbs	1
10’ 175W metal halide pole light	45W LED lamps with retrofit kits	2
15’ 175W metal halide pole light	60W LED fixture head, with type IV distribution and integral multi-level motion sensing control	5
70W metal halide bollard	15W LED bollard fixture	11

175W metal halide wall pack	24W LED wall pack	5
24 hour timeclock lighting control	Astronomical timeclock lighting control	1

Table 8 - Exterior Lighting Replacements

The recommended actions are predicted to save $1,776 each year, giving this measure an SIR of 4.1.

3.4 Replace 14 Inefficient Refrigerators

It was found to be cost effective to replace the (14) inefficient refrigerators, determined by an annual energy consumption of 650 kWh/year or greater. This lower kWh limit was determined 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. It is recommended that they be replaced with new Energy Star refrigerators rated at an annual energy consumption of 330 kWh or less.

Replacing these refrigerators is predicted to save $1,140 each year, giving this measure a SIR of 2.2.

3.5 Low-Flow Fixtures

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

Fixture	EPA Requirements (GPM)	Recommended Minimum Performance (GPM)	Anticipated Number to Be Replaced
Shower	2.5	1.5	50
Kitchen	2.2	1.5	50
Bathroom Lavatory	2.0	1.0	50

The recommended actions are predicted to save $1,095 each year, giving this measure an SIR of 1.3.

3.6 Central Heating Plant Upgrade to High Efficiency Condensing Boilers

Existing Condition:

The building is served by two (2) natural draft space heating boilers. Heating water is distributed in a single speed, primary only distribution loop. These boilers provide hot water to perimeter baseboards in the units. Unit baseboards are controlled via in-unit thermostats operating two-way control valves.

The space heating boilers consist of two Weil-McLain boilers. The boilers have the following characteristics:

Boiler Tag	Approximate Year Installed	Input (MBH at Sea Level)	Output (MBH at Sea Level)
B-1	1987	780	632
B-2	1987	780	632

During testing, both boilers fired without issue. Boiler #1 had a full fire efficiency of 83.5%. Boiler #2 had a full fire efficiency of 84.3%. Both boilers had CO readings at a reasonable level.

The heating water distribution is primary only through two parallel constant volume distribution pumps operated when outside air is below 65°F. The heating plant in enabled anytime the outside air is below 60°F. The boiler outside air sensor is located on the north wall beside the mechanical combustion air louver. The pump outside air sensor is located on the north side of the building near the entry door by the mechanical room. Both boilers cycle to maintain a minimum of 160°F supply temperature that increases up to 200°F based on an outside air curve. Temperature begins increasing when outdoor temperatures drop below 7°F, with the maximum temperature reached when outdoor temperatures reach -20°F. The boilers fire independently rather than in a lead/standby arrangement, resulting in both firing intermittently even when there is very little load. Heating fins have been added to some of the exposed piping near the combustion air louver to provide supplemental heating to the mechanical room, and none of the space heating piping has been insulated.

Efficiency Measure:

The boilers have reached their service life expectancy. It is recommended to replace the boiler with two (2) modulating condensing boilers (minimum 5:1 turn down ratio). The new boilers shall be designed so that each can handle 2/3 of peak heating load. Heat loss calculations shall be performed to determine the necessary capacity of the new boilers without oversizing.

New parallel high efficiency pumps shall be installed with variable frequency drives. The new pumps shall be engineered to individually meet the total system flow and pressure requirements. The new pumps shall be controlled to maintain minimum system flows either by utilizing a differential pressure sensor located on the top floor of the building or by utilizing a minimum flow controller. These flows shall be verified by an independent balancer for both part load and full load conditions. The pumps shall be sized for peak efficiency in parallel operation on a design heating day.

A new boiler control system shall be installed to operate the boilers and pumps with the following sequence of control:

> *Enable boilers when the outside air temperature falls below 62 F (adj.). Disable boilers when outside air temperature rises above 65 F (adj.). Stage and modulate boilers using manufacturer's controls to meet the HWST setpoint. System pumps and primary boiler pumps to be controlled by boiler plant controls.*
>
> *The HWST Setpoint shall be reset according to a linear outdoor air reset schedule in which the design hot water temperature, 180 F (Adj.), is delivered at 5 F (Adj.) outside air temperature and lower, and 110 F (Adj.) HWS is delivered at the high outdoor air temperature of 60 F (Adj.). This reset shall be optimized to deliver 110F water at the furthest most radiator.*

The following provides a schematic of the piping layout for the proposed system:
**Note: Actual piping layout and pumping arrangement to be engineered during the design process and confirmed with the boiler manufacturer.*

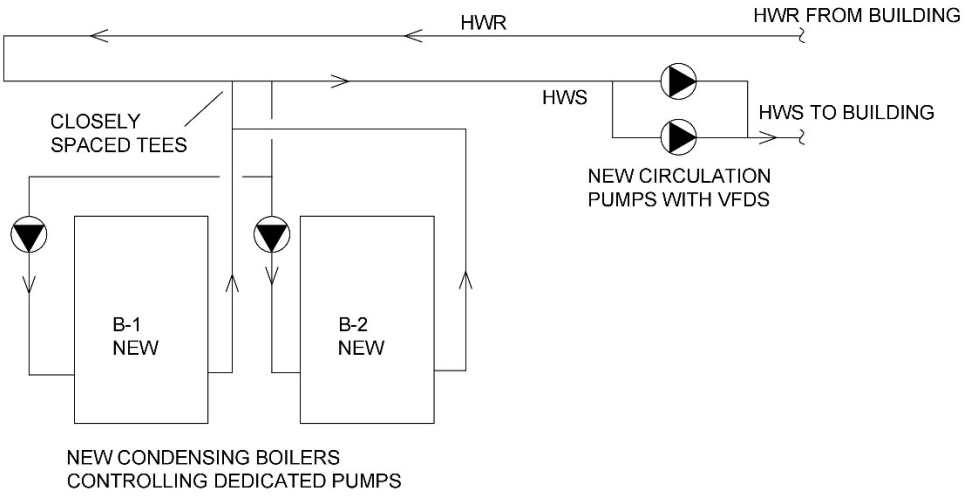


Figure 47 – New Space Heating Boiler Piping Diagram

Combustion air intakes and flues shall be installed for the new condensing boilers and terminated per the manufacturer's recommended installation guidelines. The new condensing boilers shall have ducted combustion air (direct vent) on the north wall of the mechanical room. Once direct vent combustion air is in place, the existing combustion air openings shall be sealed off and insulation shall be added to the exterior wall. If the atmospheric domestic water heaters remain in place, ensure there is still adequate combustion air available for the natural draft appliances.

The contractor needs to confirm the flue termination meets the manufacturer's clearance requirements from all operable windows. The flue should be terminated through the north mechanical room wall if the flue can meet all of the manufacturer's clearance requirements. If these requirements cannot be met, the flue should be routed through the existing vertical flue. Flue paths should be approved by the owner prior to installation.

General Requirements

New condensing boiler plants shall have a minimum of 2 boilers each to aid in the turndown abilities of the plant and to add redundancy (minimum 5:1 turn down ratio).

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 space heating boilers shall be engineered to match the anticipated space heating loads. 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. The new boilers shall include a factory start-up. This factory start-up shall include at least one return trip for the purposes of tuning and optimizing boiler plant operation.
7. Piping and pumping shall meet the following requirements:
    a. The new condensing boilers shall have primary pumps with EC motors capable of varying flow based on delta T. The pump shall start when the associated boiler is called to activate.
    b. One line piping diagram shall be provided to owner prior to ordering any equipment.
    c. Insulate all exposed piping.
8. Provide proper venting for condensing boilers. The combustion air and flues of both the boilers and the water heaters shall be engineered to meet manufacturer's requirements and code. Flue paths should be approved by the owner prior to installation.
9. If applicable, the Contractor shall work with and assist the Owner's Commissioning Agent to commission the plant operation.
10. Install a means of water treatment and hire a qualified firm to flush and treat the both the newly installed components and hydronic heat piping. The means of water treatment installed shall be based on the results of a water quality test conducted by the contractor or it's sub, and be provided to the Owner and CxA for approval.
11. 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.

- 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
- 232123 – HYDRONIC PUMPS
- 235216 – CONDENSING BOILERS
- 262923 – VARIABLE FREQUENCY DRIVES

Improvements to Operations and Maintenance:

New boilers will extend the lifecycle of the plant, and will reduce the number of maintenance and repair work orders in the near future.

Pricing and Site Specific Installation Notes to Contractor:

Price project with current boiler plant size. 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.** Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

The recommended actions for the central plant upgrade to condensing boilers is predicted to save $1,608 each year, giving this measure an SIR of 0.7.

3.7 Domestic Hot Water Plant Upgrade to High Efficiency Condensing Boilers

Existing Condition:

The existing domestic hot water (DHW) is provided by two natural gas, atmospheric Rheem-Ruud packaged water heaters. There is a 1/8 HP DHW recirculation pump that runs constantly. See Appendix B for an existing piping diagram.

Efficiency Measure:

Replace the existing water heaters with two (2) or more condensing domestic water heaters. 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.

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 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 on the east side of the building.

The Contractor shall install, test, and balance the thermostatic mixing valve to temper the domestic hot water to 120°F. The domestic hot water storage tanks should be maintained at 140°F to prevent the risk of Legionella.

Replacement of the DHW recirculation pump should be included in the scope of the upgrade. The new pump shall have an EC motor and be able to automatically adapt its setpoint to adjust to actual system characteristics, sized to meet the calculated pressure loss of the longest piping run. Pressure loss calculations should be submitted with the pump submittal.

The following provides a schematic of the piping layout for the proposed system:
**Note: Actual piping layout to be engineered during the design process.*

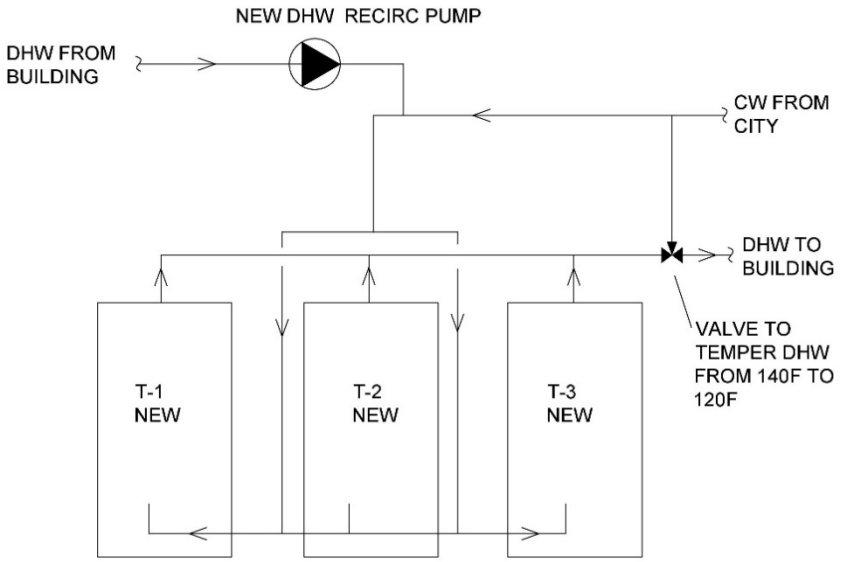


Figure 48 – New Domestic Hot Water Piping Diagram

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 domestic 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 the 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.

The following specifications apply.

- 15514 – DOMESTIC WATER HEATERS
- 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT
- 232123 – HYDRONIC PUMPS
- 235216 – CONDENSING BOILERS
- 262923 – VARIABLE FREQUENCY DRIVES

Improvements to Operations and Maintenance:

A new domestic hot water system will increase the lifecycle of the plant, and will reduce the number of maintenance and repair work orders in the near future.

Pricing and Site Specific Installation Notes to Contractor:

Price project with current boiler plant size. 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.** Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

The recommended actions are predicted to save $582 each year, giving this measure an SIR of 0.6.

3.8 Replace Make-Up-Air Unit (MAU)

Existing Condition:

The building has one (1) make-up air unit located on the roof that provides indirect gas-fired heating with evaporative cooling. The unit was manufactured by Essick Air in 1990. The unit heater is designed to provide a 30 degree temperature rise for approximately 4,400 CFM of ventilation to the hallways, lounge, and laundry room. The unit is designed for 75% combustion efficiency and an input of 375 MBH. Evaporative cooling is provided during the summer months, and the fan is set to operate constantly with heating and cooling controlled from discharge air temperature. The unit was reported to be in operable condition, although the

evaporative cooling medium shows signs of deterioration which could be decreasing ventilation air flow to the building.

Efficiency Measure:

The MAU has surpassed its life expectancy, and the unit is already showing signs of deterioration. It is recommended to replace the unit with a new indirect fired MAUs that includes a high efficiency fan motor and evaporative cooling. The new system shall be designed to meet the current ventilation requirements of the building.

Please consider the following while pricing the project:

1. The new makeup air unit shall be equipped with evaporative cooling and indirect gas fired heating.
2. Once the unit is installed, the airflow shall be balanced to each corridor.
3. Load and ventilation calculations shall also be performed and available for the owner and commissioning agents review.
4. The new system shall be equipped with a VFD to control the fan motor. Program the VFD to supply the scheduled airflow in cooling mode, and during day time in the heating season (6AM-10PM). During the heating season, reduce night time (10PM-6AM) fan air flow to 0.06cfm/sf.
5. It is assumed that the existing supply ductwork does not need to be replaced. Contractor shall examine the ductwork to confirm that there are no issues or leaks in the system.
6. The Contractor shall provide a full and operational system including but not limited to the equipment, dedicated power supplies, supports, anchors, and associated controls.
7. The Contractor shall be responsible for the demolition, removal and proper disposal of all of the existing equipment to be replaced. Any regulated materials shall comply with state and federal regulations.
8. The Contractor shall secure all permits and inspections required for demolition and installation.
9. The Contractor shall work with and assist the Owner's Commissioning Agent to commission the RTU operation as requested.
10. 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.
11. Insulate all exposed existing and new ducting.
12. Contractor should train facility personnel on how to operate the new equipment.

The following specifications apply.

- 237433 – MAKEUP AIR UNITS

Improvements to Operations and Maintenance:

The new equipment will decrease risk of near term failures due to ageing components. Additionally, it will have a higher level of control and reduced energy consumption.

Benefit to Residents:

The units will provide improved ventilation to the hallways, while also maintaining comfort in the common areas.

Pricing and Site Specific Installation Notes to Contractor:

Price project with current MAU size. 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. Contractor will be responsible for issuing a deduction if plant has been reduced significantly in size.

The recommended actions are predicted to save $593 each year, giving this measure an SIR of 0.8.

3.9 Attic Improvements

It is recommended that upgrades to the attic be performed. The attic contains LED can lights which are not covered and did not have a visible ICAT rating, creating a fire hazard. It is recommended that covers be added to these lights. The area around roof access hatch was littered with debris and construction materials which could negatively affect thermal boundary performance at this location. This area is over a residential unit. Considering removing debris.

The recommended actions are predicted to save $6/year, giving this measure an SIR of 0.1.

4 Efficiency Measures Not Recommended

4.1 Increase Attic Insulation

Currently, there are 18" of insulation in the attic, for an overall R-value of R-49. The impact of increasing the insulation level of the attic to R-52, R-55, and R-58 was considered.

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. Must be installed for all insulation measures. Insulation must be installed in such a manner that ensures complete coverage at the thermal boundary, including the access panel and elevator shaft walls, 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.

An increase in attic insulation to R-52 would save $10/year. That measure has an SIR of 0.02.

An increase in attic insulation to R-55 would save $22/year. That measure has an SIR of 0.02.

An increase in attic insulation to R-58 would save $33/year. That measure has an SIR of 0.01.

5 Recommended Health and Safety Measures

5.1 Replace Non-functional or Low Flow Exhaust Fans

As part of the audit, all of the unit exhaust fans were tested for functionality and air flow. Two of the fans had flows so low that they were unreadable. 35 fans, 66% of the total unit exhaust fans, were drawing less than 50 cfm, the code minimum bathroom exhaust airflow. This can create mold and air quality health and safety issues. These fans should be replaced with functioning Energy Star exhaust fans and measured to verify they are removing an appropriate amount of air from the space. Please reference Appendix D for a listing of the specific unit numbers where new exhaust fans should be installed.

Fans are available with efficacies above 13 cfm/W, so it is advised that a fan with an efficacy of at least 10 cfm/W be selected. Exhaust fans should be replaced without change to existing ventilation strategy. If current duct configuration is not code compliant, any issues should be brought to the attention of the owner.

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 Valves

Currently, there is no functioning thermostatic mixing valve on the domestic hot water system, presenting a scald risk to residents. The Contractor shall install, test, and balance a new TMV.

5.3 Attic Improvements

It is recommended that upgrades to the attic be performed. The attic contains LED can lights which are not covered and did not have a visible ICAT rating, creating a fire hazard. It is recommended that covers be added to these lights. The area around roof access hatch was littered with debris and construction materials which could negatively affect thermal boundary performance at this location. This area is over a residential unit. Considering removing debris.

The recommended actions are predicted to save $6/year, giving this measure an SIR of 0.1.

Appendix A – Bid Specifications

SECTION 15514 - DOMESTIC WATER HEATERS

Part 1 - 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: **Lochinvar Shield** 96% efficient water heater 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 (if applicable) 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 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

Part 2 - GENERAL

2.01 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.

2.02 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 3 - PRODUCTS

3.01 General Motor Requirements

A. Comply with NEMA MG 1 unless otherwise indicated.

3.02 Motor Characteristics

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

3.03 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.

3.04 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.

3.05 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 4 - 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

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 5 - 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.**

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 62F (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, 130F (Adj.) HWS is delivered at the high outdoor air temperature, 60F (Adj.) The contractor shall be responsible for tuning these setpoints to provide the minimum HWS while still meeting the loads.

2) The boiler plant controller shall have the ability to provide Domestic Water Heating Prioritization (this function will not be used at this time).

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.
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 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 – MAKE-UP AIR UNIT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. AAON, Reznor, Trane, Carrier, or other approved manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Cabinet Thermal Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
2. Maximum Overall U-Value: **0.10 Btu/h x sq. ft. x deg F (0.57 W/sq. m x deg K)**
3. Include effects of metal-to-metal contact and thermal bridges in the calculations.

B. 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.

C. 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.

D. Capacities and Characteristics:

1. Supply Airflow, external static pressure, and Supply Fan requirements to be engineered to meet code ventilation and system requirements.

2. Overall Unit Electrical Characteristics: Design to match available electrical power.

2.3 CABINET

A. Construction: **Single** 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. 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.

F. Cabinet Insulation:

1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II
2. Thickness: 1 inch (25 mm).
3. Insulation Adhesive: Comply with ASTM C 916, Type I.
4. 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.

G. Condensate Drain Pans: (Not required for heating only system.)

1. Shape: Rectangular, with 1 percent 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 (50 mm) 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.
    c. Minimum Connection Size: NPS 1 (DN 25).

8. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

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

2.4 SUPPLY FAN

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

1. Fan Wheel Material: Galvanized steel, mounted on solid-steel shaft.
2. Bearings: Self-aligning, permanently lubricated ball bearings.

B. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.

1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
4. Fan Enclosure: Easily removable enclosure around rotating parts.
5. Fan Balance: Precision balance fan below 0.08 inch/s (2.0 mm/s) at design speed with filter in.

C. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.

D. 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.

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

2.5 HOT-WATER HEATING COIL

A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.

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.

2.6 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.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.7 FILTERS

A. Cleanable Filters: 2-inch- (50-mm-) thick, cleanable metal mesh.

B. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, viscous-coated, flat-panel type.
3. Minimum Merv: 6, according to ASHRAE 52.2.
4. Media: Interlaced glass fibers sprayed with nonflammable adhesive.

C. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, dry, extended-surface type.
3. Minimum Merv: 7, according to ASHRAE 52.2.
4. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.

D. Extended-Surface, Nonsupported-Media Filters:

1. Comply with NFPA 90A.
2. Factory-fabricated, dry, extended-surface, self-supporting type.
3. Minimum Merv: 13, according to ASHRAE 52.2.
4. Media: Fibrous material constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.

E. 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.

2.8 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. Wiring: Numbered and color-coded to match wiring diagram.

C. Wiring Location: Install factory wiring outside an enclosure in a raceway.

D. 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.

E. Factory-Mounted, Overcurrent-Protection Service: For each motor.

F. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

G. Controls: Factory wire unit-mounted controls where indicated.

H. Lights: Factory wire unit-mounted lights.

I. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.

J. Control Relays: Auxiliary and adjustable time-delay relays.

2.9 CONTROLS

A. Control equipment per the following sequence:
1. Operate make-up air unit continuously. Modulate the heating water valve to maintain a minimum discharge air temperature of 65 deg F.

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. Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:

a. Filter dirty.
b. Fan operating.
c. Cooling operating.

d. Heating operating.
e. Smoke alarm.
f. General alarm.

4. Digital Numeric Display:
   a. Outdoor dry-bulb temperature.
   b. Outdoor dew point temperature.
   c. Supply temperature.

E. 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. (33 L/s per sq. m) at a static-pressure differential of 4.0 inches water column (1000 Pa) when a torque of 5 inch pounds per sq. ft. (30.1 Newton meters per sq. m) 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.
7. Blade Type: Single-thickness metal reinforced with multiple V-grooves.
8. Blade Material: Extruded aluminum.
9. Maximum Blade Width: 6 inches (150 mm).
10. Maximum Blade Length: 48 inches (1200 mm).
11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
12. Bearings: Thrust bearings for vertical blade axles.

F. 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 60 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.

Appendix C – DOE-2 Documentation (Provided Separately)

G. Hot-Water Coil Controls: Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to modulate factory-mounted coil control valve to maintain temperature.

H. Hot-Water Coil Controls: Space-temperature sensor with adjustment on remote-control panel to modulate factory- coil control valve to maintain temperature.

I. Integral Smoke Alarm: Smoke detector installed in supply air.

J. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

1. Hardwired Points:

a. Monitoring: On-off status.
b. Control: On-off operation, supply temperature set-point adjustment.

2. ASHRAE 135 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices per manufacturer’s receommendations.

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. Install separate devices furnished by manufacturer and not factory installed.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Install drain pipes from unit drain pans to sanitary drain.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L (ASTM B 88M, Type B), with soldered joints.

2. 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."

3. 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 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 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 237433

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 50,000 hour warranty, energy star rated.

1. 11W 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.

2. 14W maximum for the replacement of any CFLs higher than 26W and incandescents higher than 75W

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.
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.

D. Adjust aimed lighting fixtures to provide required light intensities.

3.02 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.

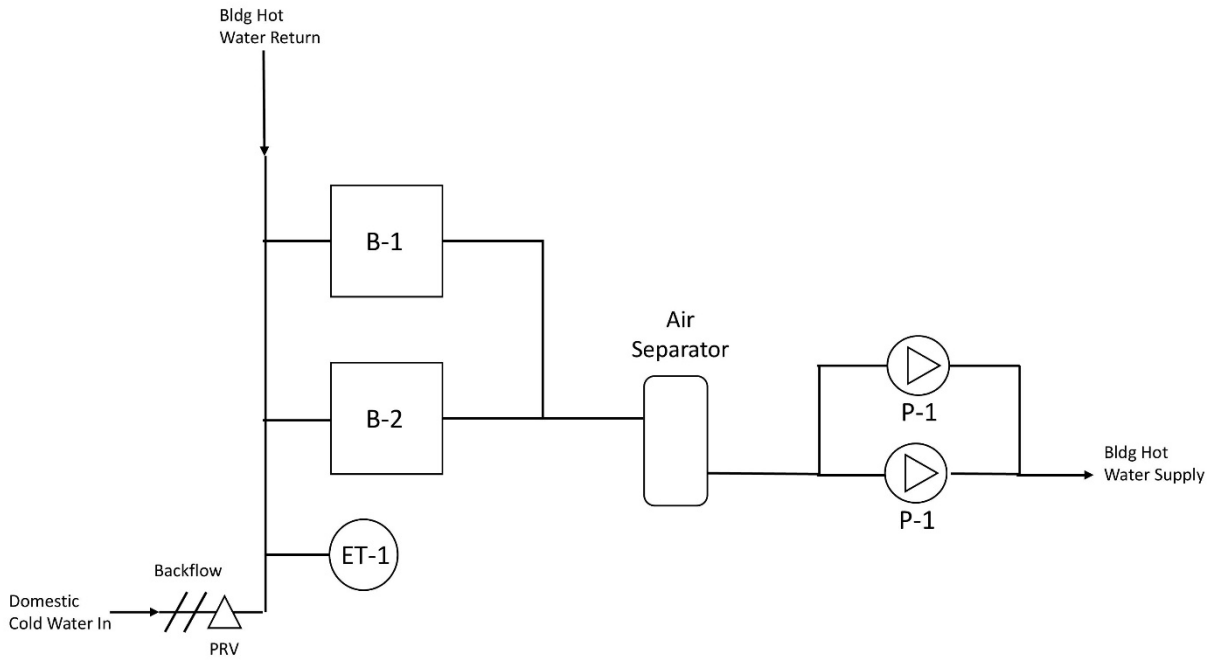
Tag	Fixture Type	Lamp/ Ballast Type	# Lamps /Fixture	# Fixtures	Lamp Watts	Spaces Served	Comments	Recommended Action	Specification guidelines
F1/F2 /F4/ F5/F6	4' ceiling surface mounted	T12, magnetic	2	36	40	Elevator room, community closets, mechanical room, office closet, coordinator's office, community room, laundry, stairwells, elevator, trash room	Fixtures in good condition	Retrofit fixtures	42W LED Retrofit 4', Type C LED tubes and remote driver
F3	4' ceiling surface mounted	T12, magnetic	4	10	40	3rd & 2nd floor common rooms	Fixtures in good condition	Retrofit fixtures	84W LED Retrofit 4', Type C LED tubes and remote driver
I1	Vanity	Incandescent	4	2	60	Restrooms	Fixtures in good condition	Retrofit fixtures	Lamping: (8) 11W LED A19, 2700K
I2	Ceiling surface mounted	Incandescent	1	2	60	Electrical room, community room stove light	Fixtures in good condition	Retrofit fixtures	Lamping: (2) 11W LED A19, 2700K
I3	Track flood lights	Incandescent	3	1	65	1st floor corridor	Fixtures in good condition	Retrofit fixtures	Lamping: (3) 11W LED A19, 2700K
AA	4' ceiling surface mounted	T12, magnetic	4	1	40	Dwelling Unit Kitchen	Fixtures in good condition	Retrofit fixtures	84W LED Retrofit 4', Type C LED tubes and remote driver
MM	Multiple	Incandescent	1/2/3/4	348	40/60	Dwelling Units	Fixtures in good condition	Re-lamp fixtures with screw-in LED lamps	Lamping: (623) 11W LED A19, 2700K
		CFL		114	13				
H1	Flood Light	Halogen	1	1	150	Exterior entrance	Fixtures in good condition	Retrofit fixtures with LED floodlight fixtures	Lamping: 27 W LED flood
M1	10' pole light	Metal halide	1	2	175	Exterior	Fixtures in good condition	Retrofit fixture heads with LED with type IV distribution with integral multi-level motion sensing control	Lamping: 60 W LED, 530 mA, 4000K

M2	15’ pole light	Metal halide	1	5	175	Exterior	Fixtures in good condition	Retrofit fixture with LED retrofit kit and 45W LED bulb	Lamping: 45W LED
M3	Bollard	Metal halide	1	11	70	Exterior	Fixtures in good condition	Replace fixtures	15W LED bollard fixture
M4	Wallpack	Metal halide	1	5	175	Exterior	Fixtures in good condition	Retrofit fixture with LED wall pack	Lamping: 24 W LED, 530 mA, 4000K

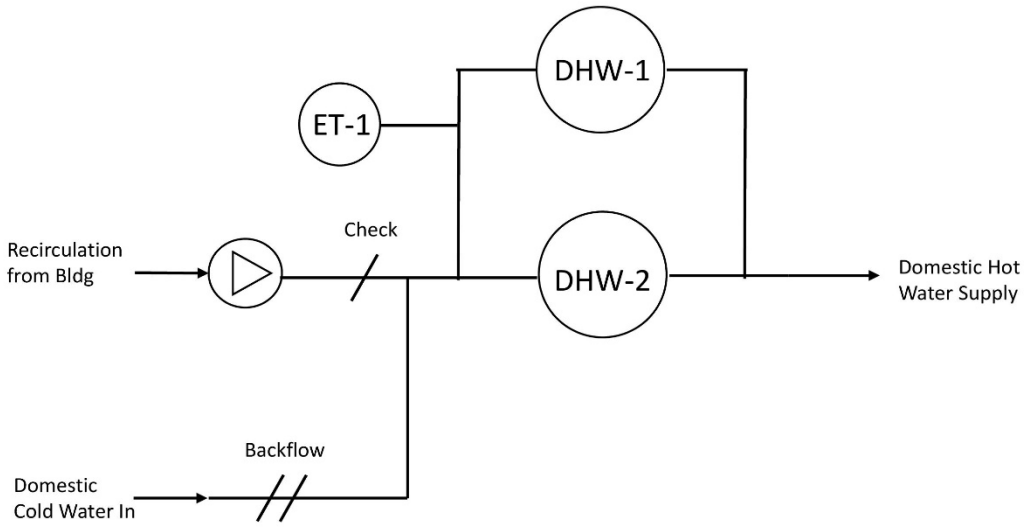
END OF SECTION 26510

Appendix B – System Diagrams

Space Heating System Diagram:



Domestic Hot Water System Diagram:



Appendix D – Auditor Notes (Provided Separately)

Appendix E – Site Photos (Provided Separately)